Organisation and management of fire safety in buildings

João E. Almeida[1], A. Leça Coelho[2], João Paulo C. Rodrigues[3]
[1]*Layout – Engenharia e Serviços, Portugal.*
[2]*LNEC – Laboratório Nacional de Engenharia Civil, Portugal.*
[3]*FCTUC - Faculdade de Ciências e Tecnologia da Universidade de Coimbra, Portugal.*

Abstract
The fire safety of buildings depends, for besides the passive and active measures to define and implement in the conception and construction phases, to the correct exploration and administration of the facilities.
This paper outlines the principles to take into account on the management of fire safety in buildings.
The paper finishes with a reflection on the teams of fire safety, their formation and dimension, in way to create conditions more effective of fire safety on the exploration of the buildings.
Keywords: fire; organization; management; safety; safety team

1 Introduction

Fire protection in buildings goes beyond passive and active measures defined both in design and building construction phases. It is useful to continue this work during the normal building exploitation. Major concerns with fire safety usually end when achieving the building license of use from the authorities. Fire protection equipment and systems remain unused, without maintenance and stop working properly shortly. Building users without a convenient fire safety education don't know the right procedures to follow in fire case.
Portuguese fire safety regulations (recently updated) impose the need of implementing fire safety measures not only for new but also for existing buildings. However, many building users and owners don't have the necessary

sensibility and education to maintain all safety equipment in proper condition nor the know-how to use it in fire case.

2 Building Fire Safety Management situation in Portugal

After 1988 Chiado fire, that destroyed several buildings in Lisbon downtown, there was a revolution in Portuguese fire safety legislation. A set of laws in preparation for several years by LNEC and other entities was published. It took some years to cover all building sectors and activities. Only in 2002 legislation specifically made for Fire Safety Management was published for hospitals, schools and administrative buildings.
Recently (in 2008) a unified code was published covering all fire safety aspects including systems management, buildings exploitation, training and fire drills.
There is some progress in the recent years on this matter, in part due to the implementation of quality systems requiring emergency planning.
New code is not only for new buildings but also for existing ones. One year was given to organizations to fully implement the new law requirements.
More important than legislation would be actual measures to implement them and make it part of daily routine. In this area there is still a lot to be done. Schools should lead by integrating fire safety culture in the curricula and academic projects. Companies and organizations should develop training sessions and set up at least one fire drill per year. Public services should also be aware of fire safety requirements and be the first to implement the fire code.
Let's hope that in this year actions will be taken to improve the actual scenario.

3 Building Fire Safety Management in other countries

English-speaking world (Commonwealth, USA) and most European Countries, have legislation on this matter. Fire drills are common and a great part of population is familiarized with fire safety concepts. However, there is a lot to be done.
Fire Safety Management practices are not equal everywhere. In USA, NFPA and other organizations have an important and active role in this matter.
European Union should have take more actions in order to spread a Fire Safety culture, using the proved practices of more advanced countries as a model for the others.
In the rest of the world, namely third world countries, it is our belief that there is almost everything to be done. The impact of these measures in the economy could be important, due to reducing the losses of lives and goods originated by fire.

4 Proposals to improve Building Fire Safety Management

To improve fire safety management some measures can be proposed:

- Implementation of proper maintenance plans for the fire safety equipments and systems;
- Periodic audits to verify the accomplishment of the maintenance;
- A well-organized, prepared and designed fire safety team;
- Education campaigns for fire safety teams and building users.

5 The maintenance plan

The maintenance plan has the main goal to establish the procedures to assure that the fire safety equipment is on-use whenever needed.

A maintenance plan must address the following aspects:

- External accessibility to fire vehicles;
- Ensure water supply and access to fire hydrants;
- Verify the accessibility to fire alarm buttons, portable extinguishers, fire hoses and other equipment;
- Keep evacuation routes free of obstacles and all emergency exits operational;
- Ensure structural fire stability of the buildings and fire compartmentation;
- Dangerous and hazardous materials and equipment must be stored and operated according to the safety rules;
- Specific instructions for particular risk sites;
- Surveillance of areas with higher fire risk or normally unoccupied;
- Ensure that all compartments and areas are clean and garbage properly collected and stored.

All equipment must be properly maintained according to manufacturer instructions and applicable standards.

Records should be kept with both preventive and corrective maintenance operations.

6 Periodic Audits

Complex buildings or set of buildings belonging to the same entity, besides the maintenance plans, should have periodic audits to guarantee that all safety maintenance procedures are being followed. This should be carried out by an independent external entity.

Using the same evaluation system for each building will allow comparisons between them in what concerns to the evolution of the fire safety aspects in the period of time in analysis.

Fire equipment and systems are organised into different groups as shown in table 1. The weight of each group shows its relative importance for safety and how much it counts for the final evaluation. The scale shall vary from 1 to 100%. A

value smaller than 50% means that the building needs urgent intervention because it is not compliant with the minimum safety level required.

All tests and results are to be registered in the audit report. This will allow to create a ranking to the benchmark of the fire safety level.

Final goal of the audits is to reduce fire risk of the buildings.

Table 1 – Fire safety targets

Group	Description	System or equipment	%
I	Evacuation Routs	Fire doors Emergency lightning Safety signs Evacuation routs and exits	20
II	Electronic safety	Automatic smoke detection CCTV – Close Circuit TV Access control Integrated safety management	15
IIII	Electrical systems	Electrical power generator and UPS Electrical switches Lifts	10
IV	Smoke control	Exhaust mechanical systems Dampers Smoke curtains	20
V	Firefighting means	Fire pumps Fire hoses Hydrants Sprinklers Other automatic systems	20
VI	Firefighting means	Portable fire extinguishers Sand boxes	15

7 The safety team

In large buildings with some degree of complexity the presence of a permanent safety team is required to ensure maintenance and use of fire means.
The safety team shall:

- Ensure normal building routine operations;
- In case of fire, combat with the adequate equipment and procedures or, ultimate case, ensure an orderly building evacuation.

7.1 Safety team organization

Safety team hierarchy depends on the complexity and number of buildings. It may be formed by full-time elements or normal workers with safety functions as an extra task.

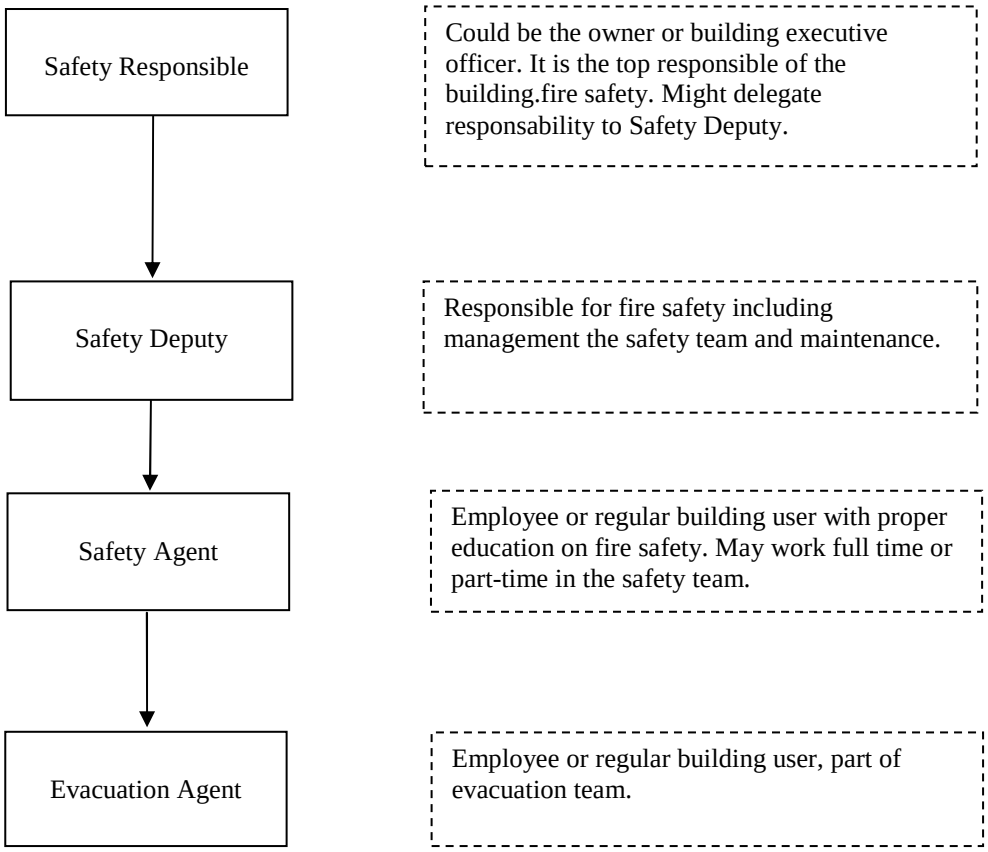

Figure 1 – Safety Team Organigram

Figure 1 shows typical organigram of a safety team. In smaller buildings sometimes only one or two levels exist.
In certain situations there are two or more safety teams under coordination of the same Safety Deputy.

7.2 Safety Responsible (SR)

The Safety Responsible is the top responsible for the safety of all building occupants and goods. Has the duty to call external entities or demand for immediate evacuation of the building. Furthermore, it is responsible for the safety equipment conditions and maintenance.

Normally the SR delegates competences on someone to accomplish these tasks, as for example the Safety Deputy.

7.3 Safety Deputy (SD)

The Safety Deputy has the responsibility of fire safety under the orders of SR. SD must create and manage the safety team. Also has to take care of all safety devices and installations, promoting and following a Maintenance Plan.
May accumulate these functions with others, although in complex buildings this is a full-time job. Must have a specific training adequated to the duty.

7.4 Safety Agent (SA)

Safety Agent is an employee that besides other tasks and functions belongs to the fire safety team.
This can often be a full-time job, but is usually a part-time occupation. Must have adequated training to accomplish the job.

Training will focus on:

- Fire safety equipment use and maintenance;
- Fire principles (basic chemistry and extinguishing methods);
- Emergency planning.

7.5 Evacuation Agent (EA)

Evacuation Agent is an employee or regular building user that will help if needed in the building evacuation. Whilst Safety Agent might do other tasks the Evacuation Agent will only operate in the event of an evacuation. Should have adequated training for the job.

The EA should have the following skills:

- Self-control under stress and panic situation;
- Leadership capabilities;
- Presence and loud voice.

7.6 Safety team duties

Safety team normally works in three situations:

- Regular
- Fire
- Evacuation

7.6.1 Regular condition

Daily functions include:

- Safety systems and equipment check-up;
- Preventive and curative maintenance procedures;
- Complementary support activities (logs, training).

To accomplish these tasks, a relatively small number of people is needed. A team of 2 or 3 persons is sufficient for most buildings.

7.6.2 Fire

In case of fire, the safety team has a limited action, only in the initial moments. All fire safety measures assume a fire begins in a single place[1], so that only one team of 2 or 3 elements will be needed. Possibly there will be one supervisor (the SR) and another element in charge for communications. Total: no more than 5 elements.

7.6.3 Evacuation

The egress capacity is limited to the number of stairs and exits. So the safety team must be sized according to these factors. The evacuation of a building with several storeys must be done orderly to avoid bottleneck in the stairs.
According to the Portuguese fire safety regulation[2] stairs width are designed to the sum of the biggest population possible in two consecutive floors.
Thus egress operations from several building storeys must be coordinated. It is not possible to start the evacuation of all floors simultaneously, otherwise the following could happen:

- Stairs would be crowded;
- Doors between the corridors and stairs would remain open allowing the smoke to invade the stairs and eventually the upper floors;
- Smoke would reduce visibility and expose people to toxic and hot gases.

Immediate consequence would be panic.
To avoid this it is necessary to:

- Implement an evacuation plan;
- Calculate stairs capacity;
- Define evacuation cenarios for the different floors and establish the exact evacuation sequence in each case;
- Have an evacuation coordinator.

The best solution is to have an evacuation agent (EA) in each floor and stair exit holding the people or letting them out, depending on the coordinator orders. To verify no one was left behind, another EA will be need in the end of the evacuation group. So, a total of 2 EA per stair / exit will be need.
One key aspect is the communications between EA and the evacuation coordinator. Fire drills will be of extraordinary importance to test procedures and create the adequate routines.

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[1] NFPA 1 – Uniform Fire Code, 4.2.1 (NFPA 2006)

[2] Portuguese fire safety of buildings regulation, Portaria 1532/2008

[4]http://www.nfpa.org/categoryList.asp?URL=Learning/Public/FirePreventionWeek

7.7 Design the safety team

One possible method to size the safety team could be using the following expression:

$$\mathrm{NES} = 1 + NF + \sum_{p=1}^{np} \mathrm{f}_{\mathrm{NES}}\left(VVE_p\right) \quad (1)$$

where:

NES – Number of safety elements
NF – Number of fixed elements in the safety team
VVE_p – number of stairs
Np - number of storeys
f_{NES} – function returning the NES needed per floor

The function f_{NES} depends on the number of exits (VVE) in the floor, needing two EA per exit:

$$\mathrm{f}_{\mathrm{NES}}\left(VVE_p\right) = VVE_p \times 2$$

There are other parameters that could be used like the number of occupants, the activities held and risk level. The formulae presented can be used as a base for further investigation.

8 Education campaigns

Education and instruction in Fire Safety is a relatively easy and cheap way of reducing the fire risk and improving the safety culture of the building users.
Some possible campaigns can be performed giving simple ideas of great impact on the target audience. In the USA, these campaigns exist for years, that is not the case of Europe.

8.1 Fire Prevention Week (FPW)

Fire Prevention Week[4] (FPW) exists in USA since 1925 (fig. 2). I was established in memory of the Great Chicago Fire that killed more than 250 people in 1875. On the 40th anniversary of the Great Chicago Fire, the Fire Marshals Association of North America decided that the anniversary should henceforth be observed not with festivities, but in a way that would keep the public informed about the importance of fire prevention. In 1920, President Woodrow Wilson issued the first National Fire Prevention Day proclamation, and since 1922, FPW has been observed on the week in which October 9 falls. According to the National Archives and Records Administration's Library

Information Center, FPW is the longest running public health and safety observance on record. Each year a new theme is selected for FPW campaigns. This is the ideal timeframe to promote education, safety inspections and drills.

Figure 2 – Fire Prevention Week Ad

It would be very import to take this practice from US to Europe. The use of the media, as the magazines, radio and TV might amplify the impact and reach a broad audience.
October is perfect since school has already begun but is still in an early stage of the year not colliding with examination periods.
In companies the FPW motivated by schools campaigns could also have a great impact. Implementing in all companies, organizations and public services, at the same time, would improve the acceptance by the workers, as over the 80 years of experience in US demonstrate.

8.2 Winter and Spring prevention campaigns

Winter is the time of the year when fire risk is more present. Heating devices, such as fireplaces. might originate fires and CO toxic hazard. It is the ideal time of the year for public prevention campaigns promoting inspection of the electrical apparatus and Christmas decorations.
Spring is the time of the year for house cleanings and ideal for promoting inspections and education campaigns.

8.3 School campaigns

Fire safety education should start in schools. It could be inserted in the programs of other existing classes such as Project, Chemistry or Physics, with the cooperation of firemen, municipality technicians and the support of fire related companies. The experience and testimonials of professionals create great impact on students.
In some countries and schools it is usual to give new students a welcome book. In that guide all fire safety procedures could be provided.

8.4 Community campaigns

Community campaigns could be promoted with the help of local organizations like unions, churches, and sport clubs, music or cultural associations.

Ideally civil protection or the central government ministry in charge could create a task force to prepare campaigns directed to the various public, age groups and activities.

9 Conclusions

The main research effort and regulation on the fire safety of buildings has been concentrated in the design and construction phases. The use of the buildings and the inherent subjects to the organization and administration of their fire safety are in a certain way ignored and treated as smaller. It is, though, an area that deserves our major attention, because the systems and equipments left abandoned and neglectful compromise the fire safety of the building and its occupants.
The subjects of the maintenance, formation and training, they are of largest importance. It is necessary to invest in these areas, through the implementation of maintenance and emergency plans, that, on one side, guarantee the functionality and operating of the equipments and safety systems, through a correct politic of maintenance, and for other, the continuous formation be guaranteed to the actors in emergency case.

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