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Safety village

Analisi del Rischio incendio

Padova 23 ottobre 2024

Ing. Fabio Dattilo

La nostra quotidianità

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Nuovi o modificati pericoli di incendio

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Ora facciamo un pò gli Ingegneri!!! Quali parametri ci interessano nei vari incendi? Come li modelliamo?

Esplosioni

Aumento della pressione istantanea in punto dello spazio attiguo alla esplosione

Incendi

Andamento delle temperature nel tempo e nello spazio

Esplosioni/incendi

Produzione e rilascio di sostanze tossiche nelle spazio e nel tempo

SCENARI DI INCENDI, ALL'APERTO O AL CHIUSO

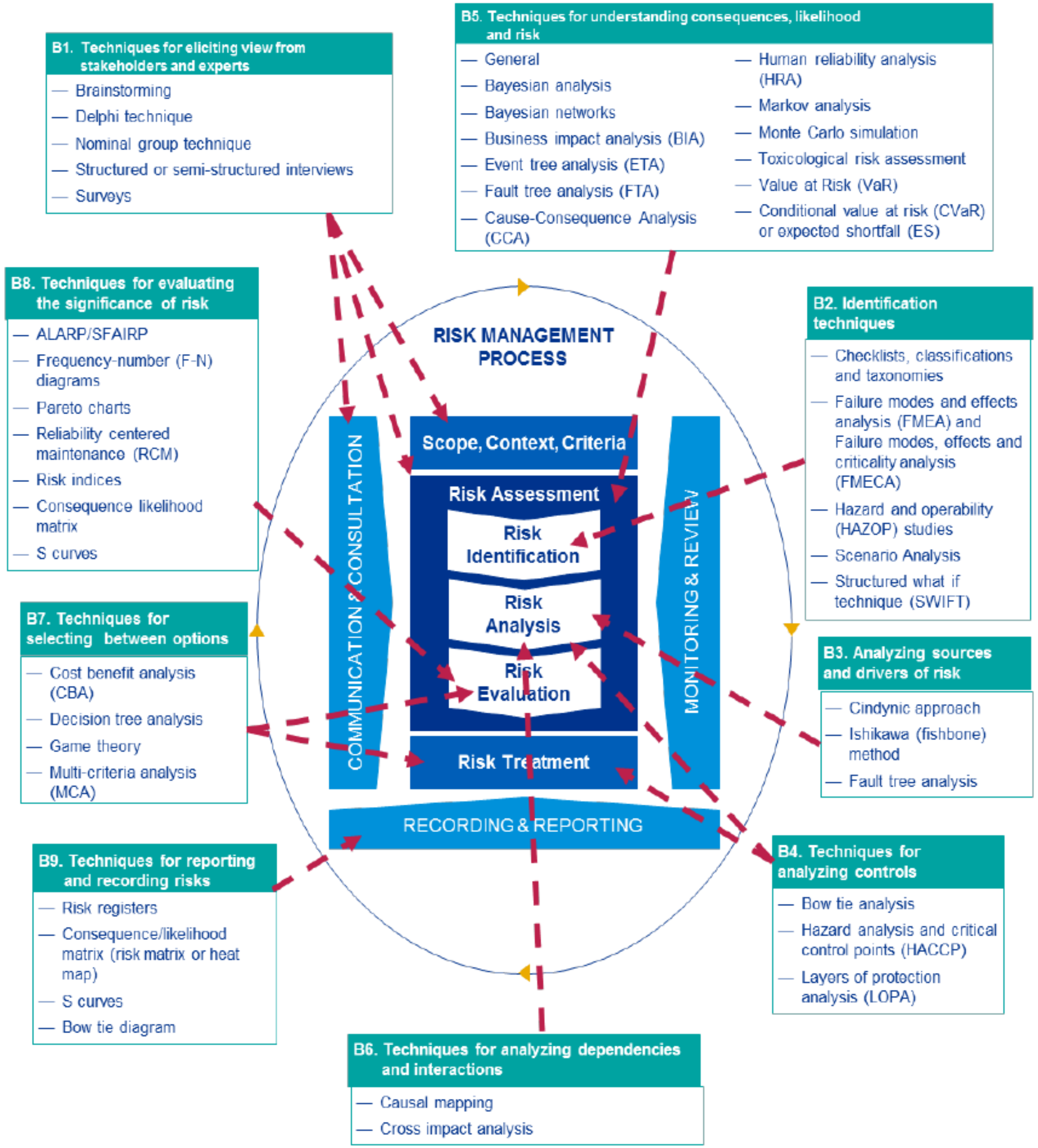
SCENARI DI ESPLOSIONI ALL'APERTO O AL CHIUSO

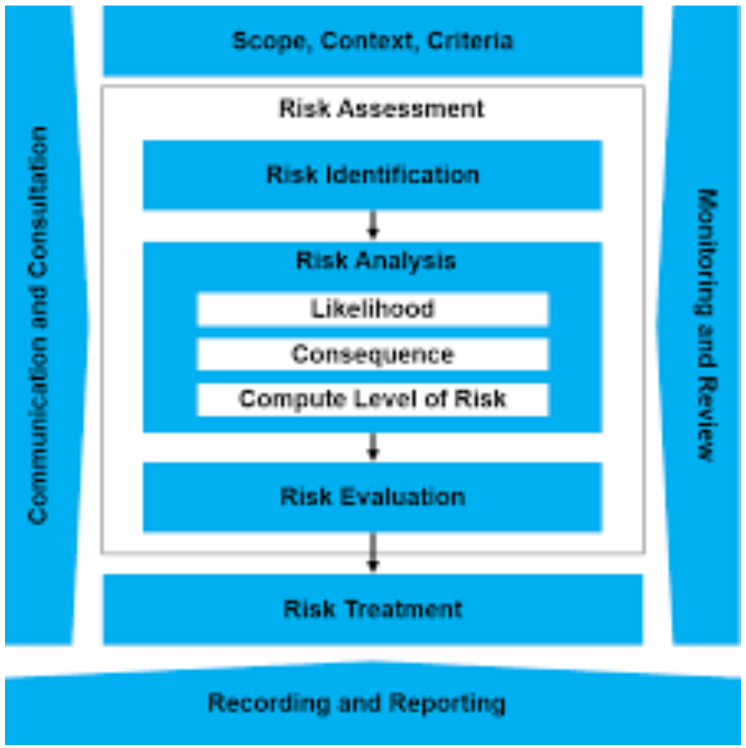
SCAMBI TERMICI CON I CONTENITORI, LE STRUTTURE ECC

ESTENSIONE E CONCENTRAZIONE DI FUMI E SOSTANZE PERICOLOSE ALL'APERTO ED AL CHIUSO.

Risk analysis

ISO/EN 31010





RISK ASSESSMENT

01

RISK IDENTIFICATION

This section presents some methodologies generally used in the preliminary identification phase of hazards while remaining their applicability (more or less recommended) to the other phases of the "risk assessment“.

02

RISK ANALYSIS

This section presents some methodologies generally used in the risk analysis phase while remaining their applicability to the other phases of the risk assessment. Since risk analysis activities generally require a "quantitative" approach, a number of methods have been selected, which allow for numerical insights, including, possibly as a deepening of initial qualitative studies such as HAZID and HAZOP.

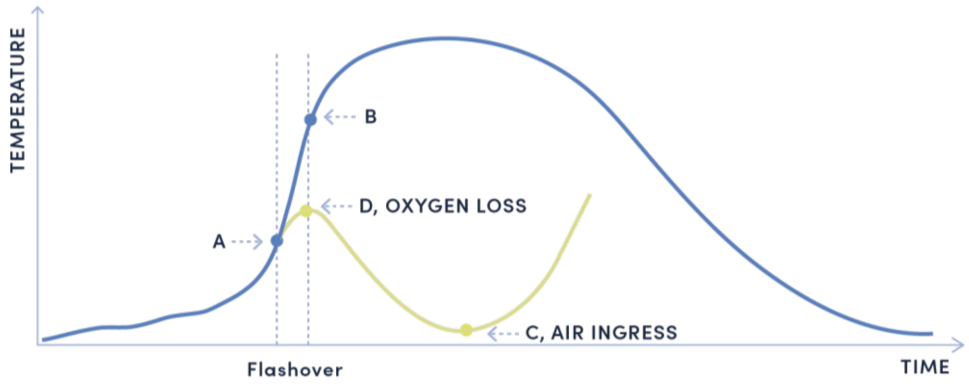
03

RISK EVALUATION

Thanks to "risk evaluation", the level of risk obtained through the previous analysis phase is translated into indices or values that can be compared with the thresholds of acceptability and tolerability defined at the preliminary stage together with the objectives of the analysis and the general objectives of the organization, in order to determine whether the risk can be accepted (and therefore be found in the context of continuous improvement), tolerated (and therefore falls into the so-called ALARP region) or whether it should be treated further.

FIRE IN COMPARMENTS

A fire in a **confined space** (e.g. a room or compartment) can develop in a multitude of different ways, mainly depending on the geometry of the compartment, the type of ventilation and combustible material present and the size and type of surface.



FIRE ENERGY IN COMPARMENTS

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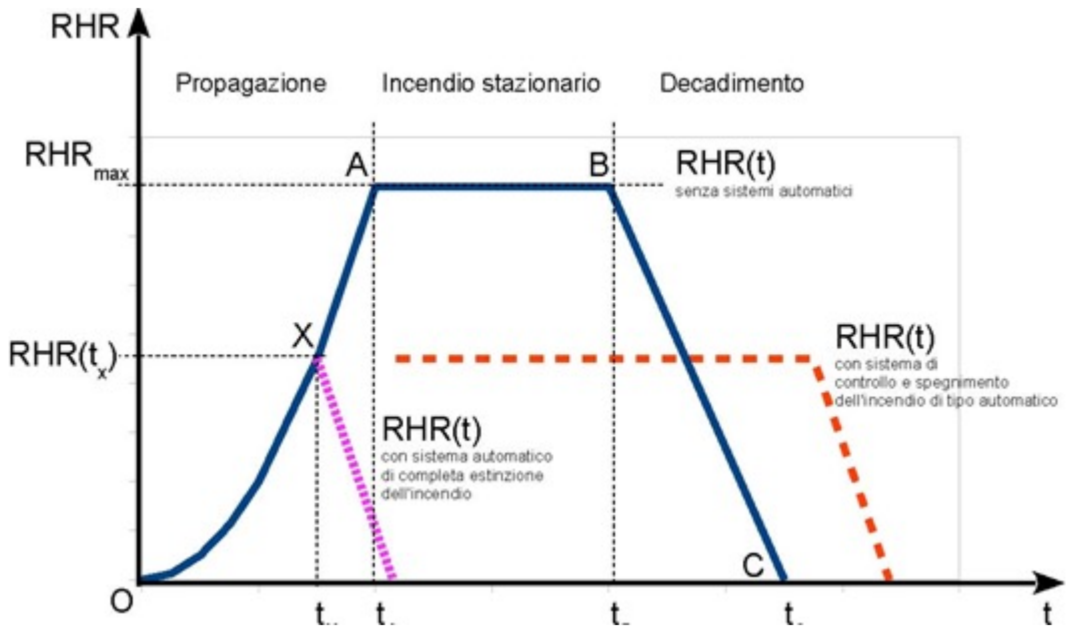
A fire in a **confined space** (e.g. a room or compartment) can develop in a multitude of different ways, mainly depending on the geometry of the compartment, the type of ventilation and combustible material present and the size and type of surface.

Heat release rate

In fase iniziale
RHR (**t**) = a · ***t*2**

t_α = 300 s (Medio)
t_α = 150 s (Rapido)
t_α = 75 s (Ultra-rapido)



I MODELLI.. QUALE SCELGO?

Modelli analitici
Metodo di Thomas (flashover), metodo di Heskestad e Hasemi (*incendi localizzati, temperatura dei gas sotto certe condizioni*)

Modelli numerici a zone
Fase pre-flashover (*strato di gas caldi superiore e strato di aria fresca inferiore*)
Es.: CFAST, Ozone

Modelli numerici di campo
Fase pre e post-flashover, risolvendo le equazioni di Navier-Stokes.
Es.: CFX, FDS, Fluent

Modelli di simulazione dell'esodo
Strumenti avanzati, internazionalmente riconosciuti, la cui validazione è però tuttora oggetto di studio da parte della comunità scientifica

Modelli di movimento
Il moto degli occupanti segue sostanzialmente le leggi dell'idraulica

Modelli semi-comportamentali (FDS+Evac)
Il comportamento viene inserito indirettamente per i singoli occupanti (funzioni di probabilità, tempi di reazione, familiarità con le vie di esodo)

Modelli comportamentali (MassMotion)
Più complessi nella definizione del moto avviato dagli utenti

Modelli fine network (FDS+Evac, Pathfinder, Building Exodus)
Il dominio nel quale si muovono gli utenti è una mesh bidimensionale (piana o inclinata)

Modelli coarse network (Building Exodus)
Lo spazio è suddiviso in aree (stanze, corridoi) che contengono gli utenti ma il loro movimento all'interno dell'area non è simulato direttamente (aree connesse tra di loro da archi)

Modelli continui (Legion, MassMotion)
Il dominio è continuo e si simula direttamente il movimento degli utenti nello spazio di calcolo

Modelli di analisi termostrutturale
Consentono di studiare l'evoluzione dello stato tenso-deformativo della struttura con le fasi dell'incendio, con analisi di tipo non lineari in grandi spostamenti.
La resistenza al fuoco è valutata contestualmente alla modalità di collasso (implosione o esplosione della struttura).
Generalmente si utilizzano curve di incendio naturali, invece delle curve nominali monotone crescenti (ad es.: la ISO 834), nonostante sia ancora in parte dibattuto il comportamento dei materiali durante la fase di decadimento.

Es.: codici di calcolo Abaqus, Adina, Ansys, Diana, Safir

Modelli di calcolo
Analisi quali-quantitativa degli effetti dell'incendio in relazione agli obiettivi assunti, confrontando i risultati ottenuti con le soglie di prestazione individuate

Utilizzo dei metodi avanzati della FireSafetyEngineering per la progettazione della sicurezza antincendio
G. Gai, E. Cartapati
Sapienza Università di Roma
P. Cancelliere, F.A. Ponziani, M. Mazzaro, D. De Bartolomeo
Corpo Nazionale dei Vigili del Fuoco

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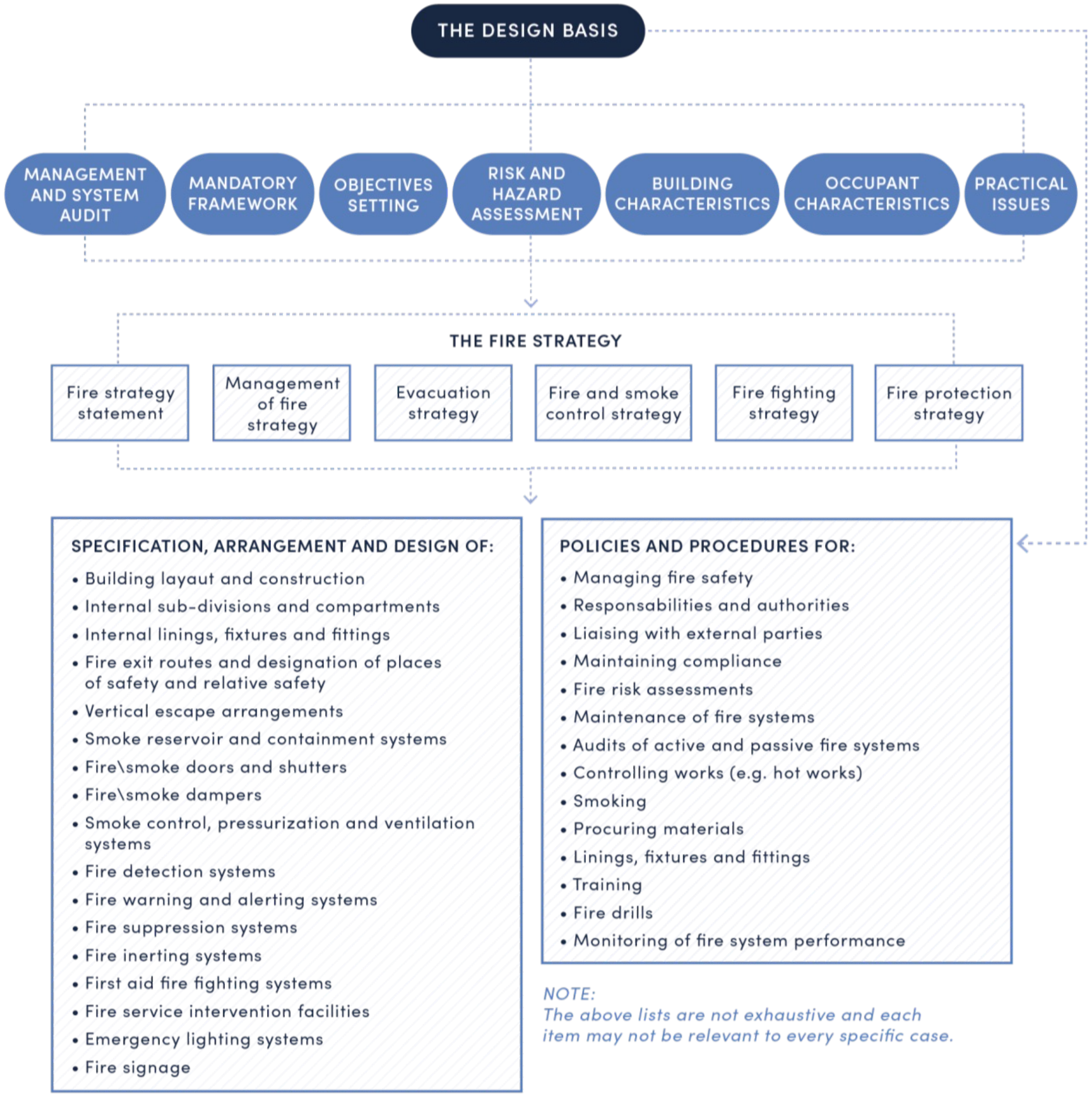
BRITISH STANDARDS (BS) - UK

The British Standards Institute (BSI) is the body recognised by the Government of Great Britain as the 'National Standards Body' (NSB). In this capacity, the BSI actively collaborates with government agencies, companies, universities and public and private research institutes, as well as with end-user groups in order **to promote the development, adoption and dissemination of standards, guidelines and norms of good practice.**

The BSI develops guidelines, national standards and reference publications aimed at both industrial and civil sectors; many of the institute's proposals often become the basis for international standards. It is important to remember that Great Britain was the first to officially adopt the BSI standards relating to performance-based fire engineering, which, pending the promulgation of ISO standards, currently represent the most authoritative international benchmark. The BSI is one of the founders of ISO (dating back to 1946), of the two European standardisation bodies CEN and CENELEC (founded in 1964) and has been involved in the IEC since its early days (1906).



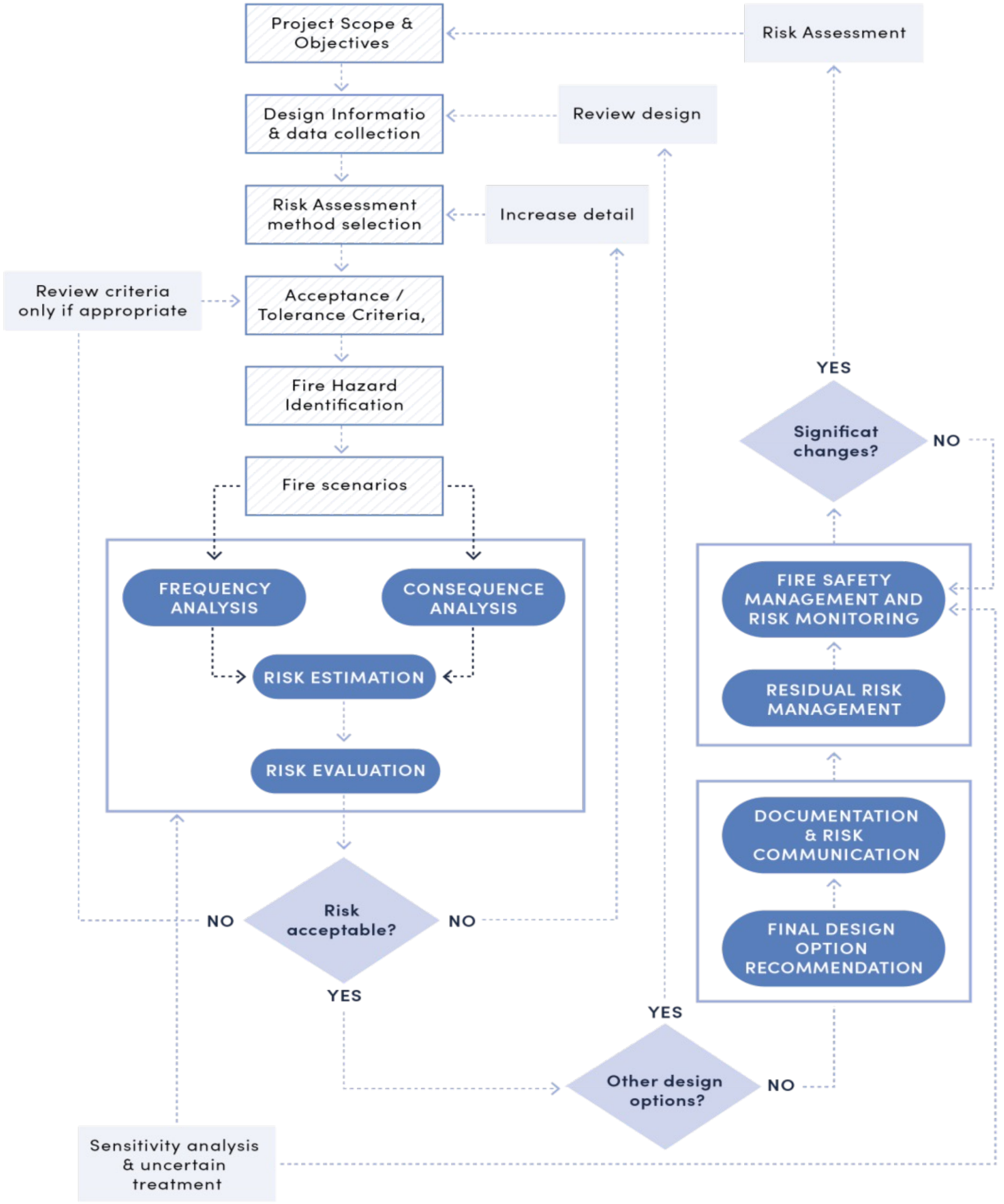
SFPE-USA (SOCIETY OF FIRE PROTECTION ENGINEERS)

The Society of Fire Protection Engineers (SFPE) is a scientific association representing those working within the fire protection engineering sector, counting more than 4000 members worldwide.

The purpose of the association is **to disseminate the science and practice of fire engineering with the aim of maintaining a high professional and ethical standard among its members and to encourage learning about the subject.** In Italy, the objectives of the SFPE are pursued by the Italian Section founded in 1983 as AIIA-Associazione Italiana di Ingegneria Antincendio, now SFPE-Italy.

One of the association's most important worksn is the 'SFPE Engineering Guide to Application of Risk Assessment in Fire Protection Design', currently one of the most significant and useful documents available internationally, that provides guidelines to be considered for the selection and use of fire risk analysis methodologies that should be adopted when designing fire safety or evaluating existing fire safety measures, based on the fire risks identified.

An up-to-date and highly significant summary of the association's work in this field is the technical publication 'SFPE Engineering Guide to Performance-Based Fire Protection'. It represents one of the main points of reference for any safety expert interested in the search for useful criteria for the implementation of a workflow for the management of the fire performance engineering aspects of a building.



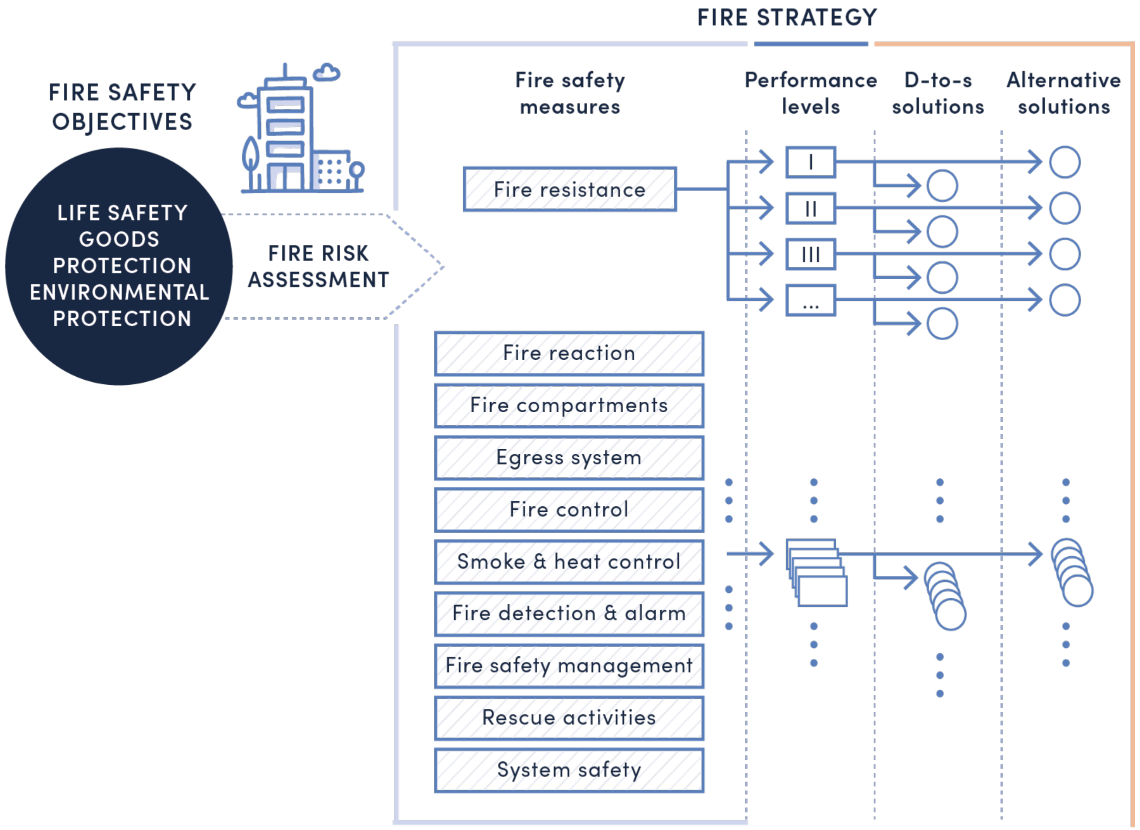
ITALIAN FIRE CODE

The Italian National Fire Rescue and Service, in charge of fire safety in Italy, in August 2015, issued a new Fire Safety Code whose design approach is more oriented to **fire performance-based design** rather than prescriptive fire codes. The flexibility of this novel fire design methodology offers a very completed tool for experts in order to design fire safety measures for buildings and activities subjected to fire inspection.

On 20th of August 2015, the Italian Home Office released the Ministerial Decree 3rd August 2015 that contains a new approach to the fire safety design of activities subjected to fire inspection. The technical Ministerial Decree is titled "Approval of fire prevention technical standards, pursuant to Article 15 of Legislative Decree 139 of 8 March 2006" but is commonly recognized among Italian fire officers and practitioners as the Italian Fire Prevention Code (IFC).

The fundamental assumptions of the IFC are:

- in ordinary conditions (no arson, no catastrophic situations), a breakout of a fire in an activity could happen only in one point of ignition;
- in any safety design, the risk of fire cannot be reduced to zero; the fire-safety prevention, protection and management measures provided applying the IFC fire design process ensure a proper selection of the measure that minimize the risk of fire in terms both of occurrence and damages, at a level that could be considered as an acceptable level of safety.



RISK PROFILES

PEOPLE, PROPERTY, ENVIRONMENT

PEOPLE

Risk profile concerning human life safety.

The R_{life} risk profile is assigned in relation to the following factors:

δ_{occ}: prevailing characteristics of the occupants

δ_{α}: prevailing rate of the growth of fire characteristic, referring to the time tα in seconds, used by the thermal potential to reach 1000 kW.

PROPERTY

Risk profile concerning the protection of property.

The assignment of the R_{prop} risk profile is performed according to the strategic nature of the entire activity or of the settings (areas) that constitute the activity, and of any historic, cultural, architectonic or artistic value it or its contents may have.

ENVIRONMENT

Risk profile concerning the protection of the environment.

The designer assesses the R_{env} risk profile in the event of fire, distinguishing the settings (areas) of activity in which this risk profile is significant, from those where it is not significant.

The assessment of the R_{env} risk profile shall take into account the location of the activity, including the presence of sensitive receptors in outdoor areas, the type and quantities of combustible materials present and combustion products developed by them in the event of fire, and the fire prevention and protection measures adopted.

FIRE STRATEGIES

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01

RISK MITIGATION

Prevention measures help prevent accidents and are largely attributable to organisational and procedural factors, as well as compliance with the relevant regulations in the design and construction of works and facilities.

02

FIRE REACTION

Reaction to fire constitutes a kind of prerequisite that is inserted in a transversal manner throughout the design and management phase of a work, identifying inputs with respect to the choice of room finishes, including furnishings, and the definition of the materials with which to realise installations.

03

FIRE RESISTANCE

The fire resistance of an element is defined as its ability to guarantee a given performance under the action of fire, quantifiedThe main performances considered are the load-bearing capacity, thermal insulation capacity and capacity to combat the propagation of fumes and hot gases of structural or non-structural construction elements; other performances are also the subject of attention, such as, for example, the capacity to limit thermal radiation or the propagation of fumes and cold gases, and the capacity to guarantee the transmission of electrical energy and data signals in the event of fire.

FIRE STRATEGIES

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04

FIRE COMPARTMENTS

One of the fundamental principles on which fire design is based is the containment, within predetermined limits, of the effects of a fire through the construction of independent units, suitably spaced or constructed in such a way that each unit constitutes a fire compartment. the objective is to counteract the spread of a fire to adjacent structural units or from one portion of a building to another.

05

EVEQUESTIONS AND ESCAPE ROUTES

As is well known, the main cause of death in fires is not linked to the high temperatures reached or direct contact with the flames, but rather to the time of exposure to the toxicity of the fumes; it follows that the sizing of escape routes cannot disregard the 'time' factor, especially since the evacuation process takes place at the same time as the fire develops and must be completed, except in special cases that we will discuss later, within a few minutes after the fire is detected.

06

EMERGENCY MANAGEMENT

Emergency management planning is an essential organisational measure to contribute to the achievement of adequate safety standards; it is implemented by the person in charge of the activity to cope with accidental events, in addition to the technical solutions indicated by the designer to compensate for the fire risk and is closely related to them. It is a responsibility linked to management and cannot and must not be delegated to the intervention of external helpers.

FIRE STRATEGIES

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07

ACTIVE FIRE PROTECTION MEASURES

Extinguishing systems constitute active protection measures aimed at extinguishing or controlling a fire. These measures are divided into two main groups, manual and automatic.

08

FIRE DETECTION

Early detection of a fire is undoubtedly the best weapon of defence against its effects. Depending on the assessment of the risk - and in particular in consideration of the strategic nature of the activity with respect to the type of users or the protection of the asset - it can be delegated to manned detection or to a system dedicated to the purpose.

09

SMOKE CONTROL

The evacuation of combustion products represents a strategic node in fire-fighting design, which unfortunately in many cases still receives little attention. The possibility of disposing of the smoke and heat of the fire slows down its development and mitigates its effects, favouring in particular the evacuation of users - improving living conditions increases the time available for ASET evacuation - and the intervention of rescuers, as well as contributing to the containment of damage to the building.

FIRE STRATEGIES

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10

FIRE FIGHTING AND RESCUE OPERATIONS

The design of a safe structure cannot disregard the way in which external rescuers intervene; the safer the structure, the more the designer has taken measures to facilitate their intervention.

The main aspects on which attention should be focused concern:

- the access of rescuers to the activity and the area on which it stands;
- the modalities of intervention.

11

TECHNOLOGICAL SYSTEMS

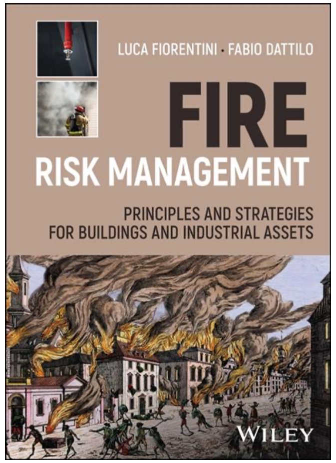
The technological and plant engineering component, both in civil construction and production sites, has progressively grown over the years to the point of absorbing a significant technical and construction effort as well as a conspicuous part of the costs of realisation of the works.

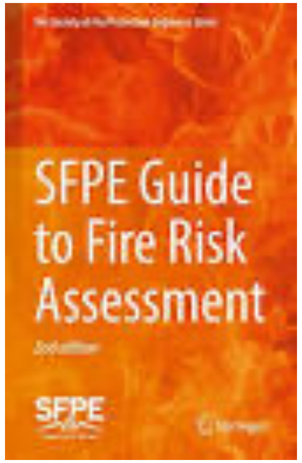
ROME BUILDING FIRE (COLLI ANIENE)

The fire spread durigng the refurbishment operation (and lasted for approximately 4 h) , before the fire brigade from the National Fire Corps could extinguish it.

MATERIALE DIDATTICO PROPOSTO

1. **ISO 16732-1:2012 Fire safety engineering – fire risk assesment**
2. **NFPA 551, Guide for Evaluation fo fire risk assesment**
3. **SFPE Engineering Guide – Fire risk assesment**
4. **SFPE - Handbook of fire protecion engineering**
5. **Fiorentini Dattilo – Fire Risk Mangement**
6. **Slide del corso**
7. **ISO 31000 standard - Risk Management - Principles and guidelines**





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Grazie

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