

MEASURES TO REDUCE NUISANCE CAUSED BY UNWANTED FIRE ALARMS IN PREMISES UNDER THE MAINTENANCE OF EMSD

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Abstract. Fire detection and alarm (FDA) system is one of the most common fire service installations (FSI) prescribed by the Authority for protecting property and life safety in Hong Kong. In reality, the higher the sensitivity of the system, the better protection will be achieved, but the higher opportunity of unwanted fire alarms will also happen together. Reliability of FDA system is vital to life safety and critical to the demands for services of the Fire Services Department (FSD). In 2015, the Electrical and Mechanical Trading Services (EMSTF) of the Electrical and Mechanical Services Department (EMSD) has carried out a review on unwanted fire alarms happened in venues under her maintenance in 2014. The causes for unwanted fire alarms were categorised and corresponding mitigation measures recommended by FSD and various organization were studied and implemented. This paper will present the outline and finding of the review as well as summarise the recommendations for mitigation at its ending.

1. INTRODUCTION

Fire detection and alarm (FDA) systems include systems ranging from simple system comprising only 1 to 2 manual call points to complex networked systems connecting a large number of automatic fire detectors, manual call points, sounders and control and indicating equipment are fundamental fire service installations prescribed by FSD for most of the buildings in Hong Kong. The aim of installing this system is to protect the properties and life safety by promptly alerting for evacuation and summoning the fire services. Undoubtedly a reliable FDA system is crucial for achieving the goal. However, according to the past statistics records of FSD, fire alarms initiated by FDA systems were mostly unwanted fire alarms which created inconvenience to the operations of the concerned buildings and stress to the resources of FSD. Take for example, there were totally 36,335 fire cases reported to FSD in 2014 and there were totally 26,765 cases identified as unwanted fire alarms.

EMSTF is currently undertaking the maintenance for electrical, mechanical, electronic and building services installations of most of the Government buildings and other quasi-government buildings such as hospitals of the Hospital Authority. The incidents of unwanted fire alarm are always a major concern to the building users in view of its subsequent inconvenience to both the occupants and the general public. With a view to improving the service of various departments to the general public, a comprehensive review on the unwanted fire alarms in venues under the maintenance of EMSTF was carried out in 2015. In the exercise, some incidents were critically examined for identifying the causes which could be good reference for the trade.

2. METHODOLOGY

Since causes for unwanted fire alarms vary, it is necessary to collect the past records and data in a classified manner to enable systematic analysis. After preliminarily reviewing the past records on hand, the following categories were used to classify the causes for unwanted alarms:

Category	Causes
A:	Breakglass actuated accidentally
B:	Defective breakglass
C:	Breakglass alarm due to moisture
D:	Smoke detector alarm due to moisture
E:	Smoke detector alarm due to nuisance activities (eg. cooking) nearby
F:	Smoke detector alarm due to works (e.g. hole drilling) nearby
G:	Defective smoke detector
H:	Heat detector alarm due to moisture
I:	Defective heat detector
J:	Unwanted alarm NOT due to detectors or breakglass (e.g. actuation of flow switch, pressure switch fault, etc)
K:	Unwanted alarm with cause UN-IDENTIFIED

Based on the above classification, a standard template was developed for various maintenance divisions of EMSTF to collect the records of unwanted fire alarms in 2014 covering a wide variety of buildings such as offices buildings, institutional buildings and hospitals, etc.

After collecting the data, they were ranked from descending order for the analysis of causes for unwanted fire alarms. This is a crucial step to identify the root causes of various nuisances to the fire detection and alarm system.

The causes for unwanted fire alarms, after classification, would be further analysed. This step could generalize the common characteristics of different cases which would enable the searching for the suitable mitigation measures.

After identifying and analysing the causes for unwanted fire alarms, responding measures were considered for mitigating the nuisances and uplifting the reliability of the FDA systems. Finally, recommendations were drawn up for the planning and implementation of all maintenance units of EMSTF.

3. DATA COLLECTION

Data collected for analysis from various maintenance divisions generally covered that happened in different buildings or venues under the maintenance of EMSTF in 2014. A template was designed to collect the necessary information including: -

- Contract number(s)
- Contractor(s)
- Venues/buildings
- Locations of incidents
- Rectification actions after incidents
- Classification of alarms/faults
- Repetition of the same fault

Summary Report for Unwanted Fire Alarms (From 01 January 2014 - 31 December 2014)									
Contract No.: 2GNXXXXX			Term Maintenance Contractor: XXX Engineering Co. Ltd. (From 01 January 2014 - 31 March 2014)						
Contract No.: 1031XXXX			Term Maintenance Contractor: YYY Engineering Ltd. (From 01 April 2014 - 31 December 2014)						
(Please fill in the names of Term Maintenance Contractors and their respective contract periods involved in 2014 if more than one Term Maintenance Contract are engaged)									
Classification of Alarm/Fault									
A: Breakglass actuated accidentally									
B: Defective breakglass									
C: Breakglass alarm due to moisture									
D: Smoke detector alarm due to moisture									
E: Smoke detector alarm due to nuisance activities (eg. Cooking) nearby									
F: Smoke detector alarm due to works (eg. hole drilling) nearby									
G: Defective Smoke detector									
H: Heat detector alarm due to moisture									
I: Defective heat detector									
J: Unwanted alarm NOT due to detection system or breakglass (eg. Actuation of flow switch, pressure switch fault, etc)									
K: Unwanted alarm with cause UN-IDENTIFIED									
*: Multi-sensor detector									
Remark: Smoke detector includes optical beam type detection installations, aspirating smoke detection installations and point type smoke detectors									
Item	Date	Time	Cause of Fault (If known)	Building	Location	Rectification Action	Classification of Alarm/Fault (eg. A, B, C, etc. shown above)	Same fault of the same equipment (Please indicate the accumulative number of occurrence)	Remark
1	8/1/2014	1:19	Heat detector fault	Building A	G/F at AC Plan room	Replacement of Heat detector	I	1	
2	8/2/2014	15:15	FS Control panel fault	Building B	Block 6	Replacement of FS Control panel	K	1	
3	8/2/2014	10:15	Smoke detector fault	Building C	34/F at AC Plan room	Replacement of Smoke detector	G	1	
4	18/2/2014	18:45	Control module fault	Building D	LG2 Car park	Replacement of control module	K	1	
5	18/2/2014	9:50	Breakglass alarm fault	Building E	2/F	Replacement of Breakglass alarm	C	1	
6	20/2/2014	14:00	Smoke detector damage	Building C	44/F at ELE room	Replacement of Smoke detector	F	1	
7	21/3/2014	13:40	Breakglass alarm damage	Building F	13/F	Replacement of Breakglass alarm	K	1	
8	15/2/2014	13:35	Heat detector fault due to building water leakage	Building G	R2/F FS Uptax Pump Room	Replacement of Heat detector	H	1	
9	20/2/2014	9:00	Sprinkler pipe leakage	Building H	Carpark LBF LF26-28	Replacement of the pipings	J	1	
10	1/5/2014	11:50	Heat detector fault	Building H	UG/F AC Room	Replacement of Heat detector	I	1	
11	12/3/2014	12:00	Sprinkler Head broken by Car	Building H	Carpark UBF near entrance	Replacement of the Sprinkler Head	J	1	
12	29/3/2014	22:30	Smoke detector damage	Building J	44/F	Replacement of Smoke detector	G	1	
13	16/2/2014	14:30	Smoke detector damage	Building K	G/F L32 Lobby	Replacement of Smoke detector	G	1	
14	17/2/2014	8:15	Smoke detector damage	Building K	45/F Cargo Lift Lobby	Replacement of Smoke detector	G	1	
15	18/2/2014	1:45	Heat detector fault	Building K	17/F Rm 1702 (3D42)	Replacement of Heat detector	I	1	
16	3/5/2014	17:40	Heat detector fault	Building K	17/F AHU Room (D015)	Replacement of Heat detector	I	1	
17	12/3/2014	16:55	Heat detector fault	Building K	17/F Rm 1702 (3D35)	Replacement of Heat detector	I	1	
18	10/1/2014	5:15	Heat detector fault	Building L	Genset Room	Replacement of Heat detector	I	1	
19	23/1/2014	11:50	Smoke detector fault	Building L	14/F	Replacement of Smoke detector	G	1	
20	17/2/2014	13:10	Smoke detector fault	Building L	FM-200 Room	Replacement of Smoke detector	G	1	
21	25/2/2014	17:15	Smoke detector fault	Building M	11/F	Replacement of Smoke detector	D	1	
22	28/2/2014	17:09	Heat detector fault	Building M	Roof	Replacement of Heat detector	H	1	
23	30/1/2014	16:15	Smoke detector fault	Building N	G/F SCIENCE ROOM	Replacement of Smoke detector	G	1	
24	8/2/2014	15:15	F.S. Control panel fault	Building B	Block 6	Replacement of F.S. Control panel	K	1	
25	1/3/2014	11:30	Breakglass alarm damage	Building P	Corridor near Staircase CS-4, 2/F, East Wing, CGO	Replacement of Breakglass unit	A	1	
26	3/1/2014	12:47	Beam detector damage	Building Q	Chamber, 1M/F (Beam Type (LS-6A) L14-058)	Replacement of Beam Detector	F	1	
27	7/2/2014	12:40	Breakglass alarm damage	Building Q	Video showing corner, G/F	Replacement of Breakglass unit	A	1	
28	11/3/2014	12:01	Breakglass alarm damage	Building Q	Corridor outside the waiting area (Big pantry), 10/F	Replacement of Breakglass unit	A	1	
29	13/3/2014	18:36	Smoke detector damage	Building P	Corridor between switch room and lift lobby (Lift no. EXS1) on LG1/F in CEO	Replacement of Smoke detector	D	1	

FIGURE 1: Template for collection of unwanted fire alarms in various venues/buildings

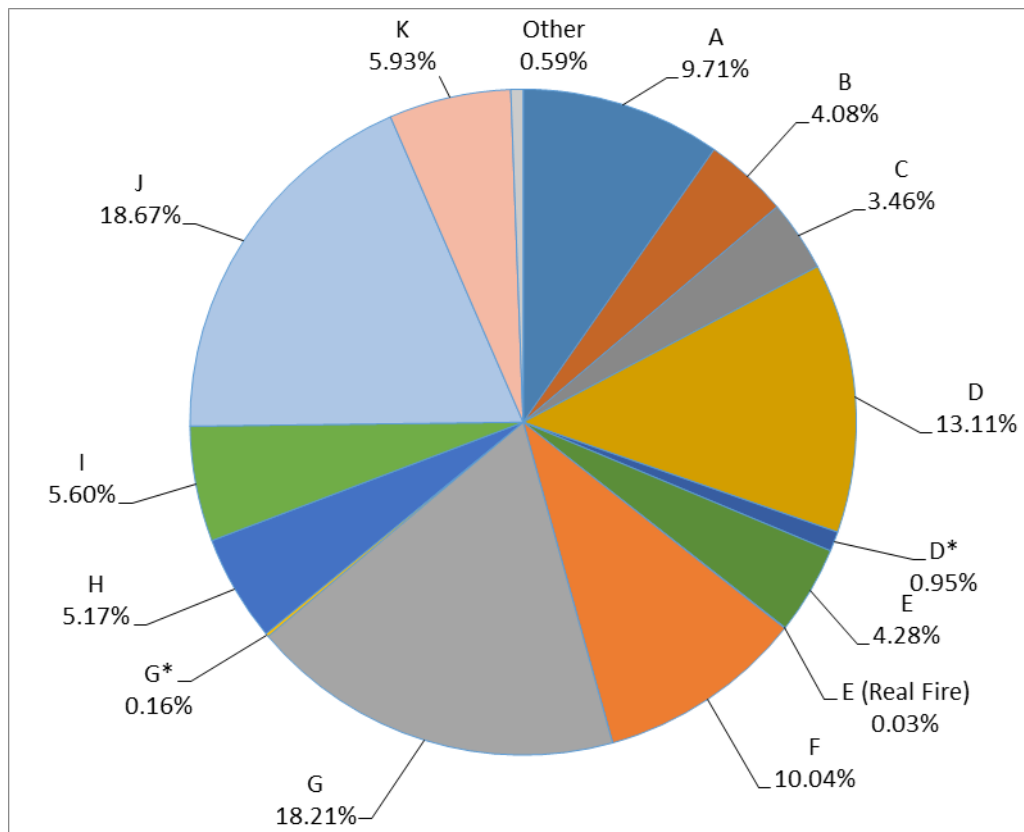
Data collection are crucial for analysis purpose. Take for example, the frequent unwanted fire alarms at the same location might represent the nuisance due to physical environment or disturbing activities being carried out nearby. Should the unwanted fire alarms always happened due to the same device, it might represent the fault due to equipment defect or problematic circuit. Should the unwanted fire alarm was mitigated after the replacement of the suspected defective equipment, it represented that the root cause for the nuisance was fixed. Hence, the approach of unwanted fire alarm classification and data collection will have a substantial and crucial influence on the entire review.

4. DATA ANALYSIS

In the review, there were more than 3,000 unwanted fire alarms in buildings/venues under the maintenance of EMSTF in 2014 with data as summarized as below: -

Category	Causes	No.	%
J	Unwanted alarm NOT due to detectors or breakglass (e.g. actuation of flow switch, pressure switch fault, etc)	567	18.67
G	Defective smoke detector	553	18.21
D	Smoke detector alarm due to moisture	398	13.11
F	Smoke detector alarm due to works (e.g. hole drilling) nearby	305	10.04
A	Breakglass actuated accidentally	295	9.71
K	Unwanted alarm with cause UN-IDENTIFIED	180	5.93
I	Defective heat detector	170	5.6
H	Heat detector alarm due to moisture	157	5.17
E	Smoke detector alarm due to nuisance activities (e.g. Cooking) nearby	130	4.28
B	Defective breakglass	124	4.08
C	Breakglass alarm due to moisture	105	3.46
D ^(Multi-sensor type Detector)	Smoke detector alarm due to moisture	29	0.95
Other	Other	18	0.59
G ^(Multi-sensor type Detector)	Defective smoke detector	5	0.16
Total:		3,037	100

FIGURE 2: Table with unwanted fire alarms in 2014 in descending order



Classification of Alarm/Fault:-

- A Breakglass actuated accidentally
- B: Defective breakglass
- C: Breakglass alarm due to moisture
- D: Smoke detector alarm due to moisture
- E: Smoke detector alarm due to nuisance activities (eg. Cooking) nearby
- F: Smoke detector alarm due to works (eg. hole drilling) nearby
- G: Defective Smoke detector
- H: Heat detector alarm due to moisture
- I: Defective heat detector
- J: Unwanted alarm NOT due to detection system or breakglass (eg. Actuation of flow switch, pressure switch) fault, etc)
- K: Unwanted alarm with cause UN-IDENTIFIED
- *: Multi-sensor detector

FIGURE 3: Distribution of unwanted fire alarms in 2014

From the result presented above, it was unexpected to note that “Unwanted alarm NOT due to detectors or breakglass (e.g. actuation of flow switch, pressure switch fault, etc)” was ranked the top. This was different from our past common understanding on this topic that most unwanted fire alarms were mainly arising from dust, moisture or other nuisance to fire detectors. This implied that a more detailed and comprehensive preventive maintenance for the entire fire service installations, not just limiting to fire detection and alarm system, would be imperative if mitigation of unwanted fire alarm is a mission to accomplish.

5. ANALYSIS AND FINDINGS

According to the categorized causes of unwanted fire alarms above, the following is noted: -

- a. Amongst all, faulty system components such as flow switch, pressure switch (excluding detectors and breakglass) is the major cause for unwanted fire alarms.
- b. Defective smoke detector is common cause for unwanted fire alarms.
- c. Moisture is an environmental factor highly affecting the occurrence of unwanted alarms.
- d. Breakglass units are prone to be accidentally activated and unwanted fire alarm was triggered subsequently in particular those installed in venues for common access of general public such as sport centres, market complexes, municipal buildings, etc.
- e. Work process such as drilling, etc., is also a human factor causing unwanted fire alarms that can be easily avoided.

6. MEASURES RECOMMENDED FOR MITIGATING UNWANTED FIRE ALARMS

6.1. Building Research Establishment Limited (BRE) of the UK

Unwanted fire alarm is not a unique problem of Hong Kong. It is also a worldwide issue including the developed countries such as the USA and UK, etc. In their past studies on the effective measures to abate the unwanted fire alarms, the Building Research Establishment Limited (BRE) of the UK have formulated the following measures in their past published paper "BRE Causes of False-Fire-Alarms in Building (2014)" which are considered effective and practical to implement. In gist, the recommendations are summarized as following: -

<u>Solution</u>	<u>Proposed Intervention Action</u>	<u>No. of Potential Causes Resolved</u>
1	Replace detector with multi-sensor	69.2%
2	Use of appropriate approved detector/s located correctly	43.5%
3	Use of protective covers over approved Manual Call Points with adequate signage and CCTV where required	16.7%
4	Use of EN 54-2 approved analogue addressable panel	10.2%
5	Better control of contractors	9.7%
6	More rigorous maintenance of the system	6.0%

6.2. Fire Services Department of the HKSAR (FSD)

Apart from the recommendations of BRE, FSD also from time to time publishes guidelines for the trade to follow in connection with effective measures to reduce unwanted fire alarms. In 2013, "Fire Protection Notice No. 16 - Fire Detection System Recommended Maintenance Procedures" was released for the reference of the trade. The common causes for unwanted fire alarms are summarized in section 6.2 as listed below: -

Environmental Factor

- Dusty environment
- Fog and high humidity
- High air velocity
- Insects
- Transient condition

Human Activity

- Smoking
- Steam from cooking or hot shower
- Burning joss sticks
- Construction works
- Contractor's installation works
- Vehicular exhaust fume
- Malicious action

Installation Design and Maintenance

- Electrical transient
- Inappropriate design
- Defective equipment
- Lack of cleaning and Maintenance

In gist, the environmental factors, human activities, and installation design and maintenance should be fully considered when formulating relevant measures. Furthermore, section 6.3, 6.4 and 6.5 pointed out the importance of system compatibility, use of analogue addressable systems and use of multi-senor detectors which are crucial for avoiding unwanted fire alarm.

In 2014, FSD further issued "Circular Notice - Measure to Reduce Nuisance Caused by Unwanted Fire Alarm" to the trade. Therein, more specific measures as below have been raised for the consideration of the trade:

- a. Discount the signal from smoke detector installed for automatic actuating device from the fire detection system.
- b. Re-arrange the location of detectors and/or remove those overprovided detectors as

appropriate to the design of fire detection system.

- c. Use technically more reliable detectors, e.g. multi-sensor detectors in accordance with FSD Circular Letter No. 2/2010.
- d. Select suitable type of detector, e.g. using heat detectors in plant room or pantry where smoke detectors are more prone to unwanted alarms.
- e. Install time related system in accordance with FSD Circular Letter No. 4/2001.

6.3 Electrical and Mechanical Services Department of the HKSAR (EMSD)

The Working Group on Enhancing Fire Service Installations and Equipment for Delivering Quality Service (WG) of EMSTF in May of 2015 had comprehensively reviewed the causes and solutions for unwanted fire alarms. Apart from the above mentioned recommendations of BRE and FSD for mitigating unwanted fire alarms, the self-diagnostic function of the intelligent addressable fire alarm system was recognised as an effective preventative maintenance tool. The maintenance personnel could run the diagnostic function and print out the system status and the component healthiness down to detector level for checking whether the smoke/heat detectors had deteriorated to their healthy threshold, and proactively derive necessary maintenance plan to resume the system healthiness and avoid unwanted fire alarms.

In a liaison meeting between WG and the Fire Service Installation Contractors Association (FSICA) shortly after the above meeting in 2015, FSICA also suggested the following practical site measures to mitigate the unwanted fire alarms: -

- a. For unwanted alarms due to manual call point prone to moisture nuisance, a junction box installed horizontally next to manual call point could drain water away and maintain the manual call point free from water nuisance.
- b. Flexible conduit bent in U-shape for final connection between the junction box accommodating heat detector and metal conduit could form a U-trap avoiding water from directly flowing into the detector along the metal conduit.
- c. Linear heat detection cables could be used to replace the point type heat detectors because of its higher reliability and less sensitivity to environmental nuisance.

7. MEASURES RECOMMENDED FOR MITIGATING UNWANTED FIRE ALARMS

Corresponding to the category of causes for unwanted fire alarms in section “2” above, the following measures are recommended: -

7.1 Breakglass Actuated Accidentally

- a. Use of approved Manual Call Points with protective covers with adequate signage and CCTV for monitoring malicious action where required.

7.2 Defective Breakglass

- a. More rigorous maintenance of the system

7.3 Breakglass alarm due to moisture

- a. A junction box installed horizontally next to manual call point could drain water away and maintain the manual call point free from water nuisance

7.4 Smoke Detector Alarm due to Moisture

- a. Flexible conduit bent in U-shape for final connection between the junction box accommodating heat detector and GI conduit could form the dripping fitting and avoid water from directly flowing into the detector along the GI conduit.
- b. More rigorous maintenance of the system.
- c. Disconnect the signal from smoke detector installed for automatic actuating device from the fire detection system.
- d. Select suitable type of detector, e.g. using heat detectors in plant room or pantry where smoke detectors are more prone to unwanted alarms.
- e. Install time related system in accordance with FSD Circular Letter No. 4/2001.

7.5 Smoke Detector Alarm due to Nuisance Activities (eg. Cooking) nearby

- a. Use technically more reliable detectors, e.g. multi-sensor detectors in accordance with FSD Circular Letter No. 2/2010.
- b. Select suitable type of detector, e.g. using heat detectors in plant room or pantry where smoke detectors are more prone to unwanted alarms.
- c. Disconnect the signal from smoke detector installed for automatic actuating device from the fire detection system.
- d. Use of EN 54-2 approved analogue addressable panel.
- e. Re-arrange the location of detectors and/or remove those overprovided detectors as appropriate to the design of fire detection system.

7.6 Smoke Detector Alarm due to Works (eg. Hole Drilling) nearby

- a. Better control of contractors

7.7 Defective Smoke Detectors

- a. Use technically more reliable detectors, e.g. multi-sensor detectors in accordance with FSD Circular Letter No. 2/2010.
- b. More rigorous maintenance of the system.
- c. Frontline staff to proactively prepare for necessary maintenance exercise to resume the

system healthy and avoid unwanted fire alarms if gradual deterioration of smoke/heat detectors to their healthy threshold was noted through the self-diagnostic function of the intelligent addressable system.

- d. Discount the signal from smoke detector installed for automatic actuating device from the fire detection system.
- e. Select suitable type of detector, e.g. using heat detectors in plant room or pantry where smoke detectors are more prone to unwanted alarms.

7.8 Heat Detector Alarm due to Moisture

- a. Flexible conduit bent in U-shape for final connection between the junction box accommodating heat detector and GI conduit could form the dripping fitting and avoid water from directly flowing into the detector along the GI conduit.
- b. Linear heat detection cables could be used to replace the point type heat detectors because of its higher reliability and less sensitivity to environmental nuisance.
- c. More rigorous maintenance of the system.

7.9 Defective Heat Detectors

- a. More rigorous maintenance of the system.
- b. Frontline staff to proactively prepare for necessary maintenance exercise to resume the system healthy and avoid unwanted fire alarms if gradual deterioration of smoke/heat detectors to their healthy threshold was noted through the self-diagnostic function of the intelligent addressable system.
- c. Discount the signal from smoke detector installed for automatic actuating device from the fire detection system.
- d. Select suitable type of detector, e.g. using heat detectors in plant room or pantry where smoke detectors are more prone to unwanted alarms.
- e. Linear heat detection cables could be used to replace the point type heat detectors because of its higher reliability and less sensitivity to environmental nuisance.

7.10 Unwanted Alarm NOT due to Detection System or Breakglass (eg. Actuation of Flow Switch, Pressure Switch Fault, etc)

- a. More rigorous maintenance of the system.

8. CONCLUSION

The protection of life safety and property is always the prime mission of those who design, install and maintain the fire service installations and equipment. Fire alarm is always the earliest alert to occupants for evacuation in the venues likely to bear a fire hazard. It also performs the early summon for fire services personnel to carry out fire intervention. Undoubtedly, the reliability of fire alarm system is vital in particular in the highly densely populated developed regions like Hong Kong. Hence the above study and review may be a

useful reference to different stakeholders responsible for fire safety, engineering and building management. However, in reality, the causes for various unwanted fire alarms may not be the same. The practicing engineers need to exercise their professional knowledge and make right judgement for finding out the root causes such that appropriate measures could be implemented to resume the reliability and effectiveness of the systems. In practice, EMSTF have implemented some appropriate measures recommended above in handling unwanted fire alarms and the results are satisfactory and encouraging. Last by not the least, it is sure that the prudent manner of the trade insisting rigorous maintenance is always the key to ensure reliable and effective fire service systems comprising different installations and equipment providing protection to both the properties and life safety in Hong Kong.

ACKNOWLEDGMENTS

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