

## **STUDY ON RELIABILITY OF MANUAL CALL POINTS IN RESIDENTIAL BUILDINGS**

**K.F. Wong**

Department of Building Services Engineering, The Hong Kong Polytechnic University, Hong Kong, China

### **ABSTRACT**

The manual fire alarm system installed in buildings is the means to give an alarm signal in the early stages of a fire by human so that actions can be taken immediately to minimize the loss of life and property. Although fire protection system continuously improves the reliability of the detection devices and systems, false alarms are still reported. The frequency of false alarms has become a problem for estate management office. And false alarm calls are a drain on the resources of the Fire Services Department. More importantly, false alarm could affect mobilisation to other incidents which may involve threat to life. This paper briefly outlines Specification for Fire Service Installation, British Standard for residential buildings in Hong Kong. The major causes of false alarms are identified and analyzed from the record obtained from the estate management office. Suggestions are made to minimize the occurrence of false alarms.

### **1. INTRODUCTION**

Most residential buildings have installed manual call points as a basic fire alarm protection system to give early warnings of fire. The system consists of manual call points, audible alarm bells, control and indicating panel, fire service transfer pump set and cable to link all those components together.

Although the manual fire protection system is of quite simple configuration and less expensive for installation and maintenance service compared with the automatic fire alarm system, the reliability of the manual fire protection system should be ensured so that in a real fire, it can activate both the audience fire alarm bells and the fire pumping system on hose reel fire extinguishing. However, the causes of unwanted fire alarms limited the credibility with the occupants during the real fire alarm. In Hong Kong situation, the occupants in the residential buildings would ignore the fire alarm bell sounded, otherwise, they smelt smoke or felt an abnormal case by their own [1]. Moreover, a lot of complaints were received from the residents on inadequate maintenance and malfunction of the manual fire alarm system after the real fire incident. As a result, it would be necessary to study the manual fire protection system on their reliability, cause of fire alarm, duration downtime, cost for settlement of each false alarm, existing regulation of fire service and human response on false alarm.

Obviously, there are limited journals on discussing the reliability of manual call points during the fire cases. However, false alarm and breakdown time on that are still troublesome problems of manual fire protection system in residential buildings. From the research paper of Building Research

Establishment (BRE), it mentioned that false alarm not only confuses the owners/occupants, but also seriously wastes the resources of the fire brigade [2]. Furthermore, there is the added nuisance of loss of time in the day-to-day activities. Probably the worst effect is the "cry wolf syndrome" which results in the alarm being ignored by the occupants until the fire has become highly destructive and life-threatening. From the information of Hong Kong Fire Services Department (FSD) circular letter in 2001, 35296 calls of unwanted alarm were recorded and the total fire alarm record including real fire and unwanted alarms was 44789 calls [3]. Almost 80 % of calls are classified as unwanted alarm that wasted the fire service manpower. Because most of unwanted alarm came from residential and commercial buildings, life and properties were involved. This paper attempts to analyse the correlation between the causes of false alarm raised by manual call points inside residential buildings and to provide some preliminary recommendations to reduce the number of false alarms. Some suggestions to prevent the occurrences of false alarms are made for management office.

### **2. GENERAL REVIEW ON THE REGULATION ON MANUAL CALL POINT OF FIRE SERVICE INSTALLATION**

A study on the reliability of manual fire alarm system was proposed. The first step is to have a general understanding of the current fire regulations and see whether the existing equipments can satisfy the minimum fire safety desires.

### 3. SURVEY METHOD

This preliminary research report presented an investigation of an residential estate of 15 years of age. There are three 35-storey blocks of trident plan in the estate, which are classified as high-rise buildings. Alarm and fault records related to fire service from 1998 to 2002 were used for statistical analysis and investigation. There were 123 alarm records reported and a manual record for each case was kept including the date, time, location, possible causes and types of alarm. The data of system failure, duration downtime, and cost for settlement of false alarm are shown in Table 2.

### 4. RESULTS AND ANALYSIS

According to the alarm record log book, the greatest number of false alarms were caused by broken manual call point. Most of the causes of

false alarms are due to vandalism. Moreover, improper installation of manual call point might cause short circuit, for example, the position might get wet easily by water droplets when service cleaning. Although the total amount for the settlement of the false alarm is about HK\$ 12,680, it would be the third amount for replacement cost. However, the total duration time is also obviously high compared with other causes. It would be better to do a site survey on the people's comment on the fire alarm system.

The duration downtime and the cost of settlement are the highest for the fire control panel fault. It is because of the inspection for alarm and time for purchasing the spare parts. Due to the spare part amount is high compared with other goods, there is no spare part stored on site. It is recommended to keep the maintenance properly to prevent false alarms [8] caused by the fire control panel [9].

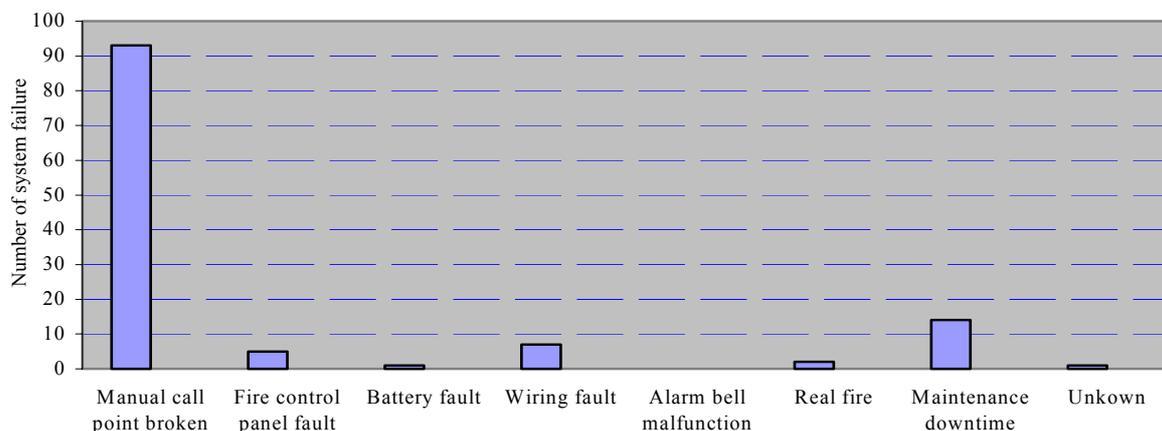
**Table 1: Regulation on manual call point in consideration [4-6]**

	Description 1	Description 2
Requirement	Complying with BS 5839 Part 2, or a type approved by the FSD and the Architect	
Electrical contacts	Automatically operate upon breaking of the frangible element at the front of the unit	Contacts shall be of silver or approved non-deteriorating alloy of the normally-open or normally-closed type to suit the alarm system as specified in the Particular Specification
Material selection	Cover shall be locked in position with a special key and the frangible element shall be clipped firmly into place	Pleasing appearance and styling, constructed of non-combustible and corrosion resistant materials, and finish enamelled red.
Marked label	The words: "Fire : Break Glass" shall be suitably engraved or embossed in English and Chinese on the front	
Feature	Concealed "test" device shall be included	
Installation method	Flush mounting or surface mounting type as specified in the Particular Specification and suitable for direct connection to the wiring system of the type specified.	
Electrical wiring	Terminals for external conductors shall be provided in the unit for connection of at least two conductors of size not less than 1.5 mm <sup>2</sup> each. (Including signal wiring and power supply wiring)	
Earthing	Providing earth continuity between external circuits	
Installation location	Subject to water damage, the call point shall be of waterproof type	
	Next to exit door and easy to identify	Provide within 30 m from any part of residential building
Standard	Fixed at a height of 1.15 m above finished floor unless otherwise specified	Surface mounting in order to present a side profile area of not less than 750 mm <sup>2</sup>

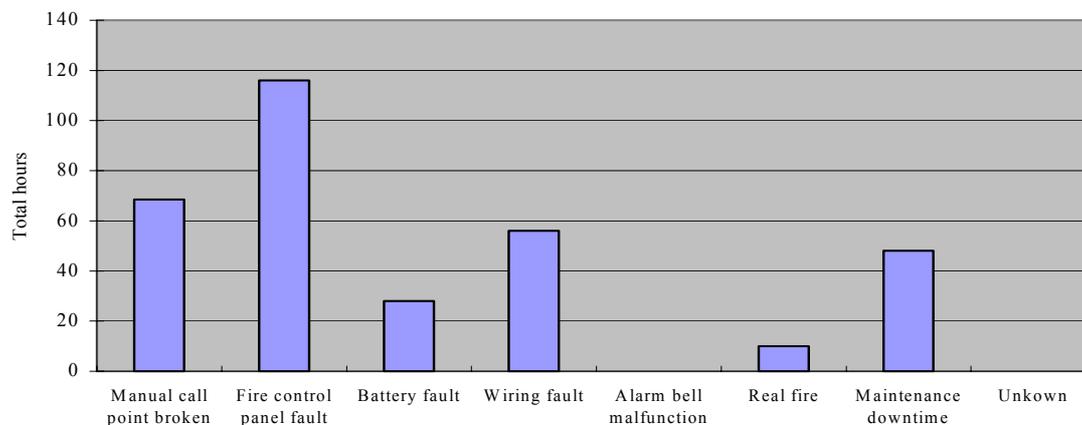
**Table 2: Outline of system failure on manual fire alarm system for Block A to C from 1998 to 2002 [7]**

Description	No. of alarms recorded	Duration time (hours)	Cost for settlement (HK\$)	Comments
Manual call point malfunction	93	68.5	12,680.0	Recorded the highest number of alarms
Fire control panel fault	5	116	31,820.0	Both the duration time and cost for settlement are largest
Battery fault	1	28	4,000.0	Battery seems to long life
Wiring fault	7	56	17,500.0	High rating on the duration time and cost settlement
Alarm bell malfunction	0	0	0	Probable cover on the maintenance period
Real fire	2	10	1,340.0	With less occurrence of fire
Maintenance downtime	14	48	22,400.0	
Unknown	1	0	0	
Total	123	326.5	89,740.0	

Schedule of rate is listed in Appendix I.



**Fig. 1: Number of system failure in FS installation from 1998 to 2002**



**Fig. 2: Total hours for system breakdown**

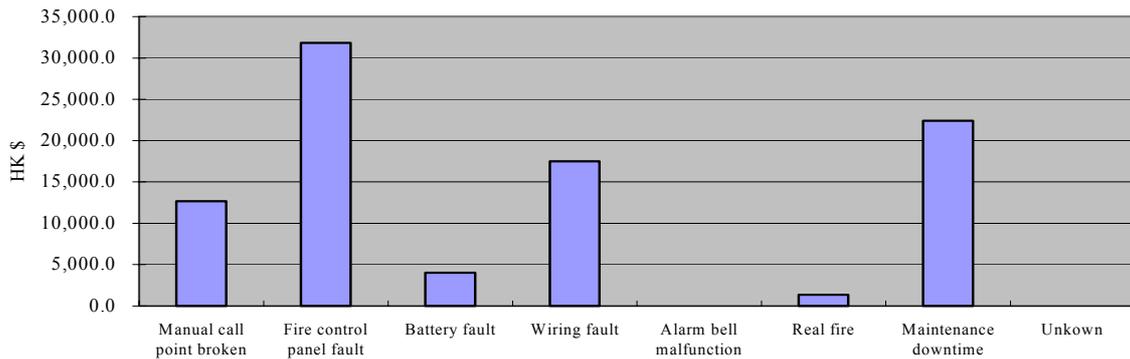


Fig. 3: Cost for settlement of the breakdown

**5. FIRE AND FALSE ALARM EVENTS ANALYSIS**

Fire and false events in operation were extracted from different database and compiled as shown in Fig. 4 [10].

Suggested reasons for having false alarms on manual call points [11]:

- Improper locations

In environments where the manual call points will not operate properly because of temperature extremes; humidity, excessive dust, dirt, or humidity, excessive air flow rates, or the normal presence of combustion particles, vapors, gases or fumes in the air steams surrounding the manual call points. In damp or excessively humid areas, water droplets can accumulate inside the chamber and make the contact relay activation. It is common to cause false alarms.

- Improper installation

In places where the manual call point wiring is not protected from interference from induced currents and noise in adjacent wiring systems. Improper installation of manual call points on outdoors without using weatherproof type. The outdoor excessive humidity and variation temperature.

- Inadequate maintenance

Would result in malfunction of both the manual call point, batteries and control panel over a period of time.

- Environmental effect

Alarms that occur during the reactivation of the building heating system after an extended summer shutdown as the dust accumulated on the heating coils is burned.

- Vandalism or mischievous acts

Manual call points set off as a prank is found to be a major problem in dormitories.

If an alarm occurs and a fire does not exist, the alarm should be silenced, the problem unit located, and the alarm system controls reset so that the effectiveness of the fire alarm system is restored. Make sure that all the manual call points in the zone or pinpointed device that shows an alarm are checked before deciding that it is a false alarm. If a fire does exist, more than one manual call point may be in the alarm state, although no signs of fire may be evident in the vicinity of the first activated detector. The fire could be overlooked.

**6. SITE SURVEY ON THE ENVIRONMENTAL CONDITION**

Site measurement of the environmental condition at two selected locations is carried out. The temperature, relative humidity, dew point and absolute humidity would be measured. It would be a trial measurement on the environmental effect for the manual call points. The above mentioned physical parameters are recorded at two selected locations easy to have false alarms. More data would be taken for further analysis. Two graphs for reference are shown in Appendix II.

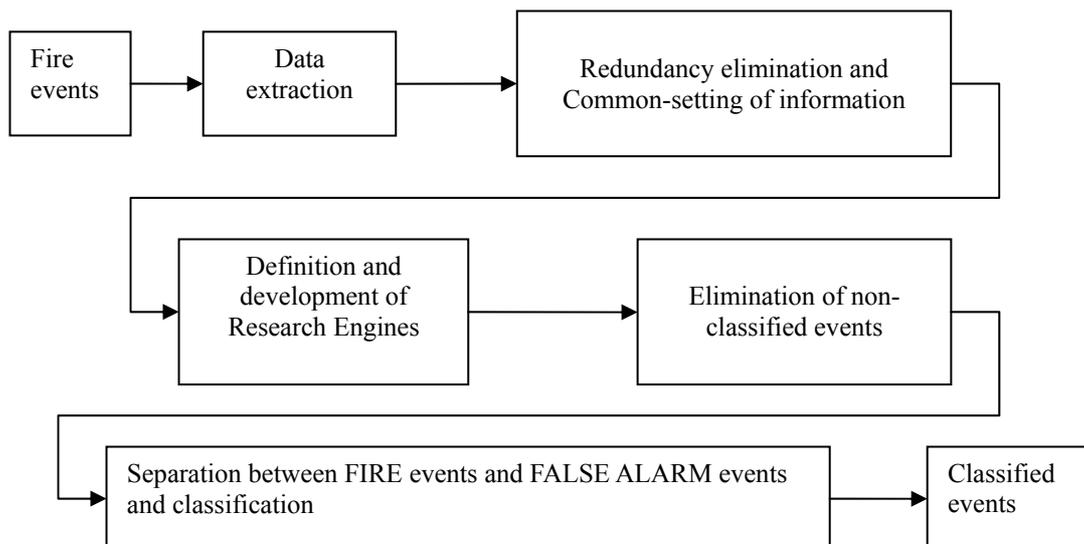


Fig. 4: Fire and false alarm events analysis

Table 3: Causes of false alarm

Cause of false alarm	No.	Percentage
Improper location	20	19.6%
Improper installation	11	10.8%
Inadequate maintenance	6	5.9%
Environmental effect	4	3.9%
Vandalism	58	56.9%
Induced current effect	2	2.0%
Unknown	1	0.9%
<b>TOTAL</b>	<b>102</b>	<b>100.0%</b>

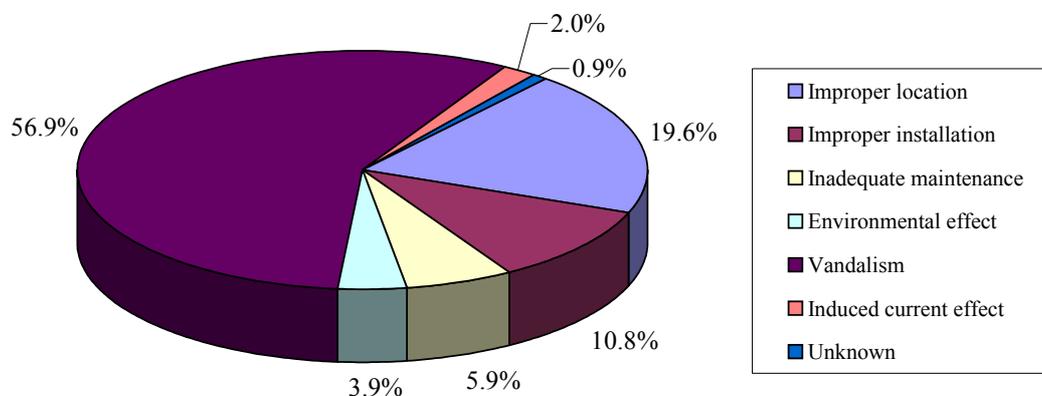


Fig. 5: Causes of false alarm

## 7. MAINTENANCE

Maintenance is essential to ensure that the fire alarm control system will perform its intended function under fire conditions. Proper maintenance of the system should include periodic testing of all fire detection and activation devices. The device should be maintained in accordance with the manufacturer's recommendations. These periodic tests should be performed on a periodic basis to determine that the installed system continues to operate in accordance with the approved design. The results of the tests should be documented in the operations and maintenance log book and made available for inspection.

Improper and insufficient maintenance of fire alarm control system is believed to be one of the major causes of unwanted fire alarms. Preventive maintenance of the system rather than maintenance only after fault is found effective in avoiding unwanted alarm. There are many maintenance programmes created by the site. Balancing the reliability of the detection device and replacement of the defective device are needed. Otherwise, it can become either more sensitive, which may cause unwanted alarms, or less sensitive, which could reduce the amount of warning time given in case of a fire [12]. Therefore, it should be tested periodically and maintained at regular intervals.

## 8. CONCLUSIONS AND FUTURE WORK

The following are proposed to reduce false alarms:

- Proper selection and installation of manual call point and system

The fire detection system should be designed not only to comply with the fire regulations and statutory requirements, but proper selection of high quality detecting devices in correct locations and system components is essential for reliable operation. Careful checking out of the compatibility of the detecting devices and fire alarm control panel will minimize interfacing problems. Manual call points must not be placed in a location which is subjected to adverse operating conditions such as high humidity or easy to be damaged by human error. Moreover, the wiring for the detection system should be either well-segregated or properly screened from the low voltage cables completed with earth fault protection wiring in order to minimize electromagnetic interference which may give rise to false alarms, otherwise coaxial cables are recommended.

- Maintenance and preventive measures

Periodic maintenance is not only essential for the reliability of the system, it can also help to reduce the number of false alarms. According to the statutory requirements, maintenance of the fire detection system has to be done by a registered fire service contractor. But budgetary constraints may force the work carried out by the contractor on each site inspection to a bare minimum. The routine monthly check may focus on the fire control panel and rectification of any defects present. To supplement the work, the management office personnel have to perform visual inspection and test the manual call points randomly. The essential elements in setting up a preventive maintenance programme are [13]:

- A detailed "equipment service library" must be established that will include manuals, schematics, part lists, failure and false alarm analysis reports.
- Each in-service false alarm should be investigated with the cause determined and documented in detail. If the failure is caused by a weak component, then all like components must be modified or replaced as soon as possible.
- Technical training in maintenance techniques must be given to operating personnel as success or failure relies on their qualifications and technical know-how.
- Records must be scrupulously maintained showing repairs required by equipment over a period of time. On each regular inspection, variations from the normal conditions should be noted. These records should also reflect the availability of spare parts, service attitude of equipment failures to date and time required for repair.

Fire service engineers and registered fire contractors should correctly select the appropriate type of manual call points in their system designs and carefully consider the further maintenance and unwanted alarm problems [14]. A healthy installation is important for the protection of life and property without causing unnecessary nuisance to tenants.

Future work would study on the reliability analysis and fault tree analysis on residential buildings. Questionnaires will be prepared to collect the human response on real or false fire alarms during the fire drill at the estate.

## ACKNOWLEDGEMENT

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## Q & A

**Q1:** Is there any management procedure imposed to reduce the high rate of false alarm caused by vandalism?

**Wong:** The property management has some measures to reduce the rate of vandalism including warning notice, invite FSD to conduct education program, frequent maintenance, etc.

**Q2:** Do you have any suggestions to protect the manual call point equipment to reduce the cost of restoration?

**Wong:** By doing more education to against vandalism.

**Q3:** Are the listed causes of false alarm in Table 3 only for manual call points, while in Figure 1 there is a range of FS installation included for counting the number of system failure?

**Wong:** Yes, the causes of false alarm are for manual call points only.

**Q4:** What is the difference between vandalism and human error?

**Wong:** Vandalism is an intentional act and human error is caused by carelessness or accidents.

**Q5:** How did you collect the data for the past four years in this study?

**Wong:** I work in the property management company for the studied residential buildings. I had read through all incident reports and records for collecting the data related to failure of manual call points.

**Q6:** Do you trust the accuracy of your collected raw data, for example, records in the incident report? Is there any wrong reporting? It is suggested to judge the raw data collected for verification of its accuracy.

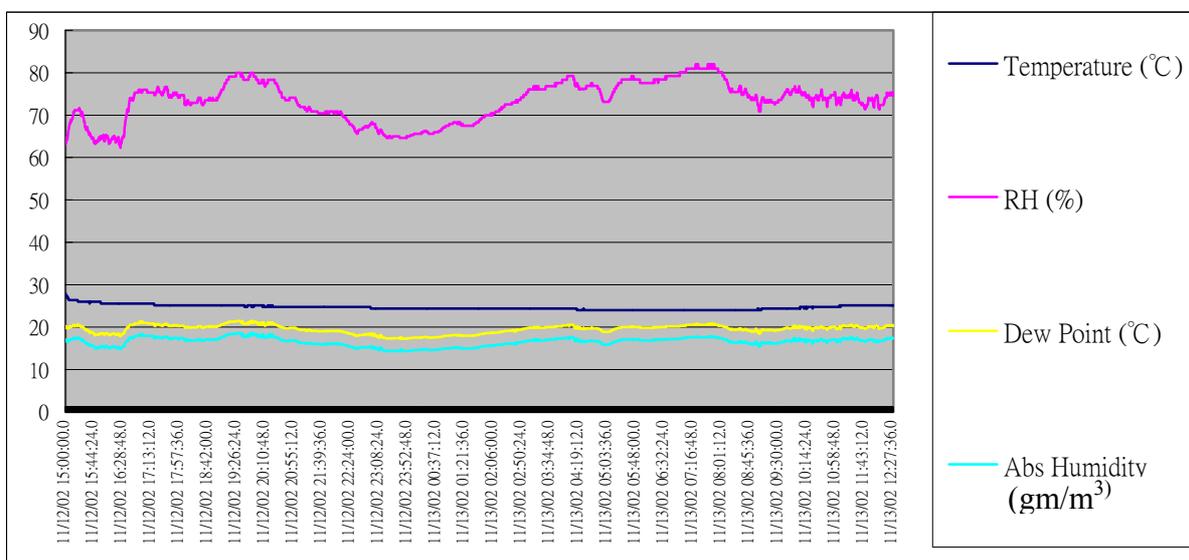
**Wong:** I will consider enlarging the size of collected data to improve the reliability or accuracy of the result.

**APPENDIX I**

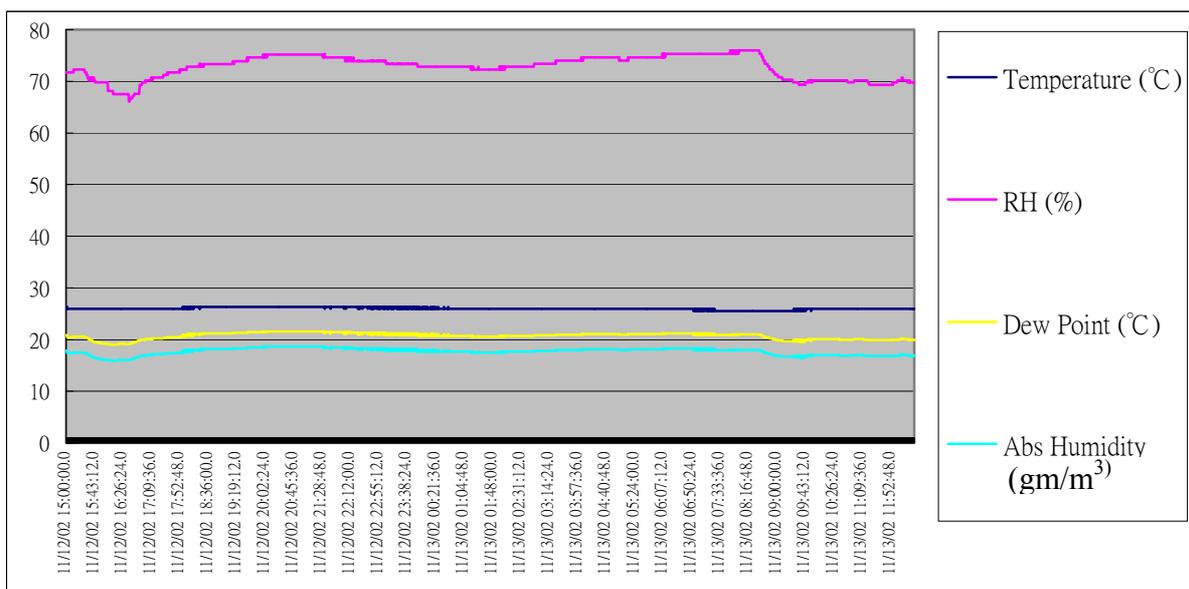
Schedule of rate for cost replacement of the fire protection equipment:

- Office hour inspection by technician: \$ 500
- Office hour inspection by engineer: \$ 1,200
- Non office hour inspection by technician: \$750
- Non office hour inspection by engineer: \$ 1,800
- Supply and install the breakglass: \$ 120
- Supply and install the battery: \$2,000
- Supply and install the wiring c/w conduit: \$2,500 for 6 m
- Quarterly maintenance fee: \$1,200
- Annually maintenance fee: \$2,000

**APPENDIX II**



**Fig. 6: Environmental data for measurement at manual call point installed at R/F of Block A (Location 1)**



**Fig. 7: Environmental data for measurement at manual call point installed at 21/F of Block A (Location 2)**

### **APPENDIX III**

Sample questionnaire for resident comment on the false alarm [8]

Question 1: Were you present in the building when the false alarm sounded?

- a) Yes
- b) No

#### Personal information

Question 2a: Age

- a) 0-20
- b) 21-50
- c) Above 50

Question 2b: Gender

- a) Male
- b) Female

Question 2c: Education background

- a) Primary education or below
- b) Secondary education
- c) Post-secondary education or above

Question 3: Do you have any previous experience on false alarm?

- a) Yes
- b) No

Question 4: Have you taken any action to leave your apartment?

- a) Yes
- b) No
- c) Others:

Question 5: How many years have you lived in this building?

- a) Less than 2 years
- b) 2-5 years
- c) More than 5 years

Question 6: Do you think the fire alarm system in this building is adequate?

- a) Enough
- b) Not enough

Question 7: Does false alarm always happen in the building that you are living in?

- a) Yes
- b) No
- c) Sometimes