Hot Issues in Fire Engineering

7 November 2013

Another Lesson to Learn after the Canton Airport Terminal Fire

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1. Introduction

Most airport terminals in large cities in the Far East are very busy, well-formulated fire safety strategies are needed to tackle the potentially high fire risk [1-3]. Serious consequences may result if normal operation of the terminals is disturbed, such as disruption of flights.

In October 2013, a small fire occurred near the departure area of the Canton airport [4]. Despite no casualties, minimal damage and a 12-hour disruption of air traffic, the fire raised two concerns on fire safety provisions in new airport terminals:

Concern 1: Many big halls in airport terminals in dense cities of the Far East are neither fully covered by fire suppression systems nor smoke exhaust systems.

Fire safety in crowded large halls [1-3,5] not fully protected by fire suppression or smoke exhaust systems should be reviewed. It should also be noted that the firefighting equipment and facilities in smaller second or third tier cities are not as advanced and adequate as in the more developed and richer cities. It was reported that even a small fire source was difficult to spot even by well-trained firemen at the International Airport in Chek Lap Kok in 1998 [6] even in big city Hong Kong. Fast-growing economies should not be reasons [7-9] to ignore providing adequate fire safety.

Concern 2: Occupational health and safety of firemen.

It is dangerous for firemen to enter fire sites with extended travel distance much longer than normal values specified by the code [10]. The portable breathing apparatus used by firemen can operate only for 30 minutes [11] normally in Hong Kong.

Moreover, many assumptions made [12,13] in designing fire safety provisions for airport terminals were based on research conducted years ago. Such assumptions might not hold true for the present situations in the Far East [14-16] and should be reviewed with reference to long-term research. New challenges [9] have emerged such as the ever-increasing passenger loadings, larger quantities of luggage that result in higher fire load densities, larger volume of air traffic and more frequent flight suspensions due to adverse weather conditions, earthquakes and even volcanic eruptions. Only up-to-date fire engineering tools and justified design data, such as the estimated heat release rates [17], should be used in working out new design and upgrading fire safety provisions.

In view of the many airport terminal fires reported globally and the local government should expand the Hong Kong International Airport (as a necessity to keep the leading role in this part of the world) into a three-runway system, it is an opportune time to review the fire safety strategy developed more than 20 years ago [7,8]. Instead of merely conducting several small-scale demonstration tests using small fires, more systematic experimental studies [9] should be carried out.

In addition, the data used in designing fire safety provisions used years ago for new buildings [1,18,19] have to be evaluated carefully. Taking the recent Canton Airport [4] fire as an example, it was assumed in there [12,13] that evacuation started at 30 s in the fire room and at 210 s in the near-fire room. It is not clear whether these values were supported by systematic research on human behaviour in this region. The estimated evacuation time of 589 s for 3 levels should be supported by research.

The Canton airport fires [4] should be taken as references to address new challenges so as to enhance and upgrade the fire safety provisions.

2. Current Design in the Far East

The cabin design [14-16] was used in many large halls over two decades ago. Research results on fire safety compiled in advanced countries cannot be applied directly to developing areas [1,20]. Therefore, full-scale burning tests are required to study flashover in cabin fires [21,22]. It is frequently observed that combustibles are always placed outside the cabin, including luggage.

As raised earlier [5], some fire professionals may misunderstand that the cabin resembles a well-sealed submarine compartment [23]. 'Open type cabin concept' appears in the new guidelines on formulation of fire safety requirements for new railway infrastructures [24]. Certainly, it cannot be taken as an enclosed compartment!

The following problems have been observed [9] for open type cabins used in retail areas storing a large quantity of combustibles:

- Large-scale fires might occur due to high air intake rate.
- A normal sprinkler system [10] might not be capable of controlling the heat release rate under 2 MW.
- When sprinklers are activated, smoke, flame and even hot steam will spread from the cabin to the outside, as demonstrated by preliminary experimental studies [25].

In view of the above, systematic experimental studies are required to further evaluate the performance of smoke exhaust systems in cabins or big halls assessed by current design guides [e.g. 13]. The results are useful in formulating firefighting strategies for existing constructions in which a design fire with a low heat release rate was used to determine the fire safety provisions.

3. Problems to Solve

If the cabin design has been demonstrated to be incapable of limiting the fire to 2 MW and avoiding smoke spread to the hall, fire suppression and smoke exhaust systems should be put in place to protect the whole big hall. For instance, the catering areas of some airport terminals using cabin design are equipped with long-throw sprinkler systems. Fire safety management must be enhanced immediately as raised by the author [3]. A long-term fire research project must be carried out to investigate how fire safety provisions can be improved to better protect airport terminals not fully covered by sprinkler and smoke exhaust systems.

There is still no updated research to support whether the tools used in the fire engineering approach [1] are appropriate for determining fire safety provisions. Similar approaches, such as the timeline analysis, are seldom updated but still being adopted. For example, the tenability limits only includes the concentration of carbon monoxide, but not other toxic gases.

Besides, fire-induced flow is three-dimensional and very unstable in the flow and temperature fields in a building. Such characteristics of the flow fields have not been adequately discussed [24,27] in most projects where computational fluid dynamics (CFD) is employed. There is no evidence so far that CFD is able to resolve the flow in the turbulent fire plume and the turbulent exchange flow across the free opening. Systematic verification and validation studies [26,27] on CFD fire models have not yet started. This is very different from developing fire safety provisions for nuclear power plants [28] with in-depth evaluation on the engineering tools and data.

More design data is required for performance-based design as pointed out recently [1,18,19]. Since most design data is gathered from wood fire research conducted years ago and many plastic products are more commonly used now, more fire research should be performed, particularly on smoke toxicity.

Recent incidents have clearly revealed such fact; fortunately, these incidents were of small scales.

But what will happen if there is a big fire?

Another problem is that research funding has been reduced significantly in the past decades all over the world except mainland China. In university rankings, more emphasis has been placed on publishing papers in prestigious scientific journals with high impact factors. Therefore, scant resources have been allocated to fire research which is regarded as vocational in many institutions. Research funding for fire studies is much lower than that [29] for structural engineering. Consequently, fire research has not been carried out systematically to collect data on fire safety provisions in new structures like supertall buildings, deep subway stations, long tunnels and large airport terminal halls. Researchers should venture into non-linear physics when studying fire-induced turbulence.

4. Immediate Actions

Firefighting and rescue may be impeded by inadequate fire safety provisions. Even worse, the safety and health of firemen may be endangered. For example, without appropriate fire service installations, it took several hours for the firemen to locate the burning source in the airport fire in Hong Kong in 1998 [6]. Obviously, new airport terminals must be designed properly and assessed rigorously on fire safety provisions in order to can meet the new challenges such as the higher passenger loadings, higher fire load densities and larger traffic volumes.

Fire safety provisions in existing airport terminals are difficult to be upgraded. If the authorities insist on doing so, serious criticisms may arise from different sectors. Fire safety provisions are upgraded usually only after a disastrous incident had happened. For example, after the tragic Garley Building fire [30] in 1996 which claimed 37 lives, much tighter fire safety control was implemented in old high-rise buildings in Hong Kong. An immediate viable action that the authorities can take is to implement tighter fire safety management.

By 2020s, stricter fire safety standards are expected. Imposing tighter government control to enhance fire safety management seems to be the only feasible way to achieve this. Taking Mainland China as an example, the top management should be held responsible if disasters happen. Relevant department officers have to bear the responsibilities as they are expected to provide top-down supervision to guarantee a safe environment to the general public. The Lamma Island ferry crash in Hong Kong is a good lesson as the staff members concerned had to face criminal charges [31]. The first step is to review the safety provisions in existing airport terminals. Special attention should be paid to those airport terminals [1-4] without fully covered by fire suppression system nor smoke exhaust system, but with extended travel distance. For example, appropriate portable breathing apparatus [11] should be equipped to firemen with adequate training.

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