SAPIENZA
UNIVERSITÀ DI ROMA

Safety of Industrial Plants

Lecture 9
Fire Risk

CORPO NAZIONALE VIGILI DEL FUOCO
NIA
NUCLEO INVESTIGATIVO ANTINCENDI
MELIOR DE CINERE SURGO

Contents and Goals

- Contents
  - Fires and fire risk
  - Classification of fires
  - Fire prevention and protection
  - Standard of reference

- Goals
  - Learning to assess the risk of fire
  - Knowing some antifire plant solutions

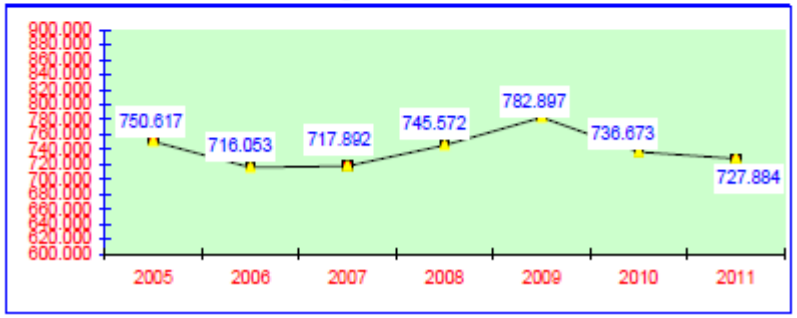
- Professional Figures of reference
  - All

Statistics

INTERVENTI EFFETTUATI DAL CORPO NAZIONALE VV.F.
SUL TERRITORIO ITALIANO
DAL 2005 AL 2011

ANNI	2005	2006	2007	2008	2009	2010	2011
TOT. INT.	750.617	716.053	717.892	745.572	782.897	736.673	727.884

Andamento degli interventi 2011



Statistics

TEMPI MEDI DI INTERVENTO DAL 2009 AL 2011 (Tutte le Categorie)
(Espressi in minuti)

PER AREA TERRITORIALE

	TEMPO MEDIO DI ARRIVO (uscita sede/arrivo sul luogo)			DURATA MEDIA DI INTERVENTO (inizio e chiusura operazioni)		
ANNI DI RIFERIMENTO	2009	2010	2011	2009	2010	2011
CENTRO	15	14	14	42	42	43
ISOLE	12	11	11	56	53	53
NORD	13	12	12	48	48	47
SUD	13	13	13	69	64	54

Statistics

TEMPI MEDI DI INTERVENTO (Categoria A – Incendi)
(Espressi in minuti)

PER AREA TERRITORIALE

	TEMPO MEDIO DI ARRIVO (Uscita Sede/Arrivo sul Luogo)				DURATA MEDIA DI INTERVENTO (Inizio e chiusura operazioni)			
	INCENDIO A SEGUITO RILASCIO DI GAS	*INCENDIO DOVUTO A SCOPPIO*	*INCENDIO NORMALE (GENERICO)*	*SCOPPIO DOVUTO AD INCENDIO*	*INCENDIO A SEGUITO RILASCIO DI GAS*	*INCENDIO DOVUTO A SCOPPIO*	*INCENDIO NORMALE (GENERICO)*	*SCOPPIO DOVUTO AD INCENDIO*
NORD	13	12	12	12	80	90	62	100
CENTRO	14	13	14	27	78	96	53	92
SUD	14	15	14	13	50	111	52	132
ISOLE	12	13	11	10	70	91	48	87

Statistics

INTERVENTI PER LUOGO/MATERIALI COINVOLTI

	COMBUSTIBILI SOLIDI	ALTRI INFIAMMABILI E COMBUSTIBILI GASSOSI E/O SOLIDI	SOSTANZE CHIMICHE	SOSTANZE RADIOATTIVE	MATERIALE DA COSTRUZIONE	MEZZI DI TRASPORTO	NON CONSIDERATO	ALTRI	TOTALE PER LUOGO
AZIENDE AD INDIRIZZO RADIOATTIVO	1	0	0	8	0	0	2	5	16
AZIENDE ALIMENTARI	191	33	8	3	57	22	104	197	615
AZIENDE CON USO SOSTANZE CHIMICHE	32	56	130	1	4	2	41	60	326
AZIENDE DEL LEGNO	632	15	8	0	36	20	83	125	919
AZIENDE DELL'ENERGIA ELETTRICA	138	27	2	1	49	14	101	307	639
AZIENDE DELLA CARTA	184	13	2	0	22	9	35	70	335
AZIENDE DELLA GOMMA E MATERIALI PLASTICI	326	11	13	0	13	3	54	68	488

Statistics

	COMBUSTIBILI SOLIDI	ALTRI INFIAMMABILI E COMBUSTIBILI GASSOSI E/O SOLIDI	SOSTANZE CHIMICHE	SOSTANZE RADIOATTIVE	MATERIALE DA COSTRUZIONE	MEZZI DI TRASPORTO	NON CONSIDERATO	ALTRI	TOTALE PER LUOGO
AZIENDE DI ESPLOSIVI E INFIAMMABILI	9	28	16	0	3	2	10	15	83
AZIENDE DI VESTIARIO	302	16	4	1	57	8	67	151	606
AZIENDE MECCANICHE	328	102	32	21	111	188	188	389	1.359
AZIENDE VARIE	936	120	26	43	284	293	490	685	2.877
DEPOSITI DI ALIMENTARI	141	17	0	0	50	21	64	108	401
DEPOSITI DI ALTRI GENERI	467	36	25	19	83	256	132	258	1.276
DEPOSITI DI CARTA	217	0	0	0	3	4	11	35	270
DEPOSITI DI COMBUSTIBILI SOLIDI	1.104	8	3	17	38	26	54	66	1.316
DEPOSITI DI MATERIALI ELETTRICI	52	4	1	0	12	4	25	60	158
DEPOSITI DI MATERIALI INFIAMMABILI	35	71	32	0	4	5	18	25	190
DEPOSITI DI MATERIALI PLASTICI	193	1	3	0	9	6	15	16	243
EDIFICI A USO PARTICOLARE	2.808	523	97	58	3.902	878	4.762	7.432	20.460

Statistics

	COMBUSTIBILI SOLIDI	ALTRI INFIAMMABILI E COMBUSTIBILI GASSOSI E/O SOLIDI	SOSTANZE CHIMICHE	SOSTANZE RADIOATTIVE	MATERIALE DA COSTRUZIONE	MEZZI DI TRASPORTO	NON CONSIDERATO	ALTRI	TOTALE PER LUOGO
EDIFICI IN GENERE	30.876	11.166	351	28	73.769	5.432	93.640	115.607	330.869
ESERCIZI COMMERCIALI	2.173	450	49	3	1.783	244	2.020	2.967	9.689
IMPIANTI E DEPOSITI COMBUSTIBILI IDROCARBURI GAS	93	477	9	0	35	94	98	164	970
LOCALI DI PUBBLICO SPETTACOLO	499	40	14	2	224	89	451	711	2.030
LOCALITA' AGRICOLE O PER ALLEVAMENTO	57.914	269	32	13	897	1.957	4.093	4.767	69.942
NON CONSIDERATO	1.084	106	10	15	141	269	19.249	1.209	22.083
ZONA DI SOSTA, TRAFFICO E ALTRO	119.782	10.269	393	214	7.541	63.493	27.133	30.899	259.724
TOTALE PER MATERIALE COINVOLTO	**220.517**	**23.858**	**1.260**	**447**	**89.127**	**73.339**	**152.940**	**166.396**	**727.884**

Statistics

CAUSE DEL SINISTRO

INCENDI		59.883	103	23	2.065	75	41	39	608	1.286	64.123
	ALTRE CAUSE	23.727	78	20	834	38	29	17	444	726	25.913
	AUTOCOMBUSTIONE	1.026	2	0	16	0	0	0	3	9	1.056
	CAMINO	10.147	3	0	114	10	0	0	44	195	10.513
	CAUSE ELETTRICHE IN GENERE	12.158	3	1	787	5	10	7	47	173	13.191
	DETONAZIONI E/O DEFLAGRAZIONI	172	3	1	95	12	0	1	3	3	290

	INCENDI	INCIDENTI STRADALI	RECUPERI	STATICA	ACQUA	VARI	AEROPORTI O PORTI	FALSO ALLARME	INTERVENTO NON PIU' NECESSARIO	TOTALE PER CAUSE
FAVILLE	4.393	6	0	39	1	0	0	14	64	4.517
FULMINE	266	1	0	36	7	0	0	1	2	313
FUOCHI D ARTIFICIO	306	0	0	20	1	0	0	2	5	334
GUASTI AD IMPIANTI DI PRODUZIONE E DI CALORE IN GENERE	336	0	0	43	0	2	1	6	12	400
MOZZICONE SIGARETTA E FIAMMIFERI	5.726	4	0	24	1	0	0	20	58	5.833
REAZIONI CHIMICHE TRA ELEMENTI	87	0	0	8	0	0	0	1	0	96
RITORNO DI FIAMMA	168	1	0	8	0	0	0	3	5	185
SURRISCALDAMENTO DI MOTORI E MACCHINE VARIE	1.371	2	1	41	0	0	13	20	34	1.482

Fires and fire hazards

- Fires are uncontrolled combustion phenomena with presence of flame or coals (solid) - characterized by:
  - Destructive power
  - High propagation speed
  - Large temperature gradient

- Fires can have the following origins:
  - Natural/Accidental
    - spontaneous combustion;
    - electrical faults (sparks, arc flash, overload, short circuit, electrostatic discharge);
    - flames (for example, furnaces, welding operations, etc.);
    - chemical processes;
    - mechanical phenomena (friction);
    - thermodynamic phenomena (gas compression)
  - Fire arson

Fires and fire hazards

- A combustion reaction is a chemical reaction of oxidation through which heat and often light and flame develop (due to the emission of volatile combustion products).

- A combustion reaction occurs when there are:
  - Fuel
  - Oxidizer (Oxigen)
  - Ignition (heat)

  ⇒ **FIRE TRIANGLE**

- The most common oxidizer is oxigen, present in the air.

- The Materials are classified in 7 categories in relation to combustion reactivity
  - from “0”, incombustible material
  - up to “6”, highly combustible material

Fires and fire hazards

- The combustible substances have as fundamental elements carbon C, hydrogen H, oxygen O, sulfur S.
- Solid fuels are characterized by:
  - size (mass of fuel)
  - compactness (the presence of air in the mass)
  - humidity (presence of water in the mass)

  In this category the powders are included.

  The powders behave as gas mixtures; based on the size of the particles and to their concentration and humidity, even a reaction of deflagration may occur.

Fires and fire hazards

- Liquid fuels tend to evaporate, and at this stage the combustion occures; the factors that influence the combustion are:
  - the temperature of the liquid
  - the concentration of the vapor in the air

- In the case of gaseous fuels, combustion is influenced by the concentration of gas in air:
  - gases are those substances that are in the gaseous state under normal temperature and pressure. In general, since the gases are very light, depending on their physical properties, they are kept either under pressure at room temperature, or liquefied, in order to be able to use little space for considerable storage.

Fires and fire hazards

- In any case it is necessary to reach

temperature of (spontaneous) ignition or self ignition

which is the lowest temperature that a fuel has to reach to ignite spontaneously without more caloric intake

Fires and fire hazards

- The flash point or the ignition temperature is the lowest temperature at which a liquid emits flammable vapors in such quantity that mixed with the air may be ignited in the presence of a flame.

- Liquid fuels are subdivided into:
  - very flammable liquids (Cat. A) with ignition temperature <21°C
  - flammable liquids (Cat. B) with ignition temperature >21°C e <65°C
  - liquid fuels(Cat. C), divided into fuel oils with ignition temperature >65°C e <125°C and lubricating oils with ignition temperature >125°C

Fires and fire hazards

- Concerning Hydrocarbons, the ignition temperature is the lower the higher is the molecular weight.
- One more important element is the presence of air in certain proportions:
  - if the amount of air is more or less than certain limits, the combustion no longer takes place
- The **lower flammable limit** is the concentration of vapors of a flammable liquid mixed with air, below which there is no ignition
- The **upper flammable limit** is the concentration of vapors of a flammable liquid mixed with air, above which there is no ignition

Fires and fire hazards

fuel	ignition temperature (°C)
gasoline	250
diesel fuel	220
hydrogen	560
pentane	420
wood chips of fir	260
Newsprint	230
cotton sheet	238
matches	163
synthetic rubber	294 – 310
wool blankets	205
wood panels	216 – 230
nitrocellulose	137
nylon	476
rayon	280

Fires and fire hazards

- **The fuels** are chemical fuel substances characterized by a high energy content which is generally in a semi-stable form in normal room conditions.

- The variation of the temperature, in the presence of oxidizer, can determine the rapid release of energy.

Fires and fire hazards

- The **flash point** of a substance - usually a fuel - is the lowest temperature at which a flammable mixture with air can occur:
  - at this temperature the vapor ceases to burn when the ignition source is removed

- At a slightly higher temperature, a point of ignition is defined, at which the vapor continues to burn after being ignited. However, none of these parameters refers to the ignition temperature (spontaneous) of the fuel, which is much higher.

Fires and fire hazards

- More definitions are the following:
  - **combustion temperature** - the maximum temperature that can be achieved in the complete combustion of a fuel
  - **heat of combustion** - amount of heat developed by a gram-atom of solid or liquid substance, or from a gram-molecule of a gaseous substance
  - **calorific power** - heat developed by the unit of mass of solid or liquid substance, or the unit of volume of a gaseous substance
  - **comburivorous power** - theoretical volume of air required for the combustion of the unit of mass or of volume of the combustible substance

Fires and fire hazards

- The development phases of a fire are:
  - ignition, the vapors of flammable substances, solid and liquid, start the combustion process
  - propagation, low temperature and low quantity of fuel involved
  - flash over, sudden rise in temperature and massive increase of the material that participates in the combustion
  - generalized fire, all the material participates in the combustion
  - exhaustion, conclusion of combustion, thanks to the end of the fuel
  - suffocation, conclusion of combustion, thanks to the end of the combustion air
  - cooling phase, post-closing phase of the fire that involves the cooling of the affected area and it is in conjunction with the solidification at the ground of the volatile substances which are heavier than the combustion residues

Fires and fire hazards

- During the combustion process, ash and combustion gases develop in addition to heat and flames
- For the purposes of protection against risks arising from fire is of significant importance to know and study the substances that evaporate in the environment or in the affected areas during the development of combustion:
  - carbon dioxide
  - carbon monoxide
  - hydrogen sulfide
  - sulfur dioxide
  - hydrogen cyanide
  - hydrochloric acid
  - nitrous vapors
  - ammonia
  - acrolein
  - phosgene

Fires and fire hazards

- The **carbon monoxide** is a gas that can be formed in large quantities and it is of great danger. This gas can combine itself with the red blood cells and can replace the oxygen transported by them, causing their death. At each breath, millions of red blood cells die, while the death of the organism occurs in 3 or 4 minutes.

- **Carbon dioxide** can be formed in large quantities and it is a suffucating gas. It causes **an increase of breathing**, for which the body tends to inhale it together with the other gases in the air. More carbon dioxide you inhale, the lowest is the oxygen level in the blood, resulting in numbness and loss of consciousness, death occurs by suffocation.

- **Hydrogen sulfide** is a gas with a characteristic odor of rotten eggs. Prolonged inhalation of air containing this gas can cause dizziness and vomiting. At high concentrations this gas can attack the nervous system causing trouble and then breathing cessation.

Fires and fire hazards

- Ammonia is a gas that can be formed by the combustion of nitrogen containing materials. It is used in some refrigeration systems and in case of escape is a serious risk of poisoning. In high concentrations it produces spasm of the glottis and subsequent suffocation.

- Hydrochloric acid is a gas that is formed by the combustion of materials containing chlorine as the majority of plastics. A concentration of 1,500 ppm may be fatal in a few minutes.

- Acrylic aldehyde is a gas that is formed for the combustion of petroleum-derived materials, fats, oils. Concentrations higher than 10 ppm can be fatal.

Fires and fire hazards

- Phosgene is a gas that is formed following the combustion of materials containing phosphorus. The presence of this gas is to be feared especially in confined areas. Extinguishers with carbon tetrachloride can cause the formation of this gas, therefore after having used them, the environments have to be abandoned .

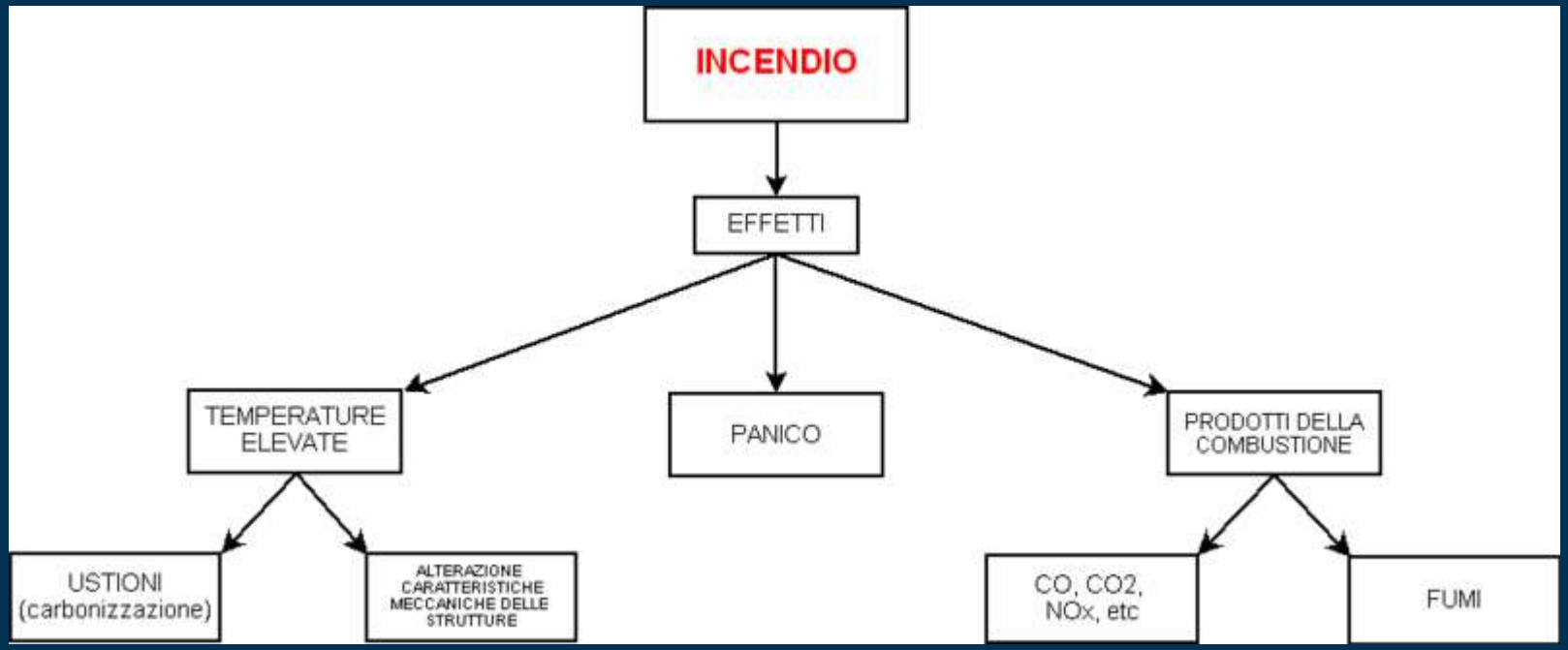
- In general, the combustion products may have effects on living beings, on items and on constructions
  - Concerning the living beings the lethal action is expressed by the toxicity of some compounds, for the lack of oxygen and the action of heat
  - Concerning the materials and the constructions the main effects are due, besides incineration, to corrosion by certain compounds and deformation due to heat.

Fires and fire hazards

- Some characteristics to take into account:
  - speed of the combustion reaction, for high speeds there are **phenomena of explosion**
    - It is not easy to indicate how an explosive reaction differs from a very rapid combustion. In general, it can be said that the explosive phenomenon manifests itself when the waves of propagation of the front flame are such as to induce the oxidation reaction not for transmission of the heat produced by the chemical reaction, but for the compression of adjacent particles; the explosion proceeds with shock waves, at speeds of up to 3500 m / s
    - the burst is the mechanical rupture of a container subject to the pressure of a fluid, unlike the explosion, which is a chemical reaction
  - **specific surface area** of the substance, if for a given mass we increase the surface area of the fuel, the reaction rate will have equivalent effects in terms of ease of ignition.

Fires and fire hazards

- A fire provokes effects of different nature:



Classification of fires

- **Class A:** fires of solids, which are called dry fires
  - combustion can occur in two forms:
    - burning alive with flames
    - slow combustion without flames, but with the formation of glowing embers.
- the recommended extinguishing agent is water (it acts on the heat) but alternatively we can use polyvalent powder extinguishers (they act on oxidation reactions)(A-B-C)

Classification of fires

- **Class B:** fires of solidified hydrocarbons fires or flammable liquids, called fat fires
  - the use of water jet is contraindicated, as it is better to use diffused water jet or spray
  - more extinguishing agents are:
    - multipurpose powders (A-B-C)
    - classified powders (B-C)
    - carbon dioxide (CO2) that "suffocates" the fire
    - the extinguishing foam (it eliminates the oxidizer); it is the best extinguishing agent (it varies depending on the type of substances involved)

Classification of fires

- **Class C: fires of gaseous fuels**
  - they are characterized by a high heat at high temperature, the flame should not go out but it is necessary to reach the upstream valve and close it to prevent it from continuing to release highly flammable gas in the environment with devastating consequences in closed environments (explosion)
  - only fractional jet or spray water is recommended to cool the tubes or the surrounding gas cylinders involved in the fire
  - more extinguishing agents are:
    - multipurpose powders (A-B-C)
    - classified powders (B-C)
    - carbon dioxide is the most effective

Classification of fires

- **Class D: fires of metals**
  - It is quite hard to to extinguish them because of their very high temperature and they require trained personnel and special extinguishing agents
  - The extinguishing agents are different depending on the type of material involved in the fire:
    - in the fires involving aluminum and magnesium, the sodium chloride powder is used
    - all the other extinguishing agents are not recommended (including water) as they may be some reactions with the consequent release of toxic gas or explosion
- It was also considered an additional class, the “E” class, concerning the fires of installations and electrical equipment under voltage (whose specific extinguishing agents are constituted by dielectric powders and carbon dioxide).

Fire prevention and protection

- Risks analysis

$$CI = H * d$$

CI, fire load [kcal/m^2]

H, lower heating value [kcal/kg]

d, density (surface or volume) of combustible material [kg/m^2]

Fire prevention and protection

- **emergency route** (or **escape route**): no obstacles to the flow path that allows people who occupy a building or a room to reach a safe place
- **emergency exit: passage that leads to a safe place**
- **floor exit**: exit that allows people not to be further exposed to the direct risk of the effects of a fire and that can be seen as follows:
  - Exit that directly leads to a safe place
  - Exit that leads to a protected route through which the exit that leads to a safe place can be reached
  - Exit that leads to an external scale
- **safe place**: a place where the people can consider themselves safe from the effects of a fire
- **protected route**: a route characterized by an adequate protection against the effects of a fire which may develop in the remaining part of the building
  - It can be constituted by a protected corridor, by a protected scale or by an external scale

Fire prevention and protection

- **Manual opening devices**, devices of doors installed along exit routes in activities under the control of the firefighters to the aim of obtaining the certificate of fire prevention, when the installation of the above devices are expected
  - devices must be marked CE
  - The installation of the devices is foreseen in the following cases:
    - On the doors of the escape routes if the installation of devices is expected, devices shall be installed at least according to UNI EN 179 or other equivalent standard, in the case that one of the following conditions occurs:
      - The activity is open to the public and the door is used by less than 10 people
      - The activity is not open to the public and the door is used by more than 9 and less than 26 people

Fire prevention and protection

- The installation of the devices is foreseen in the following cases:
  - On the doors of access routes if the installation of devices is expected, devices according to UNI EN 1125 or other equivalent standard, shall be installed in the case that one of the following conditions occurs:
    - The activity is open to the public and the door is used by more than 9 people
    - The activity is not open to the public and the door is used by more than 25 people
    - the places with manufacturing and materials involving explosive hazards and specific fire hazards with more than 5 workers involvedi

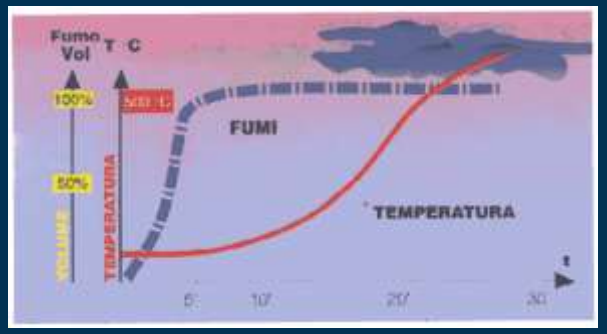
Fire prevention and protection

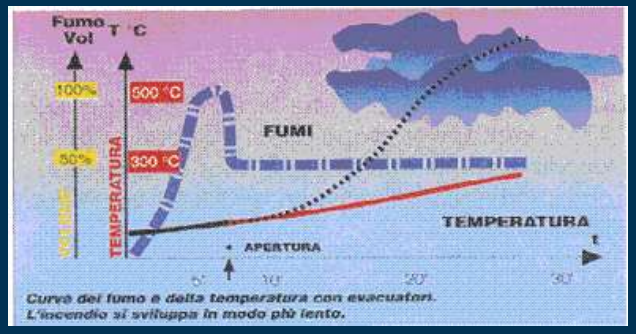
- Heat and smoke evacuators (EFC)

EFC with 1 wing

EFC with 2 wings

EFC with slats



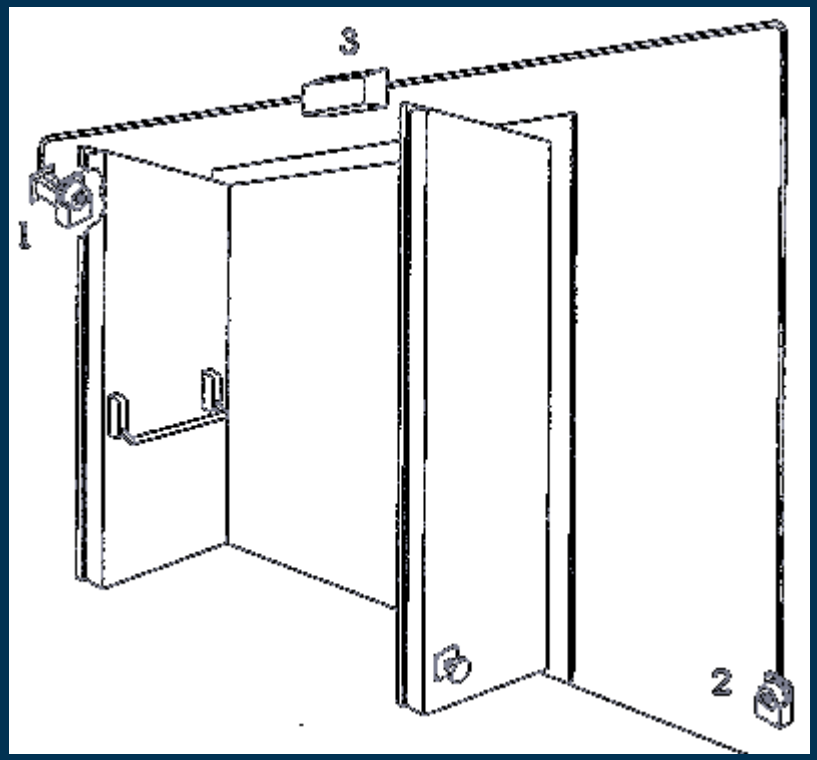


Fire prevention and protection

- Fire dampers

Fire prevention and protection

- Fire interlocked doors



1. **Electromagnet restraint with wall bracket**
2. **Electromagnet restraint**
3. **Single zone controller**

Fire prevention and protection

- The protection measures mainly deal with:
  - Heat
    - It generates an effort on people who are exposed to, decreasing the physical strenght (this is known to the Firefighters while they use the breathing apparatus during fires: the length of the cylinders is much shorter than that used during the simulations)
    - on the structures of the buildings, the heat causes, even at low temperatures, deformations that generate stress, but with increasing temperature the individual bearing elements enter into crisis, with the consequent risk of collapse
      - for disintegration (crumbling of concrete)
      - for reduction of the capacity of resistance of the materials (softening of the steel)
    - the maximum temperature developed in the combustion is not the same for all the substances, but it varies greatly and it is between 1200 ° C of dry wood to 1800 ° C of the oil to 2600 ° C of the acetylene

Fire prevention and protection

- The protection measures mainly deal with:
  - Toxic gases
    - They are the main cause of death in a fire
    - The burn wounds are generally the consequences of an explosion, but in general the victims of the fires are due to the gases developed by the combustion
    - carbon monoxide, hydrochloric acid, nitric acid, phosgene … are very frequent
    - a non-secondary aspect of their action is the attack of structural elements that can determine the crisis even where the heat has not caused excessive damages
      - for example, the combustion of even widespread (insulation of electrical cables) polyvinyl chloride (PVC) gives rise to gas, which attacks the structures and the metal tools, up to the steel reinforcement embedded in the concrete, making them unusable.

Fire prevention and protection

- The protection measures mainly deal with :
  - Smog
    - It causes important dangers for the following reasons:
      - dimming of sight
      - irritation of the eyes
      - disorientation in people escaping from a fire
    - the difference with respect to the gas consists in the fact that the smoke consists of solid particles, very finely divided, that the flows of air and hot gases disperse into the surrounding atmosphere
    - The danger of smoke mainly lies in hiding the escape routes from view and, along with the gas, it is one of the most difficult danger to control as smoke grows rapidly from the early stages of the fire
    - The danger for sight (irritation of the eyes, lachrymation) has not to be overlooked. This danger does exist outdoor too. Therefore, even for the toxic gases, the connected risk has to be taken into account even in the construction sites.

Fire prevention and protection

- The fire behavior of a material depends on:
  - Fire resistance
    - the acronym REI refers to the propensity of a wall or a floor to resist for a certain interval of time, expressed in minutes, ensuring:
      - the bearing capacity (R)
      - smoke seal (E)
      - maintaining acceptable temperatures on the face which is unexposed to fire (I)
    - In the case of beams or pillars only the letter R will be indicated, since a beam does not separate environments and should not limit the passage of fumes or gases, but it is required to ensure the requirements of resistance to stress

Fire prevention and protection

- The fire behavior of a material depends on :
  - Fire resistance
    - Current standardization assigns
      - The value REI 120 to the walls with two heads with plaster, as well as the traditional slabs in brick cement
      - lower values - which by convention are in Classes 15, 30, 45, 60 and 90 – can be found in the reinforced concrete elements according to the thickness of concrete cover

Spessori delle pareti tagliafuoco:

Tipo di parete	spessore minimo escluso l'intonaco				
	15	30	45	60	90
laterizi pieni con intonaco normale	6	13	13	13	26
laterizi pieni con intonaco isolante	6	6	6	13	13
laterizi forati con intonaco normale	6	10	14	20	30
laterizi forati con intonaco isolante	6	6	6	10	10
calcestruzzo normale	8	8	10	10	10

Spessori dei solai:

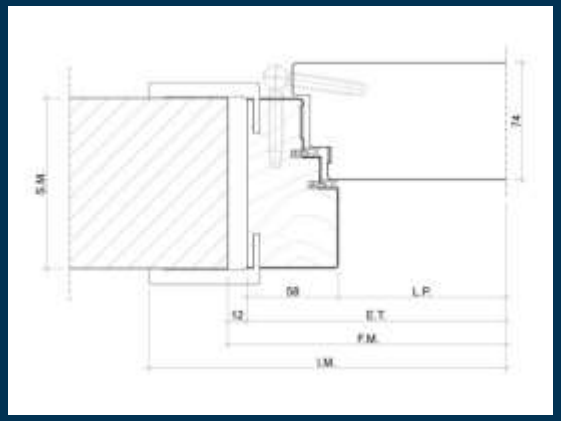
Tipo di solaio	1530456090
soletta in c.a. con intonaco normale (1,5 cm)	1010121416
soletta in c.a. con intonaco isolante (1,5 cm)	1010121414
soletta in c.a. con intonaco isolante (1,5 cm) e con soffitto sospeso	8 8 101212
solaio in laterizio armato con intonaco normale	1616202424
solaio in laterizio armato con intonaco isolante	1414181820
elementi prefabbricati in c.a. con intonaco (1,5 cm)	24

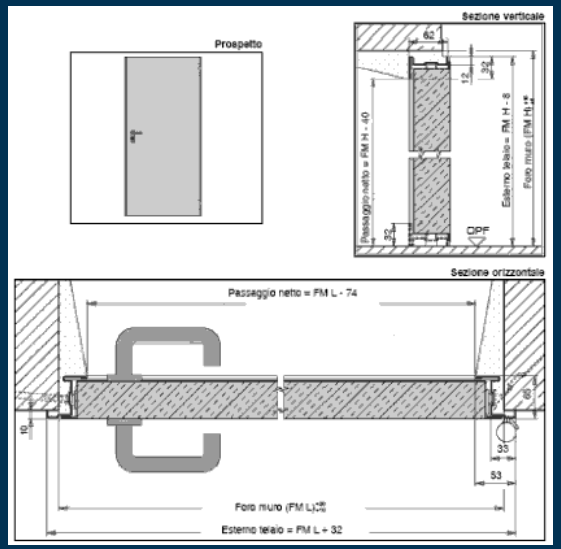
Fire prevention and protection

- The fire behavior of a material depends on :
  - Reactivity

    - Italian regulations (Decree of the Ministry of Interior 26/6/1984) regroup in class zero the noncombustible substances (stone, plaster, metals) and in class 1 the combustible materials that, properly handled, exceed in a very good way the standard tests . The upper classes, accordingly, will indicate a worse behavior
    - it is appropriate to specify that the class of reaction to fire is not on the product itself, as **it relates to its use and its installation**
    - in environments where a small trigger may result in a fire - for example, theaters or hospitals, where also the fire alarm solely may have serious consequences for the people – it is necessary to install coating materials or furniture that, even if subject to small triggers, they do not give rise to fire behavior . These materials have to be self-extinguishing, i.e. for which once removed the trigger , combustion stops

Fire prevention and protection





Fire prevention and protection

- The fire behavior of a material depends on:
  - Reactivity
    - This classification was created to increase safety in public places (a few years before the two tragedies of the cinema Statuto in Turin and in the exhibition of antiques in Todi had taken place)
    - It was later extended to other activities (hotels, schools etc.) with considerable success.
    - It should be noted that in places where there are these products even arson fires fail to develope easily, and they expire soon when the ignition is removed or when it is exhausted

Fire prevention and protection

Fire prevention and protection

- fire detectors
  - Temperature
  - Smoke
  - Brightness
- Portable/mobile fire extinguisher equipment
  - Fire extinguishers
    - Powder extinguishers
    - Chemical foam extinguishers
    - Mechanical foam extinguishers
    - CO_2 extinguishers
- fixed extinguisher plants
  - water spray
  - water jet
  - CO_2 extinguisher plant

Legal references

- The DM 10/3/98 deals with "general criteria of fire safety and emergency management in the workplaces"
  - in implementing the provisions of the former Legislative Decree 626/94, the decree sets:
    - the criteria for the fire risks assessment in the workplaces
    - fire prevention and protection measures to be adopted

Legal references

- DM 10/3/98
  - in the risk assessment report the employer shall assess the level of risk of fire in the workplace and, where appropriate, of individual parts of the same place, by classifying this level in one of the following categories, in accordance with the criteria of the “Annex I”:
    - High risk
    - Medium risk
    - Low risk

Legal references

A) LUOGHI DI LAVORO A RISCHIO DI INCENDIO BASSO

Si intendono a rischio di incendio basso i luoghi di lavoro o parte di essi, in cui sono presenti sostanze a basso tasso di infiammabilità e le condizioni locali e di esercizio offrono scarse possibilità di sviluppo di principi di incendio ed in cui, in caso di incendio, la probabilità di propagazione dello stesso è da ritenersi limitata.

9.4 - ATTIVITÀ A RISCHIO DI INCENDIO BASSO

Rientrano in tale categoria di attività quelle non classificabili a medio ed elevato rischio e dove, in generale, sono presenti sostanze scarsamente infiammabili, dove le condizioni di esercizio offrono scarsa possibilità di sviluppo di focolai e ove non sussistono probabilità di propagazione delle fiamme.

La formazione dei lavoratori addetti in tali attività deve essere basata sui contenuti del corso A.

CORSO A: CORSO PER ADDETTI ANTINCENDIO IN ATTIVITÀ A RISCHIO DI INCENDIO BASSO (DURATA 4 ORE)

Legal references

B) LUOGHI DI LAVORO A RISCHIO DI INCENDIO MEDIO

Si intendono a rischio di incendio medio i luoghi di lavoro o parte di essi, in cui sono presenti sostanze infiammabili c/o condizioni locali e/o di esercizio che possono favorire lo sviluppo di incendi, ma nei quali, in caso di incendio, la probabilità di propagazione dello stesso è da ritenersi limitata. Si riportano in allegato IX, esempi di luoghi di lavoro a rischio di incendio medio.

9.3 - ATTIVITÀ A RISCHIO DI INCENDIO MEDIO

A titolo esemplificativo e non esaustivo rientrano in tale categoria di attività:

a) i luoghi di lavoro compresi nell'allegato al D.M. 16 febbraio 1982 e nelle tabelle A e B annesse al D.P.R. n. 689 del 1959, con esclusione delle attività considerate a rischio elevato;

b) i cantieri temporanei e mobili ove si detengono ed impiegano sostanze infiammabili e si fa uso di fiamme libere, esclusi quelli interamente all'aperto.

La formazione dei lavoratori addetti in tali attività deve essere basata sui contenuti del corso B.

CORSO B: CORSO PER ADDETTI ANTINCENDIO IN ATTIVITÀ A RISCHIO DI INCENDIO MEDIO (DURATA 8 ORE).

Legal references

C) LUOGHI DI LAVORO A RISCHIO DI INCENDIO ELEVATO

Si intendono a rischio di incendio elevato i luoghi di lavoro o parte di essi, in cui:

- per presenza di sostanze altamente infiammabili e/o per le condizioni locali e/o di esercizio sussistono notevoli probabilità di sviluppo di incendi e nella fase iniziale sussistono forti probabilità di propagazione delle fiamme, ovvero non è possibile la classificazione come luogo a rischio di incendio basso o medio.

Tali luoghi comprendono:

- aree dove i processi lavorativi comportano l'utilizzo di sostanze altamente infiammabili (p.e. impianti di verniciatura), o di fiamme libere, o la produzione di notevole calore in presenza di materiali combustibili;

- aree dove c'è deposito o manipolazione di sostanze chimiche che possono, in determinate circostanze, produrre reazioni esotermiche, emanare gas o vapori infiammabili, o reagire co altre sostanze combustibili; aree dove vengono depositate o manipolate sostanze esplosive altamente infiammabili;

- aree dove c'è una notevole quantità di materiali combustibili che sono facilmente incendiabili;

- edifici interamente realizzati con strutture in legno.

Al fine di classificare un luogo di lavoro o una parte di esso come avente rischio di incendio elevato occorre inoltre tenere presente che:

a) molti luoghi di lavoro si classificano della stessa categoria di rischio in ogni parte. Ma una qualunque area a rischio elevato può elevare il livello di rischio dell'intero luogo di lavoro, salvo che l'area interessata sia separata dal resto del luogo attraverso elementi separanti resistenti al fuoco;

b) una categoria di rischio elevata può essere ridotta se il processo di lavoro è gestito accuratamente e le vie di esodo sono protette contro l'incendio;

c) nei luoghi di lavoro grandi o complessi, è possibile ridurre il livello di rischio attraverso misure di protezione attiva di tipo automatico quali impianti automatici di spegnimento, impianti automatici di rivelazione incendi o impianti di estrazione fumi.

Vanno inoltre classificati come luoghi a rischio di incendio elevato quei locali ove, indipendentemente dalla presenza di sostanze infiammabili e dalla facilità di propagazione delle fiamme, l'affollamento degli ambienti, lo stato dei luoghi o le limitazioni motorie delle persone presenti, rendono difficoltosa l'evacuazione in caso di incendio.

Legal references

9.2 - ATTIVITÀ A RISCHIO DI INCENDIO ELEVATO

La classificazione di tali luoghi avviene secondo i criteri di cui all'allegato I al presente decreto.

A titolo esemplificativo e non esaustivo si riporta un elenco di attività da considerare ad elevato rischio di incendio:

a) industrie e depositi di cui agli articoli 4 e 6 del DPR n. 175/1988, e successive modifiche ed integrazioni;

b) fabbriche e depositi di esplosivi;

c) centrali termoelettriche;

d) impianti di estrazione di oli minerali e gas combustibili;

e) impianti e laboratori nucleari;

f) depositi al chiuso di materiali combustibili aventi superficie superiore a 20.000 m2

g) attività commerciali ed espositive con superficie aperta al pubblico superiore a 10.000 m2 ;

h) scali aeroportuali, infrastrutture ferroviarie e metropolitane;

i) alberghi con oltre 200 posti letto;

l) ospedali, case di cura e case di ricovero per anziani;

m) scuole di ogni ordine e grado con oltre 1000 persone presenti;

n) uffici con oltre 1000 dipendenti;

o) cantieri temporanei o mobili in sotterraneo per la costruzione, manutenzione e ripara ione di gallerie, caverne, pozzi ed opere simili di lunghezza superiore a 50 m;

p) cantieri temporanei o mobili ove si impiegano esplosivi.

I corsi di formazione per gli addetti nelle sovrariportate attività devono essere basati sui contenuti e durate riportate ne corso C.

CORSO C: CORSO PER ADDETTI ANTINCENDIO IN ATTIVITÀ A RISCHIO DI INCENDIO ELEVATO (DURATA 16 ORE)

Legal references

Tipo di estintore	Superficie protetta da un estintore		
	Rischio basso	Rischio medio	Rischio elevato
13 A – 89 B	100 m^2		
21 A – 113 B	150 m^2	100 m^2	
34 A – 144 B	200 m^2	150 m^2	100 m^2
55 A – 223 B	250 m^2	200 m^2	200 m^2

a) ogni luogo di lavoro deve disporre di vie di uscita alternative, ad eccezione di quelli di piccole dimensioni o dei locali a rischio di incendio medio o basso;

b) ciascuna via di uscita deve essere indipendente dalle altre e distribuita in modo che le persone possano ordinatamente allontanarsi da un incendio;

c) dove è prevista più di una via di uscita, la lunghezza dei percorso per raggiungere la più vicina uscita di piano non dovrebbe essere superiore ai valori sottoriportati:

- 15 ÷ 30 metri (tempo max. di evacuazione 1 minuto) per aree a rischio di incendio elevato;

- 30 ÷ 45 metri (tempo max. di evacuazione 3 minuti) per aree a rischio di incendio medio,

- 45 ÷ 60 metri (tempo max. di evacuazione 5 minuti) per aree a rischio di incendio basso.

e) i percorsi di uscita in un'unica direzione devono essere evitati per quanto possibile.

Qualora non possano essere evitati, la distanza da percorrere fino ad una uscita di piano o fino al punto dove inizia la disponibilità di. due o più vie di uscita, non dovrebbe eccedere in generale i valori sottoriportati:

- 6 ÷ 15 metri (tempo di percorrenza 30 secondi) per aree a rischio elevato;

- 9 ÷ 30 metri (tempo di percorrenza 1 minuto) per aree a rischio medio

- 12 ÷ 45 metri (tempo di percorrenza 3 minuti) per aree a rischio basso'

Legal references

Per i luoghi a rischio di incendio medio o basso, la larghezza complessiva delle uscite di piano deve essere non inferiore a:

$$L\ (\text{metri}) = \frac{A}{50} \times 0{,}60$$

in cui.

- "A " rappresenta il numero delle persone presenti al piano (affollamento);

- il valore 0,60 costituisce la larghezza (espressa in metri) sufficiente al transito di una persona (modulo unitario di passaggio);

- 50 indica il numero massimo delle persone che possono defluire attraverso un modulo unitario di passaggio, tenendo conto del tempo di evacuazione.

Il valore del rapporto A/50, se non è intero, va arrotondato al valore intero superiore.

La larghezza delle uscite deve essere multipla di 0,60 metri, con tolleranza del 5%.

Legal references

- DM 10/3/98
  - maintenance interventions and controls on the plants and on fire protection equipment are carried out in compliance with the laws and standards of good practice in force
  - Further to the outcome of the fire risks assessment , the employer shall take the necessary organizational and management measures to be implemented in the event of fire. These measures have to be included in an **emergency plan** drawn up in accordance with the criteria set out in **Annex VIII**
  - In the workplaces where there are less than 10 employees, the employer is not required to prepare the emergency plan, anyhow, it is necessary to adopt and implement all the necessary organizational and management measures in case of fire

Legal references

8.1 - GENERALITÀ

In tutti i luoghi di lavoro dove ricorra l'obbligo di cui all'art. 5 del presente decreto, deve essere predisposto e tenuto aggiornato un piano di emergenza, che deve contenere nei dettagli:

a) le azioni che i lavoratori devono mettere in atto in caso di incendio;

b) le procedure per l'evacuazione del luogo di lavoro che devono essere attuate dai lavoratori e dalle altre persone presenti;

c) le disposizioni per chiedere l'intervento dei vigili dei fuoco e per fornire le necessarie informazioni al loro arrivo;

d) specifiche misure per assistere le persone disabili.

Il piano di emergenza deve identificare un adeguato numero di persone incaricate di sovrintendere e controllare l'attuazione delle procedure previste.

Legal references

8.2 - CONTENUTI DEL PIANO DI EMERGENZA

I fattori da tenere presenti nella compilazione dei piano di emergenza e da includere nella stesura dello stesso sono:

- le caratteristiche dei luoghi con particolare riferimento alle vie di esodo;

- il sistema di rivelazione e di allarme incendio;

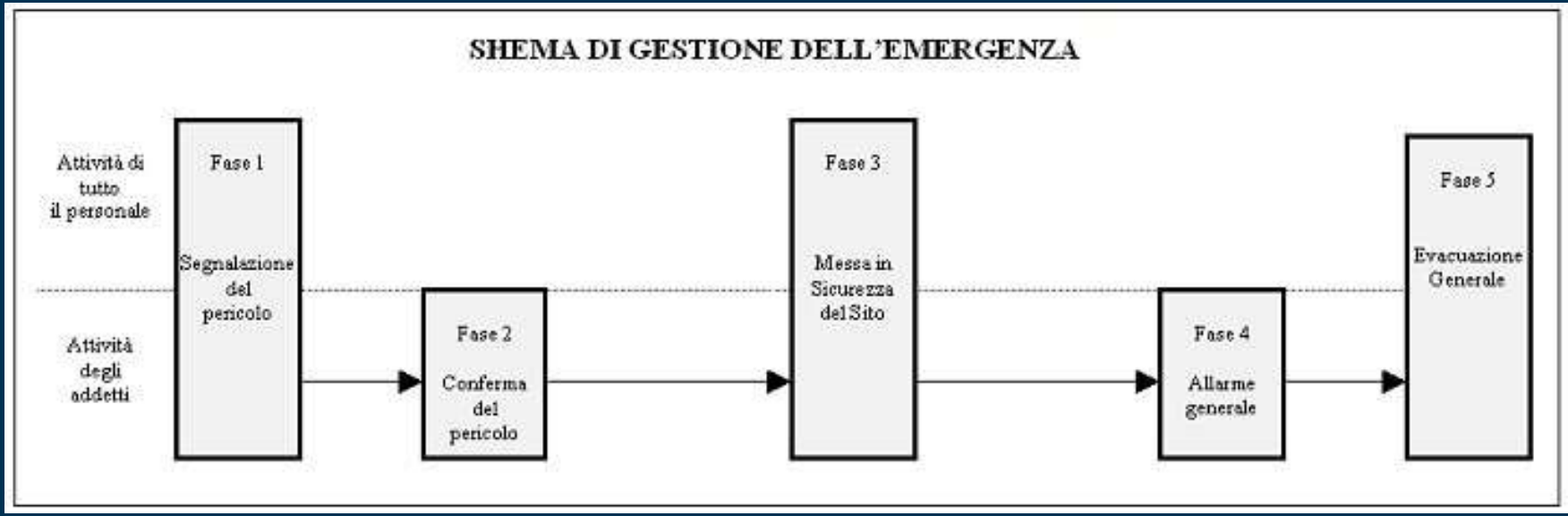
- il numero delle persone presenti e la loro ubicazione;

- i lavoratori esposti a rischi particolari;

- il numero di addetti all'attuazione ed al controllo del piano nonché all'assistenza per l'evacuazione (addetti alla gestione delle emergenze, evacuazione, lotta antincendio, pronto soccorso);

- il livello di informazione e formazione fornito ai lavoratori.

Legal references



Legal references

INDICE:

ALLEGATI:

Legal references

- DM 10/3/98
  - Further to the outcome of the fire risks assessment and on the basis of the emergency plan, if it is foreseen, the employer designates one or more workers responsible for fire prevention, fire fighting and emergency management
  - employers provide training of workers involved in fire prevention, fire fighting and emergency management as foreseen in **Annex IX**
  - All the workers designated to operate in the workplaces where the activities are carried out in Annex X ("dangerous" places and Seveso Directive), have to obtain the certificate of technical idoneity (Law 609/96)

Legal references

- **DPR 151/2011 (former DPR 37/98)** governs the procedures for reviewing safety conditions for fire prevention which is attributed, in accordance with current law, to the jurisdiction of the provincial command of the firefighters, for the relative phases
  - To the review of the projects
  - To the investigations in site
  - To the exercise of the activities under control
  - To the approval of the exceptions to the rules of compliance

- All the activities subject to inspections and monitoring of fire prevention in Annexes I and II of DPR 151/2011 are included.

- The formalities required for the major hazard industrial activities subject to the discipline of the notification are excluded from the scope of the regulation.

Legal references

- DPR 151/2011
  - All the activities subject to fire prevention are divided into three categories, A, B, C, based on the assumptions of simplicity of the structure
    - Category A: the firefighters do not assess the projects in advance
    - categories B and C: The organizations and the individuals responsible for the activities, are required to apply to the firefighter command not only for the assess of the projects for new installations or buildings but also the projects which amend the existing ones, entailing an increase of pre-existing conditions of fire safety.
    - Then, we can begin the activity by presenting to the firefighter command the certified reporting of activity beginning

Legal references

- DPR 151/2011
  - All the activities subject to fire prevention are divided into three categories, A, B, C, based on the assumptions of simplicity of the structure.
    - Categories A and B, the firefighter command, within 60 days, makes the necessary controls. The controls are arranged by sampling basis or on the basis of sectoral programs, by type of activities, or in situations of potential, reported or detected danger.
    - The firefighter command, upon the request of the person interested, in case of success, issues a copy of the minutes of the technical visit, and no longer the Certificate.
    - Category C, the firefighter command, within 60 days, makes the necessary controls. Within 15 days from the technical inspections, in case of success, issues **the fire prevention certificate**.

Legal references

- DPR 151/2011
  - All the activities subject to fire prevention are divided into three categories, A, B, C, based on the assumptions of simplicity of the structure.
    - The organizations and the individuals responsible for the activities, with reference to Annex 1, categories B and C, may ask to the firefighter command the preliminary examination of the feasibility of the projects of particular complexity, in view of the delivering of the authorization of feasibility.
    - The organizations and the individuals responsible for the activities, with reference to Annex 1 may ask to the firefighter command the technical inspections which have to be performed during the realization of the activity.

Legal references

- DPR 151/2011
  - All the activities subject to fire prevention are divided into three categories, A, B, C, based on the assumptions of simplicity of the structure.
    - The request of periodic renewal of fire compliance that, each five years, the holder of the activities listed in Annex I is required to send to the firefighter command, is made through a statement certifying that no changes have occurred to the previous conditions.
    - The organizations and the individuals responsible for the activities, with reference to Annex 1, have to maintain the systems, the devices, the equipment and all the adopted safety measures efficient. They also have to make control inspections and maintenance interventions in accordance with the established period of toime indicated by the firefighter command in the prevention certificate or when issuing the receipt following the submission of the SCIA
    - Controls, inspections and maintenance interventions have to be recorded in a register by responsible persons.
    - This register must be kept updated and made available for the purpose of the controls pertaining to the firefighter command.

Legal references

- **L 818/84**
  - For approval of a project or issuance of the fire prevention certificate, the provincial firefighter command may require certificates issued by institutions, laboratories or professionals who have been **authorized and registered in special lists of the Ministry of the Interior**
  - The provisional authorization - lasting no more than three years - issued by an engineer registered in the list of the Ministry of the Interior no longer exists (Decree 29 December 2005).

Legal references

Segnali di soccorso

	Descrizione
	Percorso uscita di emergenza
	Direzione da seguire (Segnali di informazione addizionali ai pannelli che seguono)
	Pronto Soccorso
	Barella
	Doccia di sicurezza
	Lavaggio per occhi
	Telefono per salvataggio e pronto soccorso

Legal references

Segnali di pericolo

	Descrizione
	Soggetto all'esplosione divisioni 1.1,1.2 e 1.3
	Soggetto all'esplosione divisione 1.4
	Soggetto all'esplosione divisione 1.5
	Pericolo di esplosione
	Gas non infiammabile e non tossico (la bombola può essere di colore bianco)
	Materie liquide infiammabili (la fiamma può essere di colore bianco)
	Spontaneamente infiammabile
	Pericolo d'incendio materie solide infiammabili
	Pericolo di emanazione di gas infiammabili a contatto (la fiamma può essere di colore bianco)
	Pericolo di attivazione di un incendio
	Materia comburente

Legal references

Segnali antincendio

	Descrizione
	Lancia antincendio
	Scala
	Estintore
	Telefono per gli interventi antincendio
	Direzione da seguire (Cartello da aggiungere a quelli che precedono)

Legal references

Gas con colorazione individuale e Formula chimica	Vecchia colorazione		Nuova colorazione	
Acetilene (C_2H_2)		Ogiva Arancione		Ogiva Marrone rossiccio
Azoto (N_2)		Ogiva Nero		Ogiva Nero
Ossigeno (O_2)		Ogiva Bianco		Ogiva Bianco

Legal references