FIRE SAFETY MANAGEMENT FOR SMALL AND MEDIUM ENTERPRISE OFFICES IN Old INDUSTRIAL BUILDINGS

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ABSTRACT
With the change of the economic structure, most of the old industrial buildings built before 1972 in Hong Kong are now used as offices or non-industrial workplaces. Those old buildings might not have adequate fire safety provisions and it is difficult to upgrade these hardware provisions too. The occupational safety and health problems on fire safety are even more serious if the offices are used for small and medium enterprises which have special characteristics of small areas packed with large quantity of combustibles and high occupant loading. There is limited investment on safety in those offices.

This paper aims to solve the aforementioned problems by applying a total fire safety concept to the old industrial buildings. To provide adequate fire safety, software fire safety management schemes should be worked out carefully. Actions to be taken in the management schemes are recommended to control and integrate hardware passive building construction, active fire services installations and control of risk factors. How a fire safety plan can be prepared by recommending a maintenance plan, a staff training plan, a fire prevention plan; and a fire action plan to outline the procedures clearly with normal mode is illustrated in the paper.

KEYWORDS
Fire safety management, Small and medium enterprise offices, old industrial buildings

INTRODUCTION
As surveyed (Chow 2006), small and medium enterprises (SME) in Hong Kong included those manufacturing enterprises with fewer than 100 employees and those non-manufacturing enterprises with less than 50 employees. SME is usually of limited investment. Most of them are housed in old industrial buildings, as most factories have moved to the Mainland. Industrial buildings constructed before 1972 do not have much fire safety provisions as now, because the fire safety codes were not so well-developed. There is insufficient funding for SME to upgrade the fire safety provisions. Therefore, occupational safety and health problems related to fire for such SME offices, especially in non-industrial workplaces of old industrial buildings are a concern.

There are no statutory fire safety requirements on SME yet. Fire precautions in workplaces of non-industrial sectors follow those requirements for factories, i.e. Factories and Industrial Undertakings Ordinance (FIUO) and its subsidiary regulations (Labour Department). Such provisions might not be suitable for non-industrial workplaces. It is not convincing to apply the Occupational Safety and Health Ordinance (OSHO) (Cap 59) issued on 23 May 1997 (Laws of Hong Kong 1997) and the Guidance Notes on Fire Safety at Workplaces by the Occupational Safety and Health Branch of the Labour Department for such non-industrial workplaces without detailed studies. A project aimed at surveying the current situation (Buildings Department 1995a, 1995b, 2004, Fire Services Department 2005) and exploring what to be studied was worked out (Chow 2006).
Special characteristics of these small and medium enterprises are that the offices are small and packed with large quantity of combustibles, but with many people staying inside the building. The problem is even more serious when the offices are located in industrial buildings. Those buildings built years ago might not have adequate fire safety provisions. It is difficult to upgrade their hardware fire safety provisions.

**TOTAL FIRE SAFETY CONCEPT**

As reported in the literature (Chow 2002, 2004), passive building construction, active fire protection systems (Labour Department) and fire safety management (Malhotra 1987) should be integrated to give total safety.

**Passive building construction**
Providing passive building construction (Buildings Department 1995a, 1995b, 2004) is to reduce the chance of having an accidental fire. This can be achieved by selecting building materials and components more difficult to ignite. Even if the material is ignited, the heat release rate is kept as low as possible at the early stage of a fire. The flame spreading rate is slow and the fire should be confined within the place of origin without affecting the adjacent areas. Compartmentation with adequate fire resistance should be provided. The building structure should be able to stand the fire for some time so that occupants can evacuate safely, and fire fighters are able to enter the field to take appropriate actions.

**Active fire protection systems (or fire services installations)**
Active fire protection systems (Fire Services Department 2005) are necessary for detecting a fire, giving early warnings so that management can report to the fire brigade, and might attempt to control the fire. Three terms on ‘control’, ‘suppress’ and ‘extinguish’ a fire must be distinguished. Control the fire means to restrict the growth of the fire, suppress the fire means to reduce the fire size and extinguish the fire means to ‘stop’ it completely.

**Fire safety management**
Passive building construction and active fire protection systems are only ‘hardware’ provisions as in a computer system. Good hardware might not necessarily provide adequate fire safety. Safety management schemes (Chow, 2004) are ‘software’ and they are essential in the total fire safety concept. A fire safety plan should be prepared based on hazard assessment. There should be a maintenance plan; a staff training plan; a fire prevention plan and a fire action plan.

**FIRE SAFETY PLAN**
A fire safety plan should be worked out to cover four areas (Malhotra 1987, Chow 2002) with a maintenance plan; a staff training plan; a fire action plan; and a fire prevention plan. Fire prevention plan is suggested to be included for some bigger organizations and it would identify the use and maintenance of items which could be an ignition source, or to use combustibles which can lead to rapid fire spreading upon ignition. Examples are taking care of electrical appliances, waste materials and rubbish. In other words, ‘housekeeping’ should be done properly.

Two modes of operation are recommended on normal mode NM; and emergency mode EM. There would be no management elements for fire action plan in NM. Similarly, no management elements on maintenance plan, staff training plan and fire prevention plan under EM.

**NORMAL MODE ON PASSIVE BUILDING CONSTRUCTION**

**Maintenance plan**
- Get approval and meet the fire safety standards of the authorities for any alteration, renovation, relocation of partitions or reconstruction works of the SMEs.
• Size the means of egress to handle the number of persons intended to occupy the space or according to that calculated using the specified occupant loading, whichever is larger.
• Ensure the means of egress are well-illuminated with sufficient emergency lighting.
• Ensure the number of persons intended to occupy the space or according to that calculated using the specified occupant loading, whichever is larger.
• Ensure the escape routes are clearly directed by exit signs.
• Ensure all the escape routes, including fire exits, smoke lobbies, staircases and doorways are clear of any obstructions such as furniture items, goods, rubbish bins or any illegal constructions of storage cabinets etc. at all times.
• Ensure the access to ground level, roof or refuge floors is not closed with doors or gates unless they are unlocked and readily open towards the direction of exit without using keys.
• Repair and fix the smoke doors if any damage is found.
• Maintain the smoke doors regularly to ensure proper operation and keep them in good physical conditions.
• Ensure the hinges of the smoke doors are not damaged and that they can be opened and closed smoothly and readily.
• Ensure the smoke doors are kept properly closed at all times so as not to allow fire or smoke spread to the other parts of the evacuation routes.
• Ensure the smoke and exit doors are unlocked and open in the direction of evacuation.
• Inspect frequently the automatic closures and fusible links of the fire doors, if any.
• Ensure the required effective widths of evacuation routes are maintained by keeping the routes clear of obstructions.
• Maintain a well-constructed building that allows occupants enough time to escape in case of fires by ensuring the separating walls and partitions have the necessary fire resistance period (FRP).
• Maintain the structures with certain fire rated hours for the firemen to have long enough time to fight fires and escape from the scene.
• Improve the fire resistance by spraying appropriate paints or coatings to the partition materials to delay the ignition time of the materials.
• Minimise the openings made by the services such as ducts, pipes and cables passing through the fire-resisting walls and floors and pay attention to the details of the designs.
• Ensure sprinkler systems meeting the statutory requirements are installed in the establishments with fire resisting construction (FRC) not complying with the codes.
• Provide appropriate fire resistance to refurbished structures in tall buildings since premature collapse of those would lead to serious consequences.
• Ensure a strong refurbished or temporary structure with sufficiently long FRP for the rescue of people by firemen at the basements since no collapse of structures should endanger their lives.
• Ensure the FRP under BS 476 of the corridor walls and the partitions are 2 hours; and rated as Class II or below for surface spread of flame under BS 476; or equivalent by routine checking, especially after refurbishment works.
• Ensure active systems on enhancing passive protection, such as fire extinguishers (FE), fire detection (FD) and smoke control (SC) systems are maintained.
• Ensure the evacuation routes and exits are clearly indicated by more exit signs for the evacuation of occupants at dead-ends.
• Watch carefully for SMEs with limited distance i.e. sum of the direct distance in the room and the travel distance in the corridor exceeding 18 m.
• Ensure the number of occupants in the offices or shops at dead-end corridors are within limit.

**Staff training plan**

- Trained to understand more on proper operation and functioning of complicated building elements such as fire doors, protected corridors and curtain walls in order not to cause safety problems.
• Be familiar with the escape routes and alternative means of escape in fires.
• Practised to be familiar with zone evacuation for the SMEs and be able to direct occupants to evacuate in phases in case of fires.
• Trained to remind the occupants of those SMEs at basements to escape in upward direction in emergencies.
• Trained to avoid evacuation problems from those SMEs in high-rise buildings where the normal access is through lifts.
• Ensure an effective evacuation of occupants from the SMEs within the FRP of the construction as that may not be able to withstand the fire and may collapse after a certain period of time.
• Be familiar with the number and exact locations of dead-end corridors from the layout or during site inspections in the SMEs.

NORMAL MODE ON FIRE SERVICE INSTALLATIONS

Maintenance plan
• Ensure all the FSI meet the latest statutory regulations, requirements and codes issued by Fire Services Department (FSD) on their operations and maintenance.
• Seek advices from fire experts including fire surveyors from insurance companies to recommend fire prevention and protection measures.
• Ensure preventive maintenance is carried out in schedule for all the fire services equipment to be functioning normally, properly and safely for immediate response.
• Ensure the FSI are operative by regular scheduled testing and inspections carried out at regular interval, say once every 12 months, by registered FSI contractors since most of the systems are infrequently used.
• Remind the management company to make early arrangement on the inspection of FSI in the SMEs.
• Ensure emergency power supply is available for all the emergency services and the maintenance and testing of the emergency equipment is carried out periodically.
• Check the fire hydrant/hose reel (FH/HR) according to the inspections and testing checklists and procedures listed in the FSI code.
• Ensure adequate clearances are provided around the hydrant outlet and valve for the free use of the FH.
• Ensure an effective width of exit route is maintained without being reduced by the FH.
• Keep the HR unobstructed.
• Ensure the cradle type HR can be swung freely into the corridor or passage without any blockage.
• Ensure the doors of the HR cabinets or recesses are not provided with locks.
• Ensure that when the doors of the HR are in open positions, they should not cause undue obstructions and interference with any exit point or any means of escape.
• Ensure that there is no damage to the tubing of every HR and the jet nozzle is unbroken.
• Ensure the tubing of the HR is permanently connected and properly wound around the drum without kinking.
• Ensure the 30-meter tubing of HR can reach every part of the SMEs without any blockage by obstructions.
• Ensure the manual Fire Alarm (FA) call points are clearly seen and accessible.
• Check the FA systems in fire drills and in accordance to the testing procedures in the FSI code.
• Consider an alternative backup for the alarm system since it may become inoperative in case of fires.
• Ensure the FA system is well-communicated with the central control room if any.
• Link the FA system to the nearest fire service station for automatic notification.
• Test the manual FA points when the whole FA system is required to be tested in accordance with the appropriate standards.
• Ensure an independent indication of the locations of the manual FA call points according to the zoning.
• Test the FD systems and components in accordance with appropriate FSD standards.
• Check the smoke detectors once a month and change the batteries at least once a year.
• Adjust the sensitivities of the smoke detectors to match with the general smoke densities in the offices or shops since smoking is usually allowed in SMEs.
• Ensure the smoke detectors are clean and not covered with dust that may affect the sensitivities of detection.
• Keep the smoke detectors in good conditions.
• Ensure the sprinkler systems are tested in accordance with the testing procedures in appropriate FSD standards.
• Keep the sprinkler heads in good conditions.
• Keep adequate clearance from the sprinkler heads, and the sprinkler heads are not blocked by high stack of goods.
• Carry out maintenance by following some comprehensive and typical schedules or checklists for testing and maintenance for the sprinkler system.
• Carry out visual inspection of the sprinkler systems regularly to check the proper positioning of control valves, condition and clearance.
• Ensure the sprinkler heads are not covered with dust that may affect the sensitivities of detecting and responding to fires.
• Ensure the number of suitable types of FE are adequate, available throughout the SMEs, inspected and tested according to appropriate FSD standards and manufacturer’s instructions.
• Ensure the number and locations of the FE are the same whenever counted and replace any missed ones.
• Follow the testing procedures of SC systems according to appropriate standards.
• Ensure the fire dampers inside the ductwork are in good operation in case of fires.
• Ensure all the emergency lighting is in good condition, and testing under the testing and maintenance procedures in the code.
• Ensure all batteries of the emergency lighting circuits are kept fully charged at all times and are capable of maintaining the stipulated lighting levels for a period of not less than two hours.
• Emergency lighting installed shall be tested annually by the appropriate power supply company.
• Ensure all the exit signs are in good condition and clean.
• Ensure all the exit signs are tested according to the procedures in the FSI code.
• Ensure all exit signs especially those low level directional exit signs are clearly visible and not blocked by any obstructions.
• Test the exit signs whenever an emergency lighting system is tested.
• Ensure the properly designed and operated FD systems at dead-end corridors are tested and maintained properly.
• Ensure extra FE at dead-end corridors are in good condition.
• Ensure the zone SC concept is applied in offices or shops at dead-end corridors.
• Ensure the mechanical SC systems in offices or shops at dead-end corridors can maintain positive pressures at those offices or shops by continuous supply of fresh air and also for an additional protection against the smoke ingress.
• Ensure the extra number of exit signs are well maintained to provide with clear indication of the evacuation routes and exits for the evacuation of occupants at dead-end situations.

Staff training plan
• Have in-depth knowledge of all the operations and mechanisms of the FSI or mechanical
ventilation systems installed.

- Update the knowledge of fire control and protection systems from time to time.
- Note the number and locations of FH and HR in the SMEs.
- Be trained to operate HR (not for liquid and electrical fires) following proper procedures as stated in the FSI code (Fire Services Department 2005) on i) break glass of the FA call point or actuate FA call point first; ii) then, open control valve before running out hose; and iii) turn on water at nozzle and direct jet at base of fire.
- Know and clearly mark the exact locations of the manual break glass units in the SMEs.
- Ensure audible alarms and warnings can be clearly heard by occupants in every part of the SMEs even in isolated areas.
- Ensure precise signals to be conveyed to the occupants.
- Provide public address systems to announce the fires and instruct the occupants the appropriate actions to take in case of fires.
- Conduct simple and direct messages to the occupants through the public address systems and also keep them calm.
- Ensure messages with a sense of urgency are conveyed to motivate the occupants to evacuate promptly in the correct and safest way.
- The fire safety manager should ensure sprinkler systems are maintained regularly and kept properly as stated in above.
- Give instructions to other staff and perform regular inspections on the sprinkler system by the fire safety manager with proper training from the sprinkler installing company and also adequate knowledge and a thorough understanding of the system.
- Trained to use suitable FE with sufficient instructions.
- Know the number and locations of all the FE available in the SMEs.
- Know the functions of various extinguishers and how to choose appropriate types such as gas, powder, water and foam FE to fight small fires.
- Understand the indoor air movement pattern in the SMEs.
- Trained to identify the ‘downstream’ area of the mechanical, ventilation and air-conditioning (MVAC) systems where smoke will be accumulated.

CONTROLLING RISK FACTORS UNDER NORMAL MODE

Maintenance plan

- Identify the fire hazard scenarios of a particular SME related to storing combustibles.
- Identify the possible losses of accidents and hazards due to ignition of the combustibles stored.
- Control losses resulted from human behaviour or environmental causes.
- Carry out routine inspections on controlling the causes of fires.
- Identify the ignition sources and possible causes of fires such as electrical problems and arson or misconduct; and keep them away from the combustible items.
- Minimise occurrence of the possible ignition that may lead to fires.
- Try to control by eliminating, reducing, retaining and transferring the fire risks.
- Store minimum amount of goods so as to eliminate the fuel in a fire.
- Designate storage rooms to places as near as possible to the FH/HR or areas with availability of water such as toilets.
- If possible, allocate the storage rooms to places with FD systems or with automatic sprinkler systems.
- Ensure the storage place especially those with high fire load (FL), are placed with adequate number of suitable FE for firefighting.
- Fence, separated by fire doors or suitably protect the areas for storing combustible materials.
- Ensure the storage of goods does not obstruct the evacuation routes and a free escape route
should be maintained.

- Display clear and visible ‘No Smoking’ signs at prominent places such as refuse and storage areas of combustible and flammable materials.
- Ensure piles of flammable goods and liquids are stored properly so that no falling down of items will be resulted to block the escape route.
- Prevent ignition of those combustible materials that will produce rapid rate of heat release and large quantity of black smoke.
- Ensure electrical installations and wiring meet the latest statutory regulations.
- Avoid malfunctioning of electrical equipment through regular maintenance by registered electrical workers so as to ensure the installations are in good conditions.
- Keep the maintenance records in a register for future references.
- Ensure electrical wiring is properly connected and maintained.
- Avoid using damaged or frayed cables and faulty equipment.
- Avoid overloading of the electrical systems by the significant demands on the electricity supply from lots of computers in the SMEs.
- Avoid overheating of prolonged operations of electrical appliances, equipment and electric wiring and ensure that they are properly maintained.
- Ensure the smoking areas are free of storage of combustible materials.
- Suggest the designated area for smoking inside the SMEs and enhance fire protection at that particular area.
- Avoid smoking or careless disposal of lighted cigarette ends that may accidentally ignite the carpets, furniture, decorations or goods in the offices or shops of the SMEs.
- Apply fire retardant coating to the furniture items in the SMEs so as to delay the ignition of subsequent items.
- Dispose the cigarette ends in a safe place. Ashtrays with proper design and being made of non-combustible materials should be provided in conspicuous places.
- Install closed-circuit television (CCTV) for security purposes.
- Divide SMEs into different zones according to the zoning of other FSI such as FD system.
- Ensure the evacuation plan has clearly indicated the evacuation procedures.
- Post maps of the evacuation routes at prominent places such as the entrance of each office or shop.
- Check the electrical equipment daily using procedures set up and report any unsafe conditions, such as circuits overloading, misuse of adapters and damaged sockets, plugs or electrical wires etc. to the fire safety manager for taking appropriate actions.
- Ensure the smoking areas are free of storage of combustible materials.
- Reduce the amount of materials being stored in the SMEs with high fire load density (FLD). This case is rather likely as the land price and rent in Hong Kong are high and goods may be stored above the ceiling of the office or shop.
- Ensure the FLD is less than the maximum allowed value.
- Avoid storing large amount of combustible materials in the vicinity of any naked flames so as to avoid goods accidentally being lighted up.

Staff training plan

- Ensure the cigarette ends are disposed in some metal containers and do not throw any ignitable material into rubbish bins if they are not properly extinguished.
- Avoid misconduct of occupants such as arguing and even fighting.
- Establish a systematic, safe and well-organised evacuation plan with some well-planned procedures to ensure safe egress of occupants from the tragic scene.
- Train staff to know their responsibilities and duties as listed in the FSMS.
• Trained to understand the emergency message codes to be used.
• Hold fire drills regularly.
• Trained to keep calm by practising and getting used to the procedures.
• Remind the occupants to read the map of the evacuation routes in their offices or shops.
• Give a briefing to the employees before they work in the first day.
• No blockage of the evacuation routes by occupants waiting at the corridors.
• Be familiar with areas with high FL such as storage areas for goods, papers, toys, compact discs and furniture etc.
• Ensure the number of occupants in offices or shops at dead-end corridors do not exceed the maximum allowance as stated in the building codes.
• Design an appropriate evacuation plan according to the specific features such as dead-end corridors etc. of the SMEs.

CONCLUSIONS
In applying the total fire safety concept, software fire safety management schemes (Malhotra 1987, Chow 2002) should be worked out carefully. Actions to be taken in the management schemes are recommended to control and integrate hardware passive building construction, active fire services installations and control of risk factors. A fire safety plan with a maintenance plan, a staff training plan, a fire prevention plan; and a fire action plan is recommended. Procedures with normal mode are stated clearly in the paper.

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