

# FIRE SAFETY MANAGEMENT OF PUBLIC RENTAL HOUSING IN HONG KONG

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## ABSTRACT

In this paper, a review has been made to fire safety management (FSM) as a strategy of fire safety design in buildings. The FSM practice in Public Rental Housing (PRH) in Hong Kong is also reviewed. It is found that the FSM as implemented by the Hong Kong Housing Authority is structured and organized as it is a quasi-government organisation. It has been stressed in the literatures that good FSM should be planned beforehand in the design of new buildings especially when the “fire engineering approach” is adopted. Moreover, good FSM can complement and elevate the fire safety level to existing buildings which may not fully comply with current fire safety code. A discussion on the contribution of organized FSM towards the reduction of fire risk will also be presented.

## 1. INTRODUCTION

Hong Kong (now the Hong Kong Special Administrative Region since its reunification to the People’s Republic of China in 1997) is renowned as a world class urban city with dense population. Owing to its topography, only some 15.8% of the total land area of 1092 square kilometers is considered as developable [1]. In order to house a population of about 7 million, a lot of high rise residential buildings have been built since 1960s. The Hong Kong Housing Authority (HKHA), which is a statutory body established in 1973 pursuant to the Housing Ordinance [2], is charged with the responsibility to develop and implement a public housing programme in meeting the housing needs of people who cannot afford private rental housing.

The established roles of the HKHA are threefold namely:

- To provide affordable quality housing, management, maintenance and other housing related services to meet the needs of local citizens.
- To ensure cost-effective and rational use of public resources in service delivery and allocation of housing assistance in an open and equitable manner.
- To encourage a competent, dedicated and performance-oriented team.

This is also illustrated in Fig. 1.

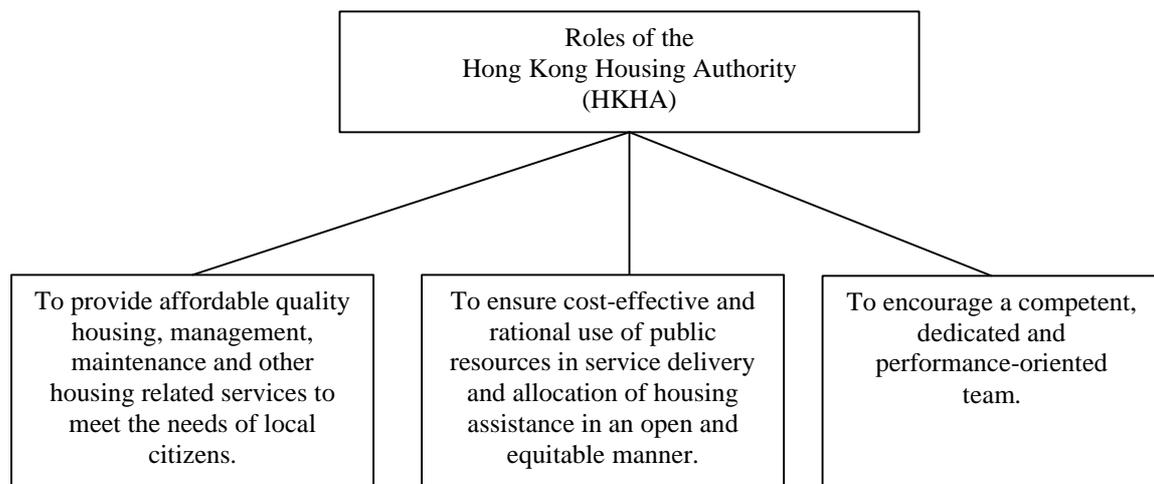


Fig. 1: Roles of the HKHA

According to current statistics, about 26% of the local population is living in public rental housing (PRH) which totaled at 153 estates or 1098 blocks [3]. The huge workforce from such “root grass” class has been contributing to the economic development in Hong Kong; and the provision of affordable accommodation to the low income group helps to maintain social stability. To ensure a safe, healthy and enjoyable living environment for those citizens, proper management and maintenance of the PRH stocks is of paramount importance.

Although the historic fire record in Hong Kong is good in terms of fatality rate, some tragic fires did occur in the past. In this paper, the fire safety management (FSM) practice which forms part of the property management function in PRH will be reviewed. The contribution of organized FSM towards the reduction in fire risk will also be discussed.

## 2. FIRE SAFETY CONCEPTS TREE

In a real world situation, there is no such a thing as absolute safety. Fire safety in buildings is of no exception. Fire safety in buildings depends on numerous factors, be it human, mechanical or environmental.

The National Building Code of Canada [4] defines fire safety as “an objective to reduce the probability that a person in or adjacent to a building will be exposed to an unacceptable fire hazard as a result of the design and construction of the building.”

Traditionally, a building is considered to be reasonably fire safe if it is designed to the

prevailing fire code which reflects the societal tolerability with respect to fire consequence at that time. However, this approach is in lack of a systematic consideration. While there is no absolute solution to building fire safety design, it is more appropriate to have a balanced design through the adoption of a combination of strategies which include:

- Prevent fire ignition
- Control the combustion process
- Control fire by construction
- Detect fire and provide warning
- Automatically suppress the fire
- Manually suppress the fire
- Manage the exposed, either people or property

The National Fire Protection Association (NFPA) has developed a “Fire Safety Concepts Tree” (FSCT) which is reproduced in Fig. 2 [5]. The FSCT is in essence a logical diagram depicting the various elements of fire safety strategies to assist us in making decisions on a myriad of alternatives. The elements down the tree branches of the pictogram represent the means to achieve the requirements immediately above them. It has to be noted that logic gates are incorporated into the FSCT to indicate those strategies which shall be adopted simultaneously under the “AND” gate; and those strategies which can be applied individually are grouped under the “OR” gate.

As shown in Fig. 2, the “Fire safety objective(s)” can be achieved either by “Prevent fire ignition”; or “Manage fire impact”. Further down the line of the diagram, we can see that “Prevent fire ignition” can be achieved by “Control heat energy source(s)”, “Control source-fuel interactions”; or “Control fuel” as suggested in Fig. 3.

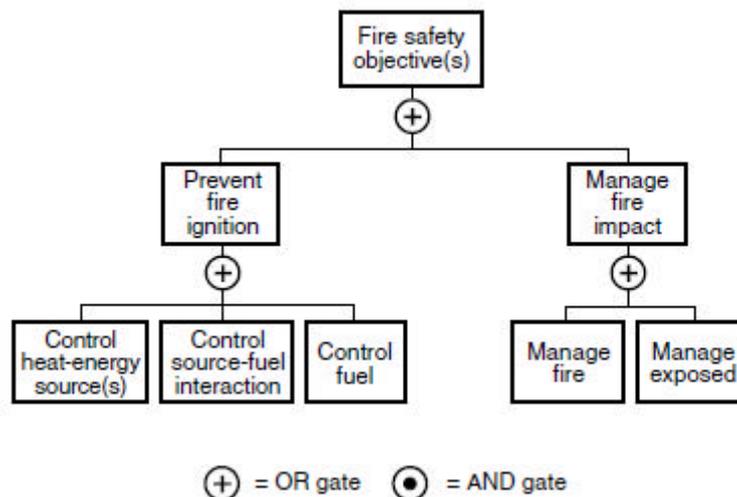


Fig. 2: Principal branches of the fire safety concepts tree [5]

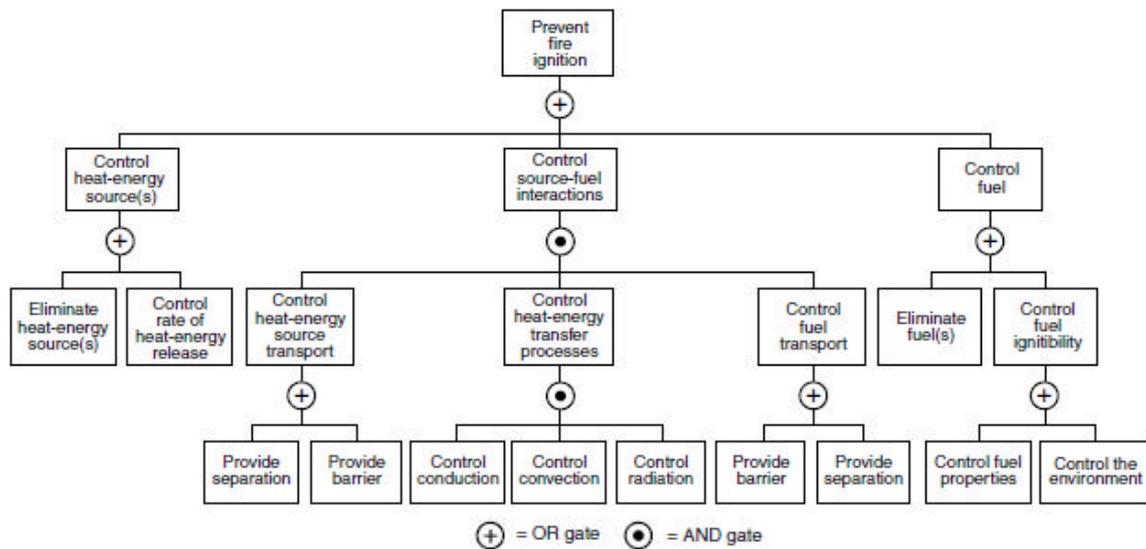


Fig. 3: Components of the prevent fire ignition branch of the fire safety concepts tree [5]

These three principles are basically predicated upon the “Fire Triangle”; which is a model conventionally used by fire engineers to put forward “Fuel”, “Heat” and Oxygen” as the three ingredients to start combustion. By removing either one of these three ingredients, the combustion process or the fire cannot start.

It is imperative that “Prevent fire ignition” should be taken as the fundamental line of defence. However, should a genuine fire occur, the safety objective can only be achieved by shifting the strategy to “Manage fire impact”; which in turn;

can be achieved either by “Manage fire” or “Manage exposed”. In order to “Manage fire”, one can control or suppress the fire. On the other hand, the “Manage exposed” approach can be utilized to protect the people, property, content etc. against the destructive effect of fire through “Limit the exposed” or “Safeguard the exposed” within tenable criteria.

To have a systematic understanding on fire prevention, NFPA has prepared a list of “Fire Prevention Factors” [6] as reproduced in Table 1.

Table 1: Fire prevention factors [6]

1. Heat Sources	<ul style="list-style-type: none"> <li>a. Fixed equipment</li> <li>b. Portable equipment</li> <li>c. Torches and other tools</li> <li>d. Smoking materials and associated lighting implements</li> <li>e. Explosives</li> <li>f. Natural causes</li> <li>g. Exposure to other fires</li> </ul>
2. Forms and Types of Ignitable Materials	<ul style="list-style-type: none"> <li>a. Building materials</li> <li>b. Interior and exterior finishes</li> <li>c. Contents and furnishings</li> <li>d. Stored materials and supplies</li> <li>e. Trash, lint, and dust</li> <li>f. Combustible or flammable gases or liquids</li> <li>g. Volatile solids</li> </ul>
3. Factors That Bring Heat and Ignitable Material Together	<ul style="list-style-type: none"> <li>a. Arson</li> <li>b. Misuse of heat source</li> <li>c. Misuse of ignitable material</li> <li>d. Mechanical or electrical failure</li> <li>e. Design, construction, or installation deficiency</li> <li>f. Error in operating equipment</li> <li>g. Natural causes</li> <li>h. Exposure</li> </ul>
4. Practices That Can Affect Prevention Success	<ul style="list-style-type: none"> <li>a. Housekeeping</li> <li>b. Security</li> <li>c. Education of occupants</li> <li>d. Control of fuel type, quantity, and distribution</li> <li>e. Control of heat energy sources</li> </ul>

### **3. IMPORTANCE OF FIRE SAFETY MANAGEMENT (FSM)**

#### **3.1 Definition of FSM**

The main objective of FSM is to ensure that in case of fire, all the safety measures provided will be available and occupants will be able to use them; and they can be guided to escape to a place of safety [7].

FSM has once been defined as “the application by a manager of policy, standards, tools, information and practices to the task of analyzing, evaluating and controlling fire safety” [8]. Under the Publicly Available Specification 79: 2007 of the British Standards Institution (BSI), FSM is defined as “the tasks carried out by a defined individuals with appropriate powers and resources to ensure that the fire safety systems, passive, active and procedural, within the building are working properly at all times” [9]. Normally, such a function is embedded as part of the daily building management responsibilities of the property manager, or the property management agent.

Moreover, the current BSI Code of Practice for fire safety in the design, management and use of buildings [10] has emphasised that “it is the fundamental assumption that features described in British Standard BS 9999 will require management and maintenance throughout the life of the building”. The statement clearly provides that the fire safety of a building can only be achieved as designed on the premise that it is properly managed and maintained.

#### **3.2 Role of FSM**

It is generally reckoned that FSM has a key role to play in the prevention of fire. Furthermore, it has been pointed out in the literature that “a common factor in many multi-fatality fires is the failure of the occupants of the building, whether management, staff or others, to take the correct action when a fire is discovered or when an alarm is raised” [11]. If a building is properly managed, it is contemplated that the chance of fire starting is greatly reduced, and the chance of successful evacuation of occupants will increase.

In the scene of Hong Kong where clusters of high-rise buildings are built, the importance of FSM is increasingly revisited [12]. However, under the

current legislation, there is only the Building Management Ordinance (BMO) [13] in place which is relevant to FSM.

#### **3.3 Legislation on FSM in Hong Kong**

The BMO enforced by the Home Affairs Department (HAD), facilitates the incorporation of owners of flats in a building in providing management. HAD can further impose mandatory management of buildings that are not managed or poorly managed. A Code of Practice on Building Management and Maintenance [14] had been published under Regulation 44(1) of the BMO to lay down the details of the management and safety for the communal areas of a building. Fire safety forms part of the elements within the Code. In general, it requires the owner or property manager to properly maintain both the passive and active fire protection measures and not to block the escape route. If the owner fails to comply with the fire safety aspects, the Fire Services Department (FSD) can issue a “Fire Hazard Abatement Notices, Direction, or Orders” to the owner or even to institute prosecution.

Although the BMO provides for governance on building management with respect to fire safety, the role of the property manager is not well-defined. Walters and Hastings [15] had stated that “if the government is serious about improving fire safety in buildings in Hong Kong, they should address the role and responsibility of the property managers in the fire legislation”. In a recent study, Tsui and Chow [16] also recommended that the property management company should appoint a suitably qualified fire protection manager to take account of the total fire safety issues such as preparation and implementation of a structured fire safety management plan, as well as the coordination with the FSM personnel of tenants and occupiers.

#### **3.4 Elements of FSM**

As suggested by Malhotra [7], FSM practice requires the preparation of a Fire Safety Plan which comprises Maintenance Plan, Staff Training Plan, and a Fire Action Plan. Moreover, Her Majesty Stationery Office [11] further postulates a Fire Prevention Plan which in effect deals with the “Fire Prevention” branch of the FSCT. The Fire Safety Plan can be depicted in Fig. 4 and details of each of these sub-plans are described as follows:

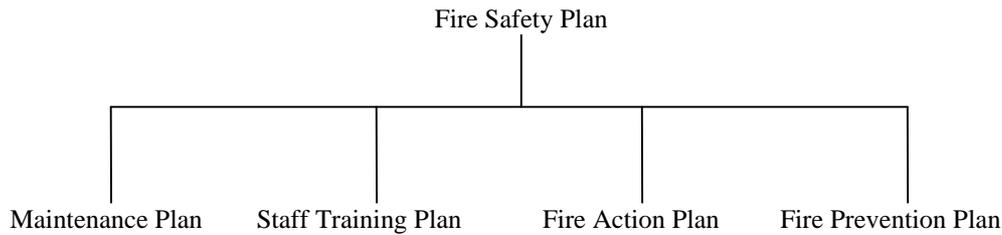


Fig. 4: Fire safety plan

- Maintenance Plan

A Maintenance Plan devises in detail how the passive and active fire services installations (FSI) of the building is regularly checked and tested to verify their functionalities. It is apparent that proper maintenance of FSI helps to assure that the fire safety systems can work as intended in case of fires. For instance, as a minimum, the hose reel system and fire alarm system is mandated to be tested by a Registered Fire Services Installation Contractor (RFSIC) once a year [17]. The escape routes are regularly patrolled to ensure that the fire door is not wedged open.

- Staff Training Plan

Staff should be familiar with the various procedures that have to be taken in a fire or similar emergency situation. Ample training to the security guards or other operational staff must be arranged once a building is occupied. Refresher training programme should also be organized from time to time to ensure that the staff are updated with the current procedures and are able to respond promptly and orderly under the fire situation. Typical training contents should include the designation of personnel (such as a fire officer) and delineation of their responsibilities; how to raise an alarm; how to guide occupants to a place of safety; how to use first-aid fire-fighting equipment; and how to provide the relevant building information to the fire officers upon their arrival etc.

- Fire Action Plan

The Fire Action Plan will document the actions to be taken by each member of designated staff once a fire is detected. The purpose is to assure that the staff take their roles effectively without panic. What have been learned in the training (such as calling the FSD, evacuation of occupants etc.) will be realized in the Fire Action Plan.

- Fire Prevention Plan

As pointed out before, fire prevention should be accorded the first priority in maintaining building fire safety. Experiences show that “most building fires are started by heat sources and ignitable materials that are brought into the building, not built into it [6]”. Therefore, control of the source of ignition and combustible materials is regarded as a first step of fire prevention. Procedures should be established through good housekeeping in the aversion of heat source and combustibles such as proper disposal of cigarette ends; limitation on storage of flammable substance, and regular removal of waste etc. Preventive maintenance of electrical and mechanical equipment should also be stressed as overheating of such equipment is a frequent cause of fire.

On the other hand, education to inculcate occupants on the fire precautionary measures should also be addressed. This may take the form of short classes, posting of posters, and distribution of educational leaflets.

In order to develop a structured Fire Safety Plan, a Fire Safety Manual is recommended. The details of the manual may depend on the complexity of the building concerned. Some typical contents of the Manual include: safety management structure, actions to be taken in an emergency, fire drills, housekeeping, planned maintenance procedures, staff training, continuous control and audit procedures, and security [18].

Besides the procedures in each of the sub-plan, the design assumption and parameters of the fire safety strategies should also be laid down in the manual for the reference of the fire safety personnel. This is particularly important for a building designed on performance based approach. Usually, FSM is dedicated as one of the strategies of fire safety in complex and large buildings where a lot of sophisticated fire engineering systems are installed. In a local example of the Lanham Place, the design consultant has already emphasized the importance

of transferring the Manual to the property management company as a fire safety package [19].

#### 4. FIRE STATISTICS IN HONG KONG

##### 4.1 Number of Fire Calls

Under the Fire Services Ordinance, the FSD is held responsible for extinguishing the fires and advising on fire protection measures [20]. After putting out the fires, the FSD will also compile and publish the fire call statistics on their website every year [21]. The fire statistics from year 2000 to year 2008 is extracted with the number of fire calls for “Public Rental Housing (PRH)”, other “Domestic Buildings” and the “Total Fire Calls” being shown in Fig. 5. It appears from the histogram that the number of fire calls in PRH is quite stable throughout the nine years; which is generally in the region of 1,500 cases each year albeit the increase in the number of housing stock.

##### 4.2 Classification of Fires by Causes

As revealed by the statistics, the total number of fire calls in year 2008 is 35,513 cases [21]. If we discard the five non-technical causes (namely unwanted alarm, false alarm, miscellaneous, deliberate act/undetermined, and unknown), the major causes of fires in year 2008 are (Fig. 6):

- Careless handling or disposal of cigarette ends, matches and candles (6.55%)
- Food stuff (stove overcooking) (5.25%)
- General electrical fault (2.24%)
- Careless disposal of joss sticks, joss paper and candles etc. (0.62%)
- Children playing with matches (0.33%)
- Over-heating of engines, motor and machinery (0.26%)
- Sparks from welding and oxygen acetylene cutting (0.23%)
- Control burning (0.04%)

Obviously, efforts on fire prevention should be concentrated on the first three causes. While the first two causes relate to the human behaviour of tenants which cannot be controlled other than intensifying on education, those fires arising out of electrical faults can be averted through regular maintenance and inspection of electrical installations. At present, it is a mandatory requirement to conduct “periodic inspection, testing and certification” (PITC) to “fixed electrical installation” with a rated capacity over 100 Amperes at least once in every 5 years [22]. As far as the in-flat wiring is concerned, PITC is not a must since the rated capacity is only 60 Amperes. Nevertheless, in recognition of the potential aging problem of wiring, HKHA has developed a regular programme of “Rewiring inside Domestic Flats” (RDF) which will be described in more detail below.

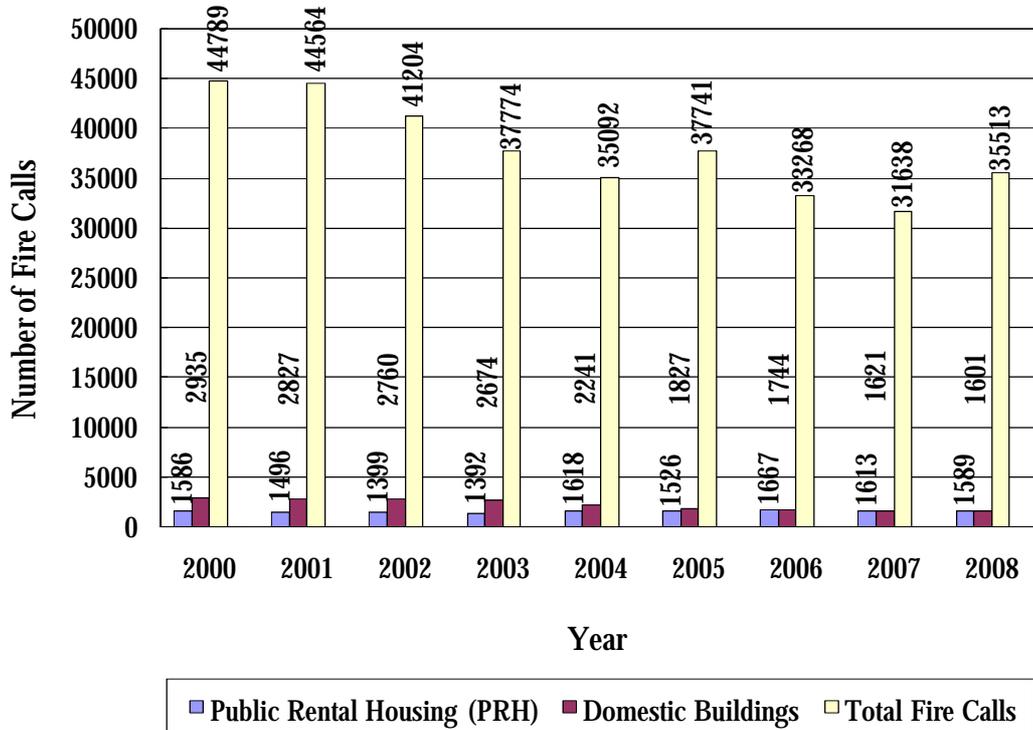


Fig. 5: Fire statistics in Hong Kong

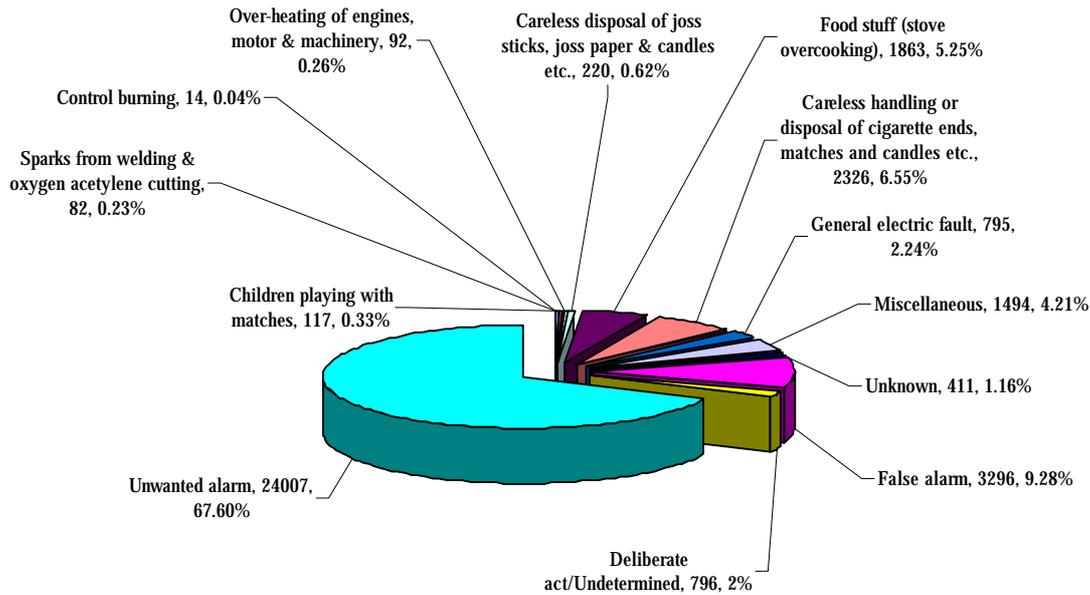


Fig. 6: Classification of fires by causes in 2008

## 5. POLICY AND PRACTICE OF FSM IN HKHA

### 5.1 FSM Procedures

Before a FSM system is put in place, the level of FSM should be specified. According to the BSI, there are three levels of FSM and a total of nine principal factors should be considered in assessing the level required [10]:

- Planning for changes in risk profile
- Resources and authority
- Staffing level
- Fire training
- Work control
- Communication procedures
- Maintenance and testing of fire safety systems
- Liaison with fire and rescue service
- Contingency planning

The HKHA manages a stock of 1098 rental buildings and Level 1 FSM (which is the highest level) is generally adopted as recommended for residential buildings. The above nine factors are addressed apart from the fact that there is no formal “Permit to Work” system for “hot work”. The various FSM practices and procedures are summarized in Appendix A under the four sub-headings of the Fire Safety Plan, i.e., a full coverage on Fire Prevention Plan, Maintenance Plan, Staff Training Plan, and Fire Action Plan.

### 5.2 Maintenance of Building Services System

As pointed out earlier by NFPA [6], “mechanical or electrical failure” is one of the fire prevention factors. Proper maintenance of building services plants and equipment is therefore a contributing factor in reducing the likelihood of fires, let alone the enhancement in the system reliability and the reduction in downtime. By recapitulating Fig. 6, one can see that about 2.24% of fires are due to electrical faults in year 2008.

All along, HKHA adopts a preventive maintenance strategy [23] in dealing with the maintenance of the communal building services systems. All the plants and equipments in the public area and plant rooms are regularly inspected, checked, tested and repaired as per statutory requirements and plant condition. Core building services improvement programmes such as “Pump Renovation”, “Electrical Reinforcement and Rewiring”, “Lift Modernisation”, “Addition of Addressable Fire Alarm System”, and “Upgradation of Security System” are also executed to bring up the building stock to present day living standard and to uplift the asset value.

On the other hand, HKHA is responsible for the maintenance of the internal services and landlord’s provisions inside flats provided that the installations have not been altered or tampered with by the tenants, and any such defects are attributable to fair wear and tear [24]. The typical building services inside flats comprise electrical, communal

aerial broadcasting distribution, door phone, and gas installations.

Whilst repair works on the in-flat installation are dealt with on a day-to-day basis upon request by tenants, such installation is also replaced and improved as appropriate during vacant flats refurbishment upon moving out of tenants. Moreover, annual appraisal on the condition of internal wiring will be carried out for estates with ages over 20 years. Replacement of internal wiring will be arranged where necessary under the RDF rolling programme [25]. According to the experience by HKHA during in-flat repairs, the

landlord’s wiring inside flats is in sound condition, while most alteration and fitting-out works on the electrical installation by the tenants are not up to safety standard. The RDF programme will definitely remove the fire hazard incurred by electrical faults due to substandard alteration works by the tenants. Incidentally the number of final circuits and socket outlets have been increased thereby obviating the need to use adaptors.

In order to visualise the routine maintenance and shutdown of FSI in particular, the workflow is indicated in Fig. 7 and Fig. 8 respectively.

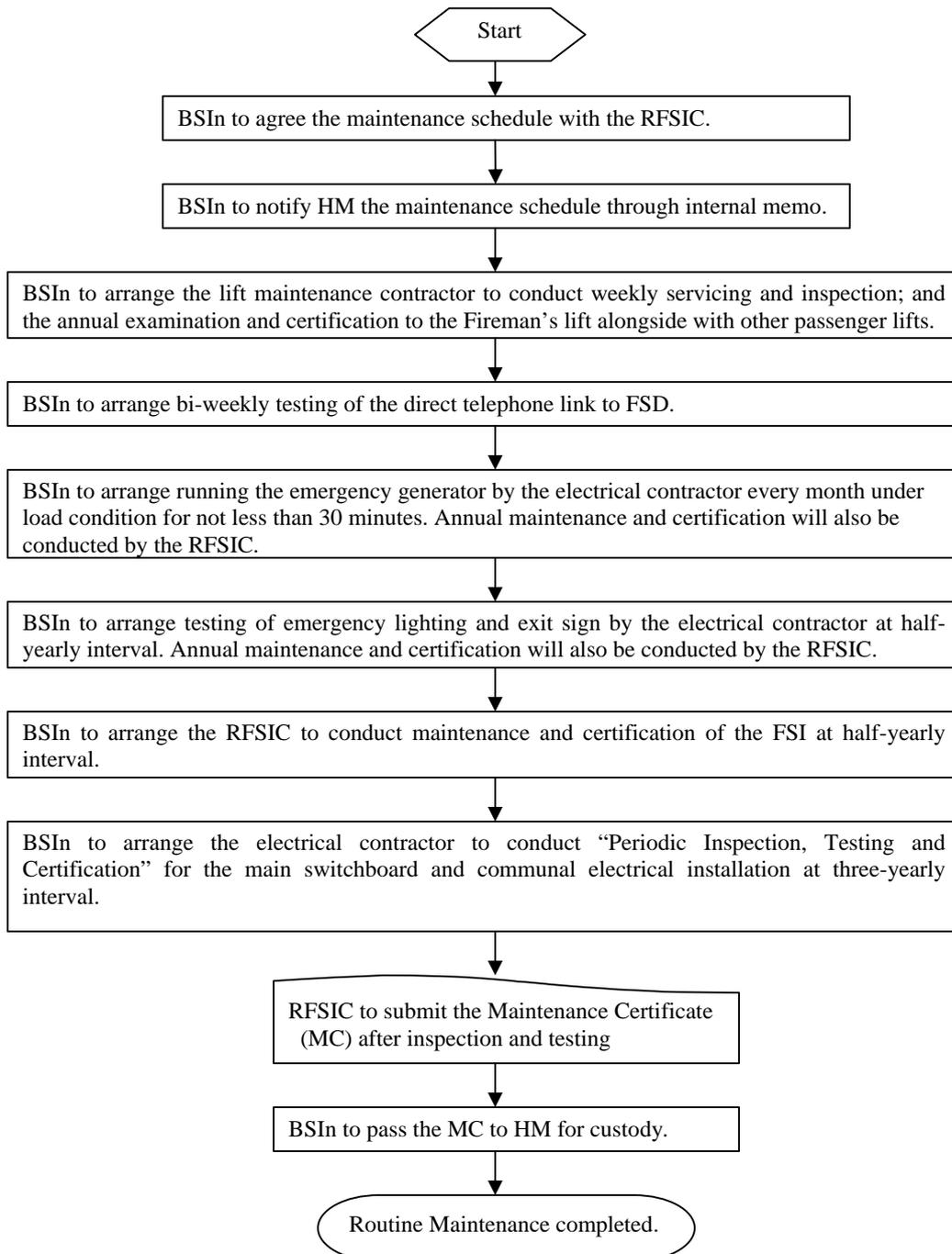


Fig. 7: Workflow of routine maintenance to FSI

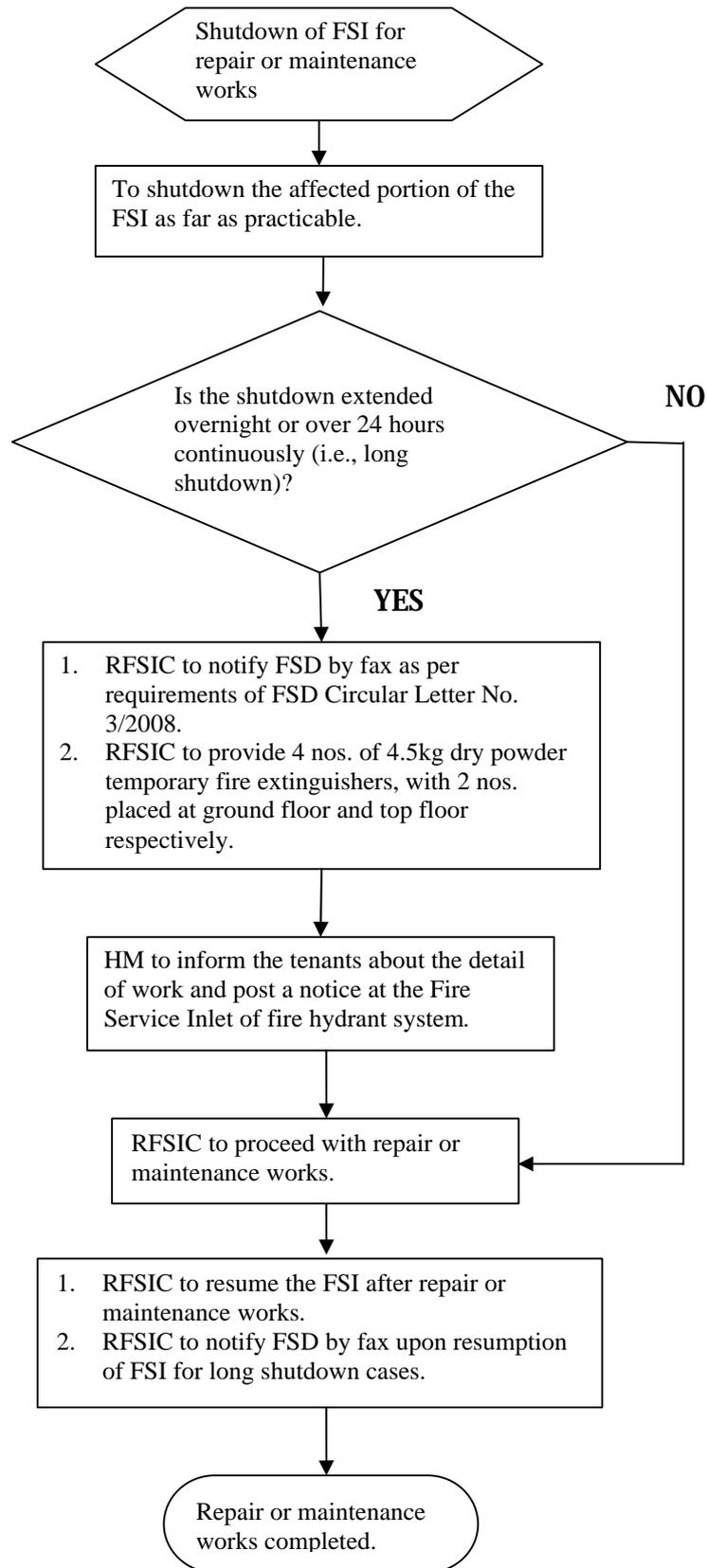


Fig. 8: Flow chart for shutdown of FSI

### 5.3 Improvement to FSI

It is HKHA's policy to improve and bring up the standard of the FSI to present day standard as far as practicable. During the past years, the upgradation works on FSI include the following:

- Wet fire hydrant systems have been retrofitted in some older estates without such provisions.
- Emergency lighting, directional signs and exit signs have been retrofitted in some older estates without such provisions.
- The FSI in the shopping centres and supermarkets have been upgraded as per the Fire Safety (Commercial Premises) Ordinance [26].
- The smoke detectors inside those blocks purposely designed for accommodating the elderly have been replaced with standalone smoke detectors. The modification works manifests to be effective in obviating the unwanted building false fire alarms due to burning of incense inside flats, smoking, and cooking etc.

### 5.4 Education to Tenants

HKHA has invested heavily on the publicity and education to tenants on fire safety. This is achieved through the publication of various information brochures and the organizing of a series of fire safety campaigns. Representatives from the Estate

Management Advisory Committee are particularly invited with a view to increasing the cohesion of the tenants.

Starting from 1999, HKHA has launched jointly with the FSD the Fire Safety Ambassador scheme to promote a proper fire safety culture amongst the residents. In addition, a "Fire Safety Education Path" has been set up in various estates to inculcate the tenants on awareness and knowledge of fire safety.

In the years 2005 and 2007, HKHA commissioned an independent consultant to conduct survey on fire safety awareness of tenants [27,28] to gauge the effectiveness of past educational endeavours. In the survey, the consultant adopted the stratified random sampling method to select the buildings with different age. Household members aged over 18 of the selected flat would be interviewed through the telephone. A total of over 1500 interviews were conducted each time with a response rate of about 70%. The survey results depicted in Table 2 below clearly demonstrate that the fire safety knowledge and awareness has significantly increased during the time lapse of just two years.

For example, tenants are becoming more aware that "leaving the cooking stove unattended" is a major cause of household fires; and the observation by tenants that there are obstructions in the corridor reduced from 10% in 2005 to 7% in 2007.

**Table 2: Survey results on fire safety awareness of tenants in public rental housing**

	Survey result in 2005	Survey result in 2007
<b>A. Fire Safety Knowledge</b>		
1. Perceived main causes of fire		
1.1 Leaving stove on when nobody is at home	46.0%	88.3%
2. Fire safety awareness of tenants		
2.1 Respondents observed that the smoke doors were being opened in the week before the survey	11.6%	10.2%
2.2 Respondents observed that there was obstruction in the corridor or staircase in the week before the survey	10.0%	7.0%
2.3 Respondents are familiar with the location of emergency exit	97.2%	97.7%
3. What to do in case of fire		
3.1 To activate the fire alarm	65.8%	70.1%
3.2 To bring wet towel for escape	37.2%	40.1%
3.3 To use staircase for emergency escape	99.0%	98.7%
<b>B. Effectiveness of Educational Activities</b>		
1. Respondents are aware of educational activities and messages hosted by HKHA	69.2%	71.8%
2. Respondents are willing to participate in fire drill	63.2%	68.5%
3. Respondents are willing to participate in educational activities	50.0%	63.2%
4. Vandalism observed by respondents	3.0%	2.1%

## **5.5 Liaison between HKHA and FSD**

In view of the high population density residing in PRH, there is a special inter-departmental liaison between the HKHA and FSD. A “Major Disaster Manual” [29] has been prepared to outline the overall alerting system and contingency plan in response to different kinds of major disasters including fire and explosion.

The Fire Services Communication Centre (FSCC), which is the centralized Command and Control Centre of the FSD, is responsible for receiving emergency calls and dispatching Fire Services resources to respond to the incidents. In the event of any incidents channeled through the 999 hotline, the FSCC will deal with it and monitor the development of the incident. In case of a Number 3 or higher alarm fire, the relevant District Officer of the HAD will co-ordinate the setting up and operation of an inter-departmental helpdesk at the scene amongst other government departments. Temporary accommodation will also be provided to those rendered homeless arising out of disastrous fire.

## **6. CONCLUSION**

Fire safety in buildings comprises three elements namely passive fire protection, active fire protection, and FSM. The role of FSM has been increasingly re-visited in recent years. Good FSM is considered as fundamental to the design, use and occupancy of buildings. When a building is designed on the principles of performance-based approach, the contribution of FSM becomes an indispensable part of the design package. The design assumptions and operational conditions must be kept under surveillance to ensure that the safety level is maintained throughout the life cycle of the building according to the design parameters. Actually, proper FSM is a “cradle to crave” business under such circumstances [30]. The effective control on the building fire load and occupant load serves as excellent example on core FSM practice.

In this paper, the FSM practice and procedures in HKHA has been reviewed. As an overall, the practice is found to be structured and well-organised. Apart from the fact that there is no formal control mechanism for “hot work” from contractors, the various Fire Prevention Factors are generally addressed. Furthermore, education on fire safety to tenants has been taken seriously. As unveiled by recent Consultancy Reports on “Survey on Fire Safety Awareness of Tenants in Public Rental Housing”, it is found that the fire safety knowledge of tenants have improved in the

past years [27,28]. The educational process is deemed effective.

The FSI are generally maintained at half-yearly interval by RFSIC which is above the statutory requirement of once a year [31]. The reliability and availability of the active fire fighting systems is greatly assured. The shutdown of FSI is closely monitored under stringent departmental procedures and extra fire extinguishers are provided during the shutdown interim [32]. The communication with the FSD is seamless through special arrangements between FSD and HKHA especially under disasters such as large fire of Number 3 alarm and above [29]. Adequate training is offered to the staff both from within and outside the organization and their role of individual staff are clearly defined.

HKHA is the landlord of some 1098 rental building blocks with some “older buildings” aged at 45 years. The “older buildings” constructed many years ago may not comply with present prescriptive fire safety code requirements. Yet there is no compromise on the life safety objective in view of the huge number of residents involved. While endeavors on alteration and improvement works on fire safety provisions are always taken by HKHA, there may still be technical constraints such as locating suitable accommodation space for installing standby generators, space constraint on constructing smoke lobby etc. Moreover, the nuisance caused to the tenants during the extensive period of alteration works may sometimes be politically unpalatable. It is a general acceptance that good FSM plays a key role in elevating the fire safety level of a building as “Fire Prevention” branch of the FSCT is heavily addressed. It is contemplated that the fire safety performance of those “older buildings” managed by HKHA may not be inferior to that of the newly constructed ones because of good management.

At present, there is little information available on quantifying the contribution of good FSM in reducing the fire risk of buildings. It is suggested that further research can be conducted to evaluate the quantitative effect of structured FSM so that its role can be clearly established. Furthermore, the extent of modification works to those “older buildings” can be narrowed while retaining an acceptable risk level. As a start, the FSCT is recommended for analyzing the various fire safety strategies in those “older buildings” and a risk based approach [33] can be adopted to assess the various options of improvement work; with enhanced FSM being one of the alternatives.

## REFERENCES

1. Hong Kong Government, Hong Kong Government Publication, Hong Kong (1996).
2. Laws of Hong Kong, Housing Ordinance, Chapter 283, Hong Kong (2008).
3. Hong Kong Housing Authority, HAHA Housing Stock Statistics (2009).
4. National Research Council, National Building Code of Canada, NRCC No. 38726, Ottawa, Canada (2005).
5. National Fire Protection Association, NFPA 550, Guide to the fire safety concepts tree, Quincy, MA, USA (2007).
6. National Fire Protection Association, Fire Protection Handbook 20<sup>th</sup> edition, Quincy, MA, USA (2008).
7. H.L. Malhotra, Fire safety in buildings, Building Research Establishment Report, Department of the Environment, Building Research Establishment, Fire Research Station, Borehamwood, Herts, UK, (1987).
8. D.J. Howarth and C. Kara-Zaitri, "Fire safety management at passenger terminals", Disaster Prevention and Management, Vol. 8, No. 5, pp. 362-369 (1999).
9. British Standards Institution, Public Available Specification PAS 79: Fire risk assessment-Guidance and a recommended methodology, UK (2007).
10. British Standards Institution, BS 9999: Code of practice for fire safety in the design, management and use of buildings, UK (2008).
11. Her Majesty Stationery Office, Design principles of fire safety, Brikerdike Allen Partners, London, UK (1996).
12. W.K. Chow, "Review on fire safety management and application to Hong Kong", International Journal on Engineering Performance-Based Fire Codes, Vol. 3, No. 1, pp. 52-58 (2001).
13. Laws of Hong Kong, Building Management Ordinance, Chapter 344, Hong Kong (2007).
14. Home Affairs Department, Code of Practice on Building Management and Maintenance, Hong Kong (2000).
15. M. Walters and E.M. Hasting, "But is fire the issue ...? The problems of managing multiple ownership buildings in Hong Kong", Property Management, Vol. 16, No. 4, pp. 229-235 (1998).
16. S.C. Tsui and W.K. Chow, "Legislation aspects of fire safety management in Hong Kong", Facilities, Vol. 22, No. 5/6, pp. 149-164 (2004).
17. Fire Services Department, Codes of Practice for Minimum Fire Service Installations and Equipment and Inspection, Testing and Maintenance of Installations and Equipment, Hong Kong (2005).
18. International Organisation for Standardisation, ISO/TR 13387-1, Fire safety engineering-Part 1: Application of fire performance concepts to design objectives, Sweden (1999).
19. S.C. Tsui and M.C. Luo, "Performance-based Fire Safety Design-A Long-term Commitment in Building Operation Management", Joint Symposium on New Challenges in Building Services, the Hong Kong Institution of Engineers and the Hong Kong Polytechnic University, 15 November 2005, Hong Kong, pp. 129-138 (2005).
20. Laws of Hong Kong, Fire Services Ordinance, Chapter 95, Hong Kong (2005).
21. Fire Services Department, Fire statistics, Hong Kong (2009). Available at: <http://www.hkfsd.gov.hk/home/eng/statistic.html>
22. Laws of Hong Kong, Electricity (Wiring) Regulations, Chapter 406 Subsidiary Legislation E, Hong Kong (2005).
23. Chartered Institution of Building Services Engineers, CIBSE Guide M: Maintenance engineering and management, CIBSE, London, UK (2008).
24. Hong Kong Housing Authority, Estate Management Division Instruction No. P13/2009, Demarcation of in-flat maintenance responsibilities and control of tenant's alterations for domestic rental units (2009).
25. Hong Kong Housing Authority, Estate Management Division Instruction No. S01/2007, Comprehensive planned maintenance for electrical wiring inside domestic flats: Wiring condition appraisal, rewiring inside domestic flats (RDF) and inspection, testing & certification of wiring inside domestic flats (2007).
26. Laws of Hong Kong, Fire Safety (Commercial Premises) Ordinance, Chapter 502, Hong Kong (2004).
27. Hong Kong Housing Authority, Consultancy report of "Survey on fire safety awareness of tenants in public rental housing" (2005).
28. Hong Kong Housing Authority, Consultancy report of "Survey on fire safety awareness of tenants in public rental housing" (2007).
29. Hong Kong Housing Authority, Major disaster manual (2009).
30. V.M. Brannigan and S.M. Spivak, "ISO quality standards for participants in performance-based regulation", ASTM's role in performance-based fire codes and standards, pp. 14-22 (1999).
31. Laws of Hong Kong, Fire Service (Installations and Equipment) Regulations, Chapter 95 Subsidiary Legislation B, Hong Kong (2004).
32. Fire Services Department, "Shutdown of fire service installation for inspection, maintenance, modification or repair", FSD Circular Letter No. 3/2008, Hong Kong (2008).

33. M.C. Hui, "How can a fire risk approach be applied to develop a balanced fire protection strategy", *Fire Protection Engineering*, Spring 2006, pp. 12-21 (2006).
34. Hong Kong Housing Authority, Paper no. K11, *Fire safety in estates* (2007).

## **APPENDIX A : FIRE SAFETY PLAN OF HONG KONG HOUSING AUTHORITY [34]**

### **1. Fire Prevention Plan**

- 1.1 Emergency Vehicular Access (EVA)
  - 1.1.1 To maintain an updated EVA layout plan of each estate and put up on the estate notice board. Prior approval must be sought from the FSD for any subsequent alteration works that may affect the EVA.
  - 1.1.2 To erect signage at entrance to EVA warning the public that it should be kept clear and free from obstructions at all times.
  - 1.1.3 To tow away vehicles that parked illegally along the EVA.
  - 1.1.4 Estate Assistant (EA) to patrol the EVA daily to ensure that the EVA is clear from obstruction and the road surface is level.
- 1.2 Fire escape route in each building
  - 1.2.1 EA to patrol the building daily and to make sure the smoke lobby doors are closed at all times. Defective smoke door to be repaired once discovered.
  - 1.2.2 To arrange for removal of all obstruction items such as furniture, bicycles, decoration materials from fire exits in accordance with the authority vested by the Housing Ordinance.
- 1.3 Disposal of domestic refuse
  - 1.3.1 The cleansing contractor is to arrange disposal of domestic refuse daily.
- 1.4 Fire drills
  - 1.4.1 Housing Manager (HM) is required to arrange with the local fire station on fire drill every year. After the drill, the fire officer will conduct a briefing to the tenants on the proper operation and use of the fire hose reel and fire extinguishers.
  - 1.4.2 In order to make the drill more effective, HM should extend invitation to "Estate Management Advisory Committee" members to participate as they are the core representative of the tenants.
  - 1.4.3 Households requiring special assistance (such as disabled) should be encouraged to participate in the drill.
  - 1.4.4 After the drill, a review will be conducted to identify any inadequacy

such that future drill could be held better.

### **1.5 Fire Safety Manual**

- 1.5.1 A Fire Safety Manual will be prepared for each building to establish the management procedures, with one copy kept in security guard console in each building and the estate control room respectively.
- 1.5.2 HM will co-ordinate the updating of the Manual.
- 1.5.3 A list of households requiring special assistance during emergencies of individual estate should be kept in sealed envelope and attached to the Fire Safety Manual kept at the tower guard counters for FSD's reference during rescue operations.

### **1.6 Education and publicity**

- 1.6.1 Message on fire safety should be widely publicized through estate newsletter.
- 1.6.2 Message of prosecution against offenders on misuse of fire hoses should be publicized through estate newsletter.
- 1.6.3 Message to remind tenants to keep the kitchen doors closed should be publicized through estate newsletter.
- 1.6.4 HM to arrange annual "Estate Fire Safety Campaign" to promote fire safety and fire prevention. Tenants are encouraged to join the "Fire Safety Ambassadors" scheme as organized by the FSD.
- 1.6.5 To set up "Fire Safety Education Path" in various estates to promote and inculcate the tenants on awareness and knowledge on fire safety.

### **2. Maintenance Plan**

- 2.1 EA to inspect the FSI everyday for any obvious damage.
- 2.2 EA to inspect the hose reels every week for any damage to the nozzle, instruction plate, gate valve etc. Moreover, white mark will be provided on the tubing to indicate the length of 30m as required by the FSD. EA should inform the Building Services Inspector (BSIn) to arrange replacement of the hose in case of absence of such mark (e.g., due to vandalism).
- 2.3 EA to inspect the fire alarm bells and the manual alarm call points every week for any damage or obstruction.
- 2.4 EA to check for any missing fire extinguishers every week.
- 2.5 EA to inspect the heat/smoke detectors every week for any damage.
- 2.6 EA to inspect the sprinkler heads every week for any damage.

- 2.7 EA to inspect the fire hydrants every week for any damage to the hand wheel.
- 2.8 EA to inspect the fire pump room every week to make sure that the indicating lamp for the pump control panel is functionally properly, and there is no low level alarm of the associated water tank.
- 2.9 BSIn to arrange the lift maintenance contractor to conduct weekly servicing and inspection; and the annual examination and certification to the Fireman's lift alongside with other passenger lifts.
- 2.10 BSIn to arrange testing of the direct telephone link to the FSD at bi-weekly interval.
- 2.11 BSIn to arrange running the emergency generator by the electrical contractor every month under load condition for not less than 30 minutes. Annual maintenance and certification will also be conducted by the RFSIC. Diesel oil to be refilled after each test.
- 2.12 BSIn to arrange testing of emergency lighting and exit sign by the electrical contractor at half-yearly interval. The emergency lighting and exit sign will be operated under battery power supply for 1 hour. Annual maintenance and certification will also be conducted by the RFSIC.
- 2.13 BSIn to arrange the RFSIC to conduct maintenance and certification of the FSI at half-yearly interval.
- 2.14 BSIn to arrange the electrical contractor to conduct "Periodic Inspection, Testing and Certification" for the main switchboard and communal electrical installation at three-yearly interval.
- 2.15 Shutting down of FSI must be strictly on a need basis and the installation should be resumed as soon as possible. FSD will be notified for any shutdown overnight or exceeding 24 hours.
- 2.16 BSIn should monitor the shutdown of FSI and its progress, and to report any shutdown exceeding two weeks to the Building Services Engineer and Senior Building Services Engineer.
- 2.17 Four 4.5kg dry powder type extinguishers should be provided during the shutdown period, with two extinguishers placed at the ground floor and top floor respectively.

### **3. Staff Training Plan**

- 3.1 Training to HKHA staff  
HKHA will provide regular training to the patrol and estate management staff on the use of FSI in estates. BSIn are to arrange the demonstration to them annually. Web-based training modules and video compact disc (VCD) on fire safety for easy access and learning of staff has been launched.

- 3.2 Training to security guard  
The security contractor is required to provide the training to their guards to get familiar with the fire safety knowledge and Fire Safety Manual. The VCD as prepared by HKHA is also provided to the security contractors to facilitate their training.

### **4. Fire Action Plan**

- 4.1 In case of fire alarm, the Tower Guard (TG) in the building concerned should immediately find out from the fire alarm control panel the zone and location of suspected fire.
- 4.2 The TG shall inform the FSD immediately.
- 4.3 The TG shall keep communication with and seek assistance from the Estate Control Room supervisor who will mobilise other staff to assist in evacuation etc.
- 4.4 In case of false alarm, TG should try to mute/silent the building fire alarm as soon as possible to minimize noise nuisance. However the fire alarm system should not be reset until the false alarm is verified and the cause of the false alarm investigated by the BSIn.
- 4.5 The guard should try to put out the fire by hose reels or fire extinguishers if safe to do so.
- 4.6 A tailor-made evacuation plan for blocks having a high concentration of elderly residents should be prepared by the HM of those particular blocks.