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ANALYSIS OF AIRPORT TERMINALS IN THE CONTEXT OF FIRE HAZARDS

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Abstract

The aim of catching up with the speed of today's life makes air travel more attractive in the eyes of people and reinforces the importance of airport terminals. The main purpose of taking fire safety measures in these buildings, which gained a different identity with the characteristic of being the first contact point with the city, is; in addition to ensuring the safety of life and property, the matter of operation continuity is also a very important situation. In order for the passive fire safety measures for all of these situations to be appropriate and sufficient, possible fire hazards must be known from the very beginning of the design. For this purpose, in this study, typical features of the airport terminals in terms of architectural program, spatial organization, functional relationship, building structure, building elements and building materials were determined and based on these determinations, fire hazards were revealed in terms of spatial and occupant profile.

1. INTRODUCTION

As well as being reliable and comfortable, transportation activities are expected to be fast in parallel with technological developments in all areas of life. In this respect, the increasing importance of airline transportation, which is one step ahead of other transportation routes, has moved the airport terminals to a different point in terms of capacity, size and facilities provided throughout the world. These buildings, which are the first point of contact with cities, beyond their intended use give the cities a formal and semantic identity with their architecture and structures.

In addition to the concept of today's airport terminals, it provides different possibilities for its occupants in a single building without the need of any other place. Box offices, baggage handling facilities and passenger lounges that will be required during the transfer of people to a aircraft, retail areas to support these areas, and airport terminals, which also include functions such as hotels and entertainment centers, are very comprehensive projects with this feature.

The main purpose of the fire safety measures to be taken regardless of the type of building is to ensure the safety of life and property. Immediately stopping aircraft landing or take-off activities may increase the degree of risk in the event of a fire. Therefore, in addition to the safety of life and property at the airport terminals, it is also very important to ensure operational continuity.

In order to recognize a building and to identify possible fire hazards, typical features of the building must be accurately determined by analysis in the context of architectural program, spatial organization, functional relationship, building structure, building elements and building materials. Passive fire safety measures to be ensured for life and property safety and operation continuity can be appropriate and sufficient thanks to knowledge of fire hazards from the design stage.

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2. TYPICAL FEATURES OF AIRPORT TERMINALS

Air travel, which is becoming more and more important day by day, has made airport terminals a sustainable phenomenon that is constantly evolving and transforming in terms of architecture. Gathering many opportunities under one roof, today's airports are based on user-centered, open to all kinds of development, functional, aesthetic, compatible with the environment and renewable (Demir, 2011).

In an airport design, runways and taxiways are the first issues that need to be considered in terms of their physical characteristics and the size of the required space. In making decisions about the plans of runways, exit taxiways and aprons, general estimates should be made on issues such as aircraft types and airport traffic density. When all these sections become clear, the terminal and cargo buildings and aircraft maintenance areas should be carefully evaluated considering all possibilities in an integrated design approach (ICAO, 1987: 94,95).

The airport terminals consist of two main parts: landside and airside. Airside sections intented for landing and take-off of aircraft and their movement on the ground; it consists of runways where airplanes land and take off, taxiways used during their movements between runway and terminal, aprons and gates where passengers park and wait for the aircraft to perform landing / boarding activities (Erden, 2007).

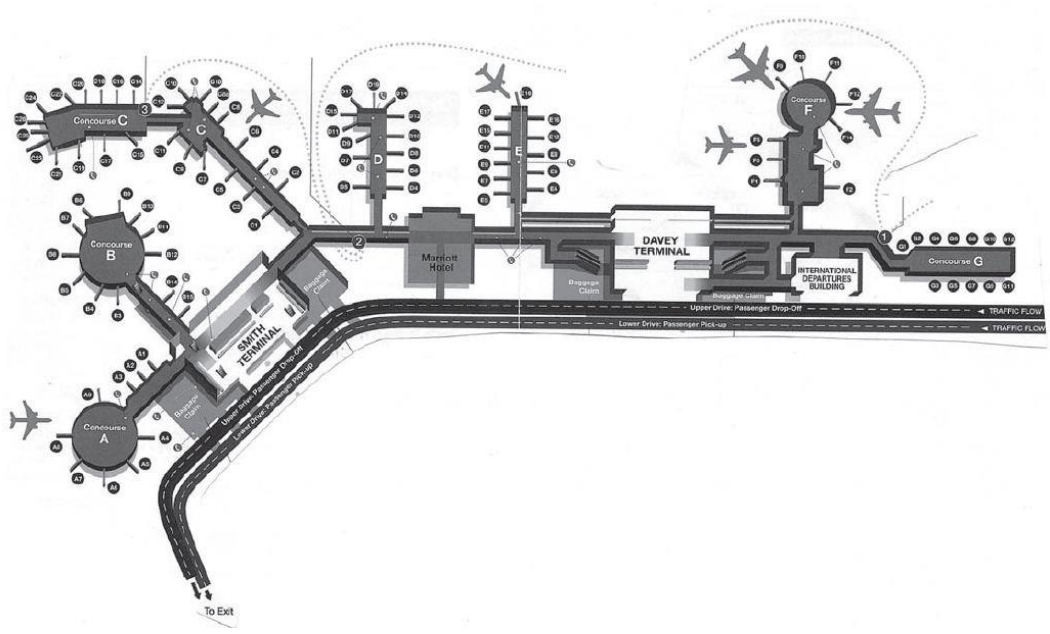

Figure 2.1. Example airport plan diagram, Detroit Airport (Edwards, 2005: 17)

2.1. Airport Terminals Architectural Program and Functional Relationship

Airport terminal buildings consist of many spaces that need to be handled quite extensively. However, in principle, it is a fiction that covers all kinds of ticket and baggage transactions that occur during the aircraft transfer of passengers who have reached the terminal, the completion of the control and security procedures during these operations and preparation for flight; or vice versa. Although the organization is similar in all terminals, it is diversified depending on arrival-departure and different control procedures performed during domestic-international crossings (Yalçın, 2017) (see Figure 2.2).

Most of the areas in the facilities are used as circulation and waiting areas for people in the process of providing catch or transfer from one transportation to another (HM Government, 2007: 70).

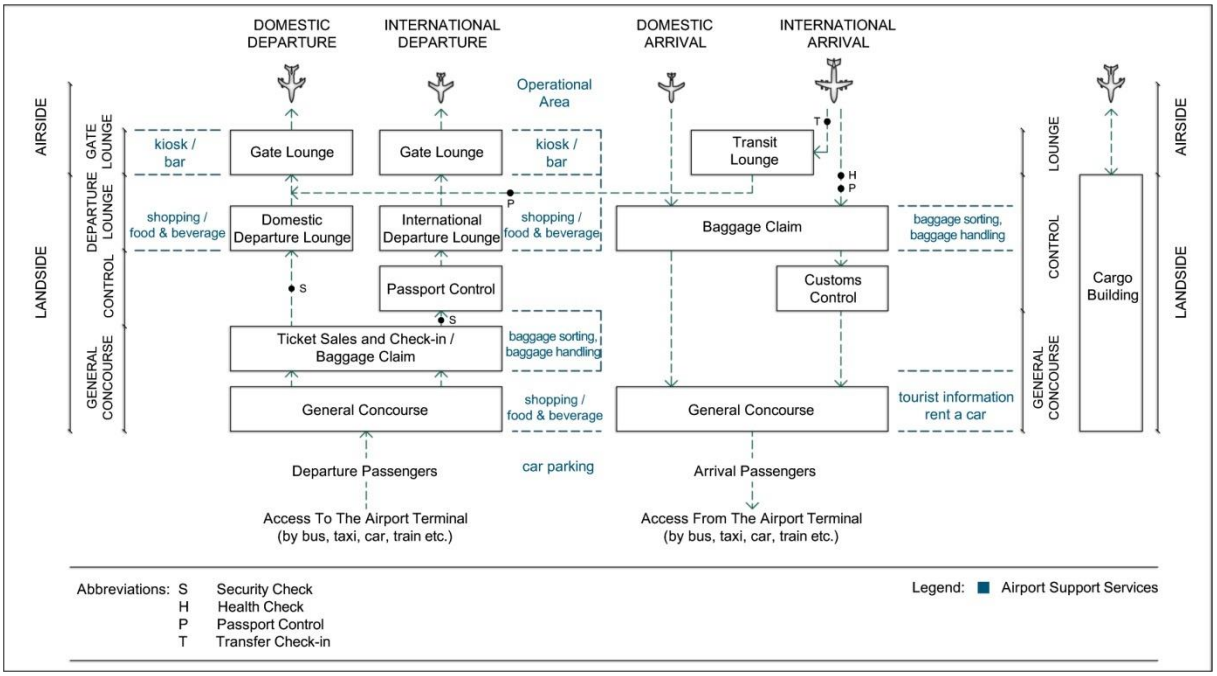

Figure 2.2. Airport terminal program and functional relationship (developed with reference to figures in (Edwards, 2005) source)

2.2. Airport Terminals Building Structure, Building Elements and Building Materials

It is as important as that the occupant with a limited time can easily be perceived by allowing holistic perception while reaching the destination among many functions, as that the terminal structures of the airport are spacious. In addition to these situations, considering the large waiting areas reserved for passengers during ticket and baggage transactions, security procedures and long waiting periods before the flight; it is necessary that a wide opening in the terminal buildings should be provided by using a small number of structural elements that would not constitute a visual barrier. In this context, the most suitable functional result can be achieved by the combination of structure system and building material (Akçaer, 2016).

In parallel with the developments in technology, materials, forms and structures have become more interactive in today's architectural designs. Especially with the changing needs and development of structural systems, the design of airport terminal buildings also has shown a significant development. Early on, the terminal buildings constructed with reinforced concrete system could not allow to meet the increase in the number of passengers or functions, therefore, the tendency towards expandable structure systems was formed. Materials such as steel, which can pass wide openings, accelerate and simplify the construction process and enable growth, have been developed and structural systems with flexible solutions have been developed (Önal, 2015).

Figure 2.3. High ceilings, large and spacious, steel structure planned airport example, Charles de Gaulle Airport (Edwards, 2005:164)

Especially with computer modeling, a judgment can be reached on the final state of the structure even while it is in the design stage, and even the structural systems that can be considered as complex can easily find solutions (Önal, 2015). With these models, apart from the building structure, many technical parameters that affect comfort conditions such as ventilation, heating, lighting and acoustics can be thought at the same time, and integrated into the design in the last case more accurately.

In addition to meeting the needs of the building, the material, form and structure elements are also important in terms of the fact that the airport terminal buildings, which are actually prestigious structures, create an acclaim for the occupant.

3. ANALYSIS OF AIRPORT TERMINALS IN THE CONTEXT OF FIRE HAZARDS

Airport terminals are hazardous buildings in terms of fire. There are long escape routes. Their closed volumes and deep plans prioritize smoke evacuation; privileged areas (restaurants, shops and bars) pose a high risk of fire. However, as they are open-plan buildings, passengers can easily move when a fire occurs. The terminal buildings are also well operated with disciplined people and regular roads. In addition, there are well-trained personnel and fire crews in the airport areas, thus in the event of a fire, it can react more quickly (Edwards, 2005: 163).

As well as fuels required for aircrafts in terminals, there are also fuels or various products to be used during the operating activities. In addition, it should not be forgotten that the materials (walls, ceilings, insulation materials, fixtures, etc.) used in every stage of the building design and the objects that can be brought with the passengers may contribute to the spread of fire. These situations should be known to determine the risk that may ocur:

- flammable liquids, solvents (oil, diesel, petrol, aircraft fuels and parafin) and flammable gases(LPG, propane and natural gas),
- lubricants and fuels (mechanical equipment lubricants and generator and vehicle fuels),
- stored goods (foodstuffs containing sugar and oil plus paper products),
- timber and plastic storage aids,
- rubber and plastics (flammable foam-filled furniture and flammable expanded plastic display materials),
- waste products,
- combustible insulation,
- fixtures and fittings (textiles and soft furnishings and upholstered furniture), and
- passenger baggage etc (HM Government, 2007: 16, 17).

All facilities can be targeted either intentionally or just because they provide easy access. Intentional fires can be particularly dangerous because they usually develop much faster and may be deliberately started on escape routes. The most benefit from all risk reduction measures can be achieved through efforts to reduce the threat from arson (HM Government, 2007: 56).

3.1. Fire Hazard Analysis by Location

Airport terminals consist of box offices, baggage sorting-baggage handling facilities and passenger lounges to provide flight activities, and areas to support them. The determination of the fire safety measures to be taken is ensured by a detailed assessment of the fire hazards in these areas (see Figure 3.1):

1. Operational areas. These areas used by ground handling personnel may pose a fire hazard as they may include storage and workshop facilities and areas for the storage of hazardous materials. Furthermore, the presence of an aircraft, which is a risky zones in terms of fire, in the apron can lead to fatal accidents.

2. Cargo building. Substances that go through the storage and loading stages prior to cargo shipping, there may be hazardous, and thus may have cause very risky consequences for an airport. For this reason, generally it is constructed in separate places from the terminals, but it may also be located within the same building even though it operates separately in some cases.
3. Retail areas. Activities of in the stores and food & beverage areas for need the people during their stay at the terminal prior to transfer to a plane, building materials, furnitures or sales materials for used in these retail areas may increase the risk of fire at airport terminals.
4. Baggage handling facilities. Passenger baggage is considered a moveable fire load. A fire that may occur in one of the carried baggage can penetrate another baggage in the baggage handling and baggage sorting system.

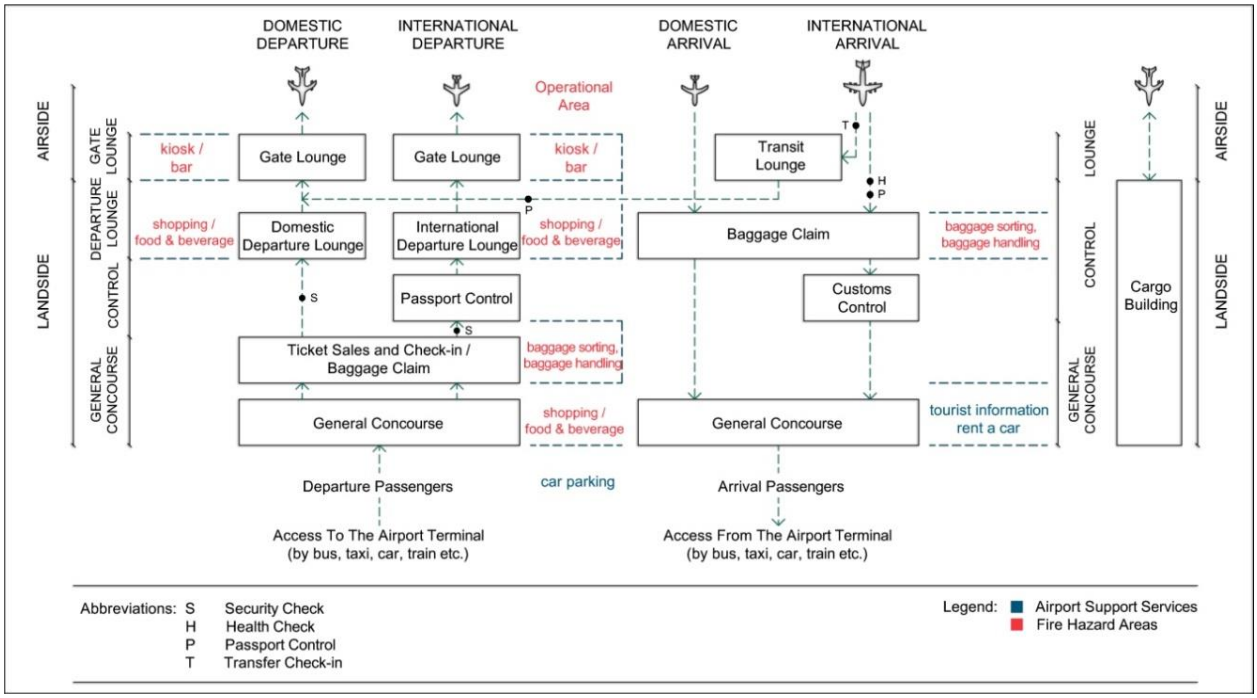

Figure 3.1. Fire hazard areas at the airport terminal

3.1.1. Operational areas

Operational areas is the name given to the area used by ground handling personnel. It is usually located near the apron and covers the areas required for flight crew, hostesses and ground handling staff. These areas may include storage and workshop facilities. Safe areas (with appropriate containers) for storage of frangible or valuable items and the volatile substances may also be required (SHGM, 2009: 21).

When the aircraft, which contains very risky zones for fire, is located in the apron, highly risky situations may occur which could result in lethal effects in a short time, in case of a possible fire. In addition, while refueling an aircraft in the airport apron, passengers may also be present (SHGM, 2016).

The airside environment of an airport is a highly controlled area. All staff and tenants working under strict procedures and everyone are limited in terms of goods that they can transfer across the landside/airside line (Lane et al., 2013).

3.1.2. Cargo building

Along with the developing technologies, the usage area of air cargo transportation is increasing day by day. Air cargo transport is vulnerable against terrorist threats by means of terrorist organization members or explosives placed in the cargo load, unless the necessary measures are taken (Korkmaz, 2017).

Hazardous material transportation is also carried out by air vehicles (SHGM, 2016: 104). Most explosives and gases are prohibited from use on airplanes, but passengers plane and cargo plane are allowed to carry a certain quantity of properly processed hazardous materials within the permissible limits. Approximately 50% of hazardous materials can be transported by both cargo planes and passenger planes. Approximately 30% can be transported only by cargo planes, not by passenger planes. The remaining 20% cannot be transported by airline. Materials included in the 20% that cannot be transported by air are highly toxic, explosive, oxidizing, self-reactive and flammable chemicals (Korkmaz, 2017).

Hazardous materials, which go through the storage and loading stages prior to shipping, can have consequences that may cause very risky situations for an airport. As an example, on May 24, 2006, a fire broke out at Atatürk Airport Terminal C, which resulted in complete burning of the cargo area and disruption of terminal operations (URL-1).

The thought that there might be radioactive leakage in the fire of Atatürk Airport, where the nuclear medicine materials in the customs warehouses were burning, caused a panic; however, as a result of the research it was determined that no harmful situation be formed. There were no sprinklers and fire detection systems, no fire zones were created, the right material choices were not made, and the cargo buildings did not provide adequate protection for the stored materials (URL-1). Although the cause cannot be determined exactly, it is clear that the fire at the Atatürk Airport shows how much danger the cargo buildings can pave the way for in the event of a fire. Therefore, the fire safety measures to be taken are very important.

3.1.3. Retail areas

Airports, like shopping centers, are constantly changing due to the large number of rental areas (Lane et al., 2013). Passengers who have a very long time at the airport terminals before the flight, spend a lot of time to use in retail areas, including shopping and eating.

Retail stores are very high fire load intensity areas. Therefore, they should be grouped together and protected separately from other areas (Ng, 2003). 70-80% of the privileged area within the airports should be on the airside. The remaining 20-30% of airport retail sales should be on the landside (SHGM,2009: 83). Depending on the operations of the airport, the vast majority of retail spaces must be located on the airside, but the danger of airside fire is also clear. Therefore, the measures to be taken in these areas are very important in terms of ensuring fire safety.

There are various levels of food & beverage areas and stores at the airport terminals to meet the needs of passengers. Restaurants at the terminals are located in the general concourse after security check. After the transition to the airside, it is accepted that the area is completely safe. Therefore, only fast food services are provided in the gate lounges. Similarly, the stores in these gate lounges are also limited in terms of products sold.

Typical combustible ingredients in retail outlets are similar to those found outside the airport. Some building management teams may impose restrictions on the types of goods to be sold, as in passenger terminals. Stored combustible substances are mainly newspapers and magazines; tobacco and cigarettes; alcohol and furniture containing polyurethane sofas or cushion; wooden coffee tables or other wooden products and chairs (Ng, 2003).

3.2.4. Baggage handling facilities

One of the areas that require a detailed assessment at an airport terminal is the baggage handling area. “This is where luggage is either sent to the planes from the check-in desks or received from the planes and sent to the baggage reclaim carousels. It generally consists of a large volume with many baggage conveyors, sorters, platforms, walkways, open stairs and mezzanines” (Lane et al., 2013).

In addition to fire spread from areas of fixed fire load within a airport terminal fire spread also can be caused by baggage items that can be considered as a moveable fire load. As a result of the calculations, it has been proved that if the baggage space is greater than 1.8 meters from one center to another, the combustible material will not affect the adjacent one. There may be possible a spread of fire between the baggage items that is very close to each other, but it is not expected that large scale fire will be spread by this means in open areas (Beever, 1991).

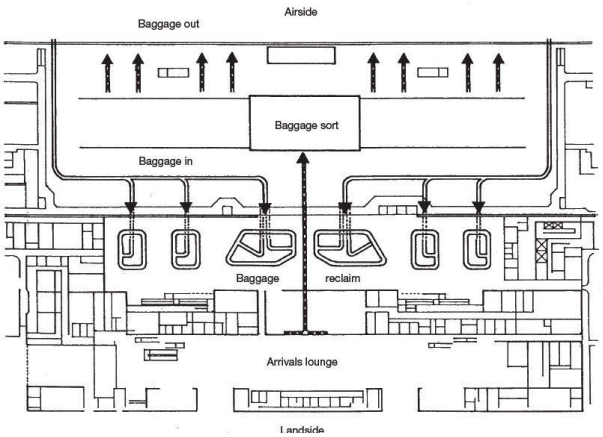

Figure 3.2. The movement of baggage at Heathrow Airport, UK (Edwards, 2005: 111)

3.2. Fire Hazard Analysis by Occupant Profile

The occupants of an airport terminal consist of a wide range of nationalities, family groups, single travelers, mobility abilities, and also diverse familiarity of travel. Occupant behavior is a key factor in successful evacuation strategy (Lane et al., 2013).

For airports, occupancy is much more complex and is measured in detail by the airport planning team. Therefore, the fire protection engineer can use the number of passengers based on the flow of people through the terminal, as dictated by the arrival and departure of the scheduled flights. This should include the number of support staff who support airport services, as well as airline staff, must also be incorporated, and look at the maximum flows they are subject to within one working day (Lane et al., 2013).

All people should be considered, but should pay particular attention to those who may be especially at risk, such as:

- Employees working alone and / or in isolated areas, eg. cleaners, security personnel;
- Persons unfamiliar with the building, eg. new staff, visitors and intermittent passengers;
- Young persons and unaccompanied children;
- People with reasons for not being able to get out of the building quickly, eg. people with mobility or vision impairments, people with learning difficulties, elderly customers, people in undress situations (staff changing rooms), pregnant women or parents with children;
- Persons who have pets and who are responsible for animal care, eg. In quarantine areas of air ports;
- Hearing impaired people, and people whose first language is not English, who might be difficult to understand audible alarms / messages; and
- Other people in the immediate vicinity of the facility (HM Government, 2007: 18).

Another important consideration for an airport is the possibility of a large number of disabled people in the terminal. In order to assist in the implementation of such a scenario and specific staff procedures, the design and the number of refuge areas with disabilities should be considered from the outset (Lane et al., 2013).

4. CONSLUSION

As a result of technological developments, at the airport terminals, which gained even more importance, have been a tendency to materials and structure systems that can provide aesthetic solutions while providing growth opportunities to meet the increase in the number of passengers or functions depending on time. By this means, airport terminals have become formal and semantic visual images for cities with their architecture and structures.

Apart from the transportation activities, terminal buildings have become more comprehensive thanks to being equipped with various support places where people can spend the waiting times before transferring

to a aircraft. These buildings, which consist of very crowded areas where different groups of area come together, are likely to be deliberately set fire to by some people who are aware of this situation. In addition, due to the fact that almost all kinds of hazardous materials are present in the building, a very risky situation may occur in a possible fire.

At the airport terminals, the qualification of the occupants is very wide. There are quite a lot of people. Most people are not familiar with the building. There are various people profiles that may require external support, such as disabled, unaccompanied children, elderly and non-English speaking persons. Because of the large floor area, it is necessary to overcome long escape distances. As a result of the high volume areas, difficulties are encountered in the use of traditional fire protection systems. For all of these reasons, it is very important to make the right decisions at the design stage and comprehensive evacuation strategies are required in case of a fire.

The increase in the demand for passenger and cargo transportation, the diversification in the range of occupant profiles and the growth in architecture, and the changes in building materials, building elements and building structures have made the airport terminals more dangerous in terms of fire. Although it is operated with disciplined people and regular roads, and fire crews and well-trained personnel are available, the decisive factor in life and property safety is the effectiveness of fire safety measures. No matter which the national or international fire standards are used, in order for the passive fire safety measures to be appropriate and sufficient, possible fire hazards must be known from the very beginning of the design.

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