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Briefing Paper

Live investigations of false fire alarms

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Contents

Summary

This research project aimed to identify the fundamental causes of false fire alarms, utilising a fire alarm industry expert to investigate false alarms as they occurred in the field in the greater Glasgow area.

The City of Glasgow Division is one of 17 Local Senior Officer Command Areas in the Scottish Fire and Rescue Service (SFRS). This Area contains 11 community fire stations providing services to approximately 600,000 people and an estimated 28,000 commercial premises. During the 2014/15 fiscal reporting period, fire crews responded to approximately 14,800 incidents of which nearly 40% (6,000) were attributed to unwanted fire alarm signal (UFAS) events.

A comprehensive online questionnaire containing 124 questions was developed to enable the fire alarm investigator to record all details of the false alarms attended. This form of 'live' investigation of false alarms has never previously been attempted. The research work was performed by a stakeholder group with a broad experience of fire detection system technology, installation and maintenance.

The proposal for this innovative approach to false alarm investigation came jointly from the Fire Industry Association (FIA) and the SFRS. It was made in light of previous BRE research, in which conclusions were restricted by a lack of objective data from fire and rescue services.

The fire alarm investigator assisted SFRS crews as they attended live callouts and, following a comprehensive investigation, completed online reports for each false alarm. Data from his anecdotal accounts and from 65 false alarm reports, gathered from November 2014 to April 2015, have been analysed by BRE. The resulting 35 recommendations could significantly reduce false alarm occurrences, and contribute to the greater integrity and reliability of systems and management processes. Proposals have also been made for the organisations that should take responsibility for implementing these recommendations.

The main causes of false alarm reported in this study were, in decreasing order of occurrence: Unknown, Fault, Dust, Cooking, Weekly testing, Accidental activations, Steam, Aerosol and Water ingress.

As well as investigating false alarms, the fire alarm investigator also witnessed four cases in which the fire detection and alarm systems operated effectively during real fires.

Abbreviations and glossary of terms

The abbreviations listed and the glossary are compiled from terms used in this publication. The descriptions in the glossary are not intended to be comprehensive, but to help the reader understand the meaning of terms used with regards to fire detection.

Abbreviations

ARC	Alarm Receiving Centre
BMKFA	Buckinghamshire and Milton Keynes Fire Authority
BRE	Building Research Establishment
DoH	Department of Health
FDFAS	Fire Detection and Fire Alarm Systems
FIA	Fire Industry Association
FRA	Fire Risk Assessor
FRS	Fire and Rescue Service
IRS	Incident Recording System
MCP	Manual Call Point
PAS	Publicly Available Specification (e.g. PAS 79 Guidance on carrying out fire risk assessment)
SFRS	Scottish Fire and Rescue Service
UFAS	Unwanted Fire Alarm Signal

Glossary

Alarm Receiving Centre – centre in which the operator receives an electronic signal from the protected premises and interprets them to organise a suitable response.

Fire Detection and Fire Alarm Systems – control equipment that utilises detectors, warning devices and other components to detect fires and provide warning.

Fire Risk Assessor – A suitably qualified individual that performs an assessment of the fire risks to occupants in and around a building to ensure that they are safe from the risk of fire and its effects.

Incident Recording System – A tool used by fire and rescue service personnel to record the details of all incidents attended.

Manual Call Point – A component used in a fire detection and fire alarm systems that allows the user, when a fire condition is present, to manually trigger and activate the fire alarm warning devices.

Unwanted Fire Alarm Signal – When a false alarm is reported to the fire and rescue service and they are requested to attend.

Introduction

Fire detection and fire alarm systems (FDFAS) are used to provide early warning of fire in order to alert the local Fire and Rescue Service (FRS). FRS attendance at fires saves lives, prevents injury and reduces associated property damage costs. The number of fire-related deaths in Great Britain has come down considerably from 967 at their peak in 1985-86, to 322 in 2013-14[1]. Successful fire detection is partly responsible for this reduction, but FDFAS are also responsible for a large number of false alarms, 293,100 of which were recorded in 2013-14.

Estimated losses of around £1 billion a year have been attributed to false alarms[2], due largely to the disruption and loss of productivity in businesses. False alarms also reduce the confidence of the general public in fire alarms.

There is no single organisation responsible for investigating false alarms or providing guidance on reducing them. Research into false alarms from FDFAS is needed to identify the underlying causes, and propose practical and effective methods of reducing them.

Not all false alarms result in the FRS being called out. For example, in some large premises with sufficiently trained staff, alarm signals can be investigated for a short period prior to calling the FRS. False alarms that result in FRS responses are described in this report as Unwanted Fire Alarm Signals (UFAS). Research on false alarms (including this project) of necessity focusses on UFAS, as data on false alarms that do not result in an FRS response is difficult to assimilate. The causes of UFAS will be very similar to those of non-FRS attended false alarms, but not identical – for example, accidental damage to a manual call point will sometimes be recognised before the FRS is called.

A previous BRE Trust funded research project investigated the causes of false alarms using very basic data, and proposed solutions that could reduce their occurrence. The briefing paper generated from this work, completed in June 2014, is available from the BRE website[3]. That study noted that few organisations were gathering such data, and concluded that the services of a specialist fire alarm investigator would be required to gather more reliable and meaningful data.

Following a multi-agency briefing to the Scottish Fire and Rescue Service Board a more thorough investigation of false fire alarm causes was proposed, leading to this research work which has been carried out by BRE in conjunction with the SFRS and with the support of a number of stakeholders.

Figure 1: Business disruption during a false alarm

Methodology

Development of a questionnaire

A comprehensive questionnaire containing 124 questions was drafted for the fire alarm investigator to complete on site or back at base. After a number of iterations the stakeholder group agreed on the questionnaire's final version, designed to provide details on all aspects of the false alarm and the investigation, as well as gathering other data of interest to stakeholders.

The questionnaire covers false alarm details such as location, management, detection systems, system maintenance, documentation, manual call point activations and environmental factors, and includes a summary of the incident and recommendations for how the false alarm could have been averted.

Quantitative data gathering

BRE's Digital Products Team used the questionnaire as the basis for creating a BRE UFAS online tool that could be accessed by the fire alarm investigator anywhere with network coverage, using a tablet, smartphone, laptop or desktop.

With a background in working with FDFAS from a technical and quality assurance perspective, the fire alarm investigator on this project had over 40 years of experience in the industry. On some of their live callouts he accompanied (and assisted) the attending crews and completed the questionnaire for each false alarm, using the BRE UFAS online tool, to create a false fire alarm database.

The online tool included fields that allowed the selection of fixed answers from drop-down menus, and open text fields to record other observations. The tool enabled reports to be created, edited, viewed and downloaded locally, either as an individual report or as collated data from all reports (see Figure 2).

Qualitative data gathering

In addition to the BRE UFAS online report completed by the specialist investigator for the callouts he attended, the SFRS developed a UFAS Form for the operational crews to complete when attending all callouts (see Figure 3). This form is more comprehensive and informative than the one currently used in the Incident Recording System (IRS). It provided concise supplementary data from a greater number of false alarm incidents than could be attended by the specialist investigator, as the comprehensive investigation of every false alarms would have been too time consuming and costly.

Over the duration of this study the fire alarm investigator periodically produced detailed qualitative reports for the stakeholder group, which provided anecdotal accounts of his observations and findings.

Figure 2: BRE UFAS data gathering tool

Figure 3: SFRS form used for gathering detailed UFAS data

Summary of data gathered

The fire alarm investigations took place in the greater Glasgow area from the last week of November 2014 to the first week of April 2015.

Eight reports were generated by the fire alarm investigator over this period, and were reviewed in detail by the stakeholder group.

Sixty-five false alarms were attended by the specialist investigator at premises including, alarm receiving centres (ARCs), SFRS control rooms, hospitals, university premises, schools, care homes, hotels, community centres, restaurants, offices, factories, leisure centres, a library and a large hall (see Figure 4) . He completed BRE UFAS online reports for these events and the resulting data was analysed. While a number of the issues addressed by the questionnaire provided valuable information for use in follow-up investigations (including details such as the quantity of sensors, fire panel types, cable types, servicing etc), they were not necessarily relevant to the recommendations provided in this report. Data from 33 of the 124 questions in this study, along with the investigator's eight reports and supporting evidence, were used to develop recommendations.

The false alarm causes reported during this study have been compared with previously acquired SFRS data generated from the IRS database. As reported in the previous BRE false alarms study, data acquired using the IRS is inaccurate and vague with insufficient detail to fully identify false alarm causes. The limited causes for the period from January to December 2014 which could be generated from IRS, are presented in Table 1. It is worth noting that poor maintenance, faults, damage, incorrect positioning and unsuitable equipment make up the false alarm causes reported below as 'others'.

Table 1: False alarm causes and frequency for the period Jan to Dec 2014

False Alarm Cause	Frequency
Dust, steam and aerosol contamination	1561
Operation of MCPs by accident, malicious and activation by good intent	840
Weekly tests being carried out and not informing the ARC	426
Sprinkler valve activation due to a change in water pressure	13
Others	3760
Total	**6600**

Figure 4: Fire Alarm Investigation

Data, for the period covered by this study, was generated by Fire and Rescue Service personnel who used the new UFAS form created by the SFRS on all of their callouts. The frequency of specific false alarm causes found are listed in Table 2.

Dust, aerosol, steam and weekly testing were identified as common causes of false alarms during the UFAS investigation period. However, 'Unknown' and 'Fault' were attributed to 699 of the false alarm calls received (over a third), because where the cause of the alarm was not obvious, the UFAS team did not have sufficient time to investigate further.

In view of these figures it will be important to consider how FRSs deploy and identify problematic issues in the future, and provide information to fire alarm engineers that design and maintain FDFAS on a regular basis.

A key issue highlighted at this stage is the fact that the causes of false alarms can be complex and not always apparent to firefighters and duty holders. This emphasised the importance of utilising an experienced fire alarm investigator –it is suggested that FRSs should consider the use of fire alarm investigators in the future.

Table 2: False alarm causes and frequency for the period Dec 2014 to Mar 2015

False Alarm Cause	Frequency
Unknown	374
Fault	325
Dust	216
Cooking	169
Weekly testing	116
Accidental activations	116
Steam	98
Aerosol	73
Water ingress	65
Malicious	56
Toast	46
Smoking	41
No Access to premises	17
Call point	16
MCP activated on smell of burning	16
Contractors	15
Artificial smoke	13
Hot works	10
Sprinkler maintenance	6
Water pressure fluctuation	6
Others (45 other causes, including false alarms during system maintenance, power-cuts, candles, hairdryers, faulty heaters, smoke cloaks, light fittings, vandalism, vehicle fumes, ovens, microwaves etc.)	114
Total	**1908**

Findings and recommendations

The eight expert reports and 65 completed BRE UFAS forms were reviewed and used to provide recommendations in nine key areas: Multi-sensor detectors, Smoke detectors, Manual call points, Alarm receiving centres, Sprinkler flow/activation switches, Staff alarms/ investigation periods, Documentation, Panel capabilities and Communication.

For each key area a summary of the findings is presented and, where relevant, findings from the previous BRE False Alarms study are also included. Recommendations are made on the basis of these findings and, while this study was conducted specifically for the SFRS, most of the recommendations will apply to UK FRSs generally.

Multi-sensor detectors

None of the false alarm observed resulted from multi-sensors (such as that in Figure 5), with 0/65 cases from the BRE UFAS forms and 0/510 from the SFRS UFAS forms. Backed by anecdotal accounts, this finding is encouraging and suggests that multi-sensors do not cause many false alarms.

However, it should be noted that without knowing the proportion of multi-sensors installed in the dataset analysed, the conclusions that can be made are limited. There are many operating multi-sensor modes with varying capabilities and with differing false alarm rejection criteria, which can produce a broad range of alarm responses. Some multi-sensor detectors may be configured to reject nuisance fire like phenomenon (e.g. steam). This would mean that, though less prone to producing false alarms, they may also be less sensitive to detecting certain types of smoke.

Further research is required to support or recommend the use of multi-sensor detectors, and to identify their performance variabilities and capabilities. The findings should then be used to support codes of practice or building regulations.

Figure 5: Optical/heat multi-sensor detector (*photo courtesy of Tyco Fire Protection Products*)

Smoke detectors and age of components

Optical smoke detectors were responsible for 74% (48/65) of the live false alarms observed during this study. The majority of these were due to cooking, dust, aerosol and steam. Although 74% may seem unexpectedly high, this type of detector most probably accounts for the highest proportion of detectors installed in the field. Stringent false alarm immunity tests may be necessary to force manufacturers to develop more sophisticated smoke detectors that demonstrate greater immunity to common false alarm sources.

Observations were also made of poor detector placement that could cause future false alarms. Figure 6 shows a smoke detector located in front of a fan. This is likely to cause a false alarm from dust being blown into the detector when the fan is started. Also the detector could potentially be less effective during a real fire as smoke will be blown away from it.

False alarms were not observed from aspirating smoke detectors, but there was one anecdotal account of activation from aerosol spray. A greater sample size would be required to identify more accurately the proportion of false alarms generated by the other less frequent offenders, such as linear heat detectors, ionisation smoke, carbon monoxide and optical beam smoke detectors. When reporting false alarms using the IRS, no distinction is made between optical point smoke, optical beam and aspirating smoke detectors which are classified under the generic heading "smoke detectors".

Figure 6: Poorly placed optical smoke detector

On many occasions it was very difficult to establish the age of detectors, particularly the older devices. The fire alarm investigator did not remove the detector from the base to find the installation/manufacturing date, but estimated it based on the manufacturer and model. There was limited data to suggest that older detectors produce more false alarms than modern ones. Some European Union member states (such as Germany and Austria) mandate the replacement of smoke detectors every eight years. Some of the detectors observed in the field during this study were more than 30 years old.

Old detectors were considered responsible for 4.9% of the false alarms observed in data from Kings College London, which was examined in the previous BRE False Alarm study. Clearly the use of old detectors needs to be reviewed at the next revision of the BS 5839-1[4].

Further research work with used smoke detectors from different service environments is proposed to identify any changes in detector performance. This would provide valuable data and identify whether smoke detectors in the field are getting less sensitive (thus effectively outside the approved limits) or more sensitive making them more likely to cause false alarms.

Figure 7: Manual Call Point with protective cover *(photo courtesy of Tyco Fire Protection Products)*

Manual call points

False alarms generated from the misuse or accidental operation of manual call points have been observed during the previous BRE False Alarm study. It was found then that the, "Use of protective covers over approved manual call points (MCP) with adequate signage and closed circuit television (CCTV) where required", could reduce false alarms by up to 16.7%. This figure is similar to the 12.7% of false alarms due to MCPs identified during this study. These resulted from physical impacts to the sides of the MCP, and other activations that were by accident, or the result of malicious or good intent.

Activations that are accidental, malicious or made with good intent could be reduced by installing protective covers (as in Figure 7) that require the dual action of lifting the protective cover and activating the MCP mechanism. It has been reported by Buckinghamshire and Milton Keynes Fire Authority (BMKFA) that the use of protective covers on MCPs have reduced false alarms (see BRE's false alarms report[3]).

A number of MCP false alarms are caused by trollies striking the side of the MCP and triggering the mechanism that signals a fire. In this case, the use of deflectors or side impact protection to push the trolley away from the MCP would prevent the impact (see Figure 8).

The product standard EN 54-11[5] has an impact test in which a chamfered hammer strikes the outer edges of the MCP, once from the side and once from the front, with impact energies of 1.9J. This is considered adequate for most applications and even though the impact energy from a trolley is much greater than this, there is no need to recommend higher levels in the standard as these are extreme applications and exposures that are not typical of most service environments.

Figure 8: Protective shielding for manual call points *(photo courtesy of Continental Sports Ltd)*

Figure 9: Manual call points for fire and for emergency door release

In addition some false alarms arise from accidentally trying to use an MCP to release an electronically locked door, rather than the normal control provided for this purpose, or the emergency override. An emergency override normally takes the form of a green fire alarm call point (see Figure 9). BS 7273-4[6] recommends that, where a green 'break glass' unit is likely to be used by persons other than trained staff, there should be a sign next to it saying, "In emergency, break glass to open door", to distinguish it from a fire alarm call point.

Greater awareness of this recommendation, which is commonly not implemented, should be promoted by the fire and rescue service and other stakeholders, particularly the fire alarm industry. The recent revision of BS 7273-4 presents an opportunity in this respect, for example, in the provision of training on the new version.

NHS Scotland's policy is for staff to activate an MCP if they smell smoke whilst performing their duties. The anecdotal accounts suggest that this is contributing to the number of false alarms observed at NHS premises as staff will trigger the MCPs without any investigation.

At the time of publication the SFRS was working alongside a range of external partners, such as BAFE and BT, to supply protective covers to premises experiencing higher levels of UFAS events as a result of MCP activations.

Alarm receiving centres

It was observed that on a number of occasions during weekly testing of the FDFAS, the Alarm Receiving Centres (ARC) were not notified of a test. This led to the signal from the premises being treated as a real fire alarm.

This false alarm cause had been observed during the previous BRE false alarm study, with BMKFA reporting 4.1% of false alarms (270/6612 incidents from June 2009 to April 2013) occurring because, "Somebody conducting weekly test of the system but not taking it off-line." This is a similar level to those reported in this study (6.5%- 426/6600), suggesting that this elementary breakdown in communication probably occurs throughout the UK.

Figure 10 Alarm Receiving Centre

Where an ARC connection is provided for property protection only, there is scope in lower risk premises for using a time-related system with a 'day/night' arrangement. This allows for the ARC connection to be isolated during normal working hours, but restored automatically at the end of the working day (this strategy is not suited for premises with sleeping accommodation).

An alternative arrangement is for alarm filtering by the ARC so that, during normal working hours only, the ARC contacts the premises prior to alerting the FRS. Where the ARC is also monitoring an intruder alarm system, it should be able to determine whether the premises are occupied, as it will know whether the intruder alarm is set. Such arrangements should only be made following a comprehensive fire risk assessment.

There was some anecdotal evidence that address details of premises were not recorded accurately or transferred effectively between ARCs, fire alarm contractors and SFRS.

Fixing the issues surrounding MCPs and false signals generated from ARCs would lead to the reduction of false alarms by approximately 20% (this estimate comes from both this and the previous BRE false alarm study).

Figure 11 Weekly test of fire detection system

Sprinkler flow/activation switches

During this study sprinkler operations were responsible for 0.2% (13/6600) of the false alarms. In the previous BRE false alarm study (from June 2009 to April 2013), BMKFA reported 0.9% of false alarms occurring because, "A drop in water pressure from an activated sprinkler system causes a signal to be sent to the fire alarm system".

Automatic fire sprinkler systems will usually have an independent mechanical alarm and pressure switches, to operate the pumps and alarms which send signals to the main fire alarm panel to give notification of the sprinkler system's status. These signals can be sent erroneously from sprinkler systems during servicing or when local changes occur, such as a drop in water pressure.

Due to the complexity and range of interactions between automatic fire sprinkler systems and the fire alarm panels, a more detailed analysis of these interactions and fault data will be necessary before detailed recommendations for reducing false alarms in this area can be made. The use of a suitable signalling time delay, as in BS 9251[7] and BS 5839-1, may in some cases reduce false alarms.

Staff alarms/investigation periods

In 93% of cases someone was available to investigate false alarms, but in only 23% were there adequate false alarm procedures. Where practical, businesses should be encouraged by the FRS or through their own fire risk assessment to implement the use of staff alarms/ investigation periods (in accordance with BS 5839-1) before calling out the FRS to an automatic fire alarm.

Figure 12 Staff investigation

Documentation

In nearly 86% of cases, logbooks were presented during the course of the investigation and most had regular entries (93%). However, there was one case where the last logbook entry had been made 18 months prior to the investigation. Ideally 100% of logbooks should be completed with regular entries.

In some cases, entries were made on scraps of paper and post-it notes, and it was not known whether they were filed away (see Figure 13). To encourage more comprehensive logbook entries it is proposed that the FRS request a copy of the previous 12 months of entries, either at audits or when attending false alarms. These would be required to verify that regular maintenance is being carried out and that staff are adequately trained.

In just over half of the incidents attended zone plans were available. These are needed by the FRS to quickly identify the location of a fire, and should be available on all occasions. Therefore, in the next revision of BS 5839-1, recommendations to update zone plans should be made, and fire alarm companies should retrospectively implement them.

It is recommended that, as a part of carrying out fire risk assessments under the Fire (Scotland) Act (and equivalent legislation elsewhere in the UK), the fire risk assessor (FRA) should ask about the occurrence of false alarms.

It is not suggested that the FRA engages in any significant investigation of false alarms. However, where high rates are found, the FRA could ensure that a maintenance company is called to assist the duty holder, and/or there is a proper record of the false alarms in the fire alarm system logbook for examination by maintenance technicians during routine service visits. A recommendation to this effect could be promulgated via professional trade bodies and could be included in the next revision of PAS 79[8].

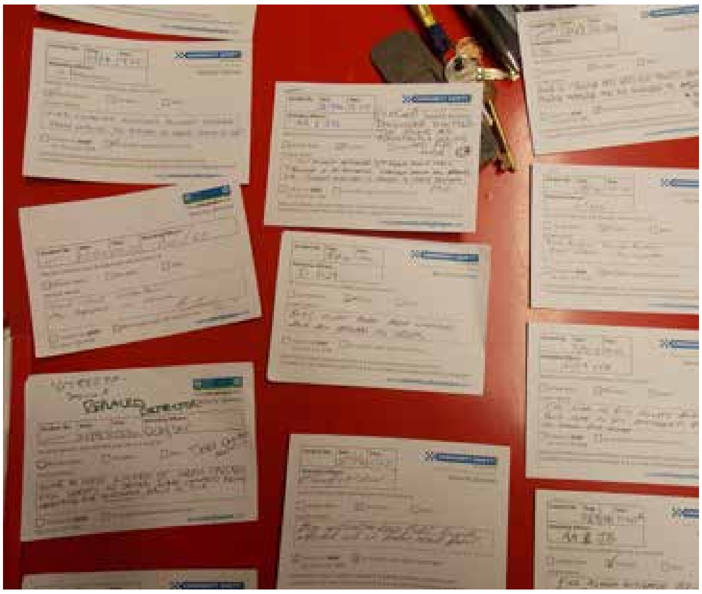

Figure 13: Example of poor record keeping and lack of logbook

Panel capabilities

It is encouraging to see the greater use of addressable panels, which allow alarming devices to be easily identified. In the previous BRE false alarm study, BMKFA had reported 50-60% non-addressable panels, but in this study the figure was 75%.

It was observed that in 15% of cases the FDFAS technology available was not being fully utilised to reduce false alarms. For 9% of cases no maintenance activity of the panel had occurred in over a year. It is recommended that guidance on FDFAS capabilities is provided to a wider audience.

Backed by anecdotal evidence, it was found that 28% of panels were indicating faults and 26% were isolated. This is a matter for concern and demonstrates that as many as 54% could have been outside of their expected operational state. The alarmingly high occurrence of this, whilst not part of the false alarms study, warrants further investigation as the parts of the FDFAS were potentially not operating as expected. It is recommended that guidance to end users is provided and guidance in BS 5839-1 for faults/isolations is enhanced, and that FRSs investigate these occurrences and review current operational procedures.

Figure 14: Panel maintenance in progress

Figure 15: Example of panel in fault and isolate condition

Communication

It was noted that some wireless systems were found to be in fault and this was suspected to be due to a loss of communication. This may suggest that some installations lack comprehensive communication between all system components. Attention is drawn to fact that a wireless system (as well as wired systems) in fault may not respond when a fire is present as the detector may be unable to communicate with the control panel.

Other findings

Where there were procedures for dealing with fire alarm activations, in 88% of cases they did not address false alarms, and in 93% of cases fire alarm contractors had given no false alarm advice. Clearly this demonstrates a need for more training for the people responsible for writing procedures, and for the greater exchange of false alarm information.

In 38% of the cases the operational crews would not have been considered capable of identifying the causes of false alarms. Therefore a key recommendation is that FRSs should consider employing specialists to investigate the causes of false alarms. Further work in other UK regions with other investigators (to even out some of the subjective responses to this question) is recommended to identify whether this figure is representative of the UK.

The findings of this research work could be used to provide valuable guidance on how to reduce false alarms to a much wider audience. Periodic liaison meetings between the stakeholders are recommended to support this. As its implementation may take a while, it is recommended that suitable guidance is provided in the Scottish Government's Sector Specific Guidance documents which already have sections on "Reducing False Alarms".

The reporting of false alarms with unknown causes

Over the course of this investigation, the top causes of false alarms were 'Unknown' (374/2017) and 'Fault' (325/2017), which together constituted 35% of the false alarms. In the previous BRE false alarm study, BMKFA reported 34% of false alarms were also from these causes. Clearly false alarms reported specifically as 'Unknown' or 'Fault' need to be investigated further by a specialist to identify the underlying causes.

Further investigations of false alarms attributed to 'Fault' found that in this study it was more likely to refer to a cause that was actually 'Unknown'. This may be because end users have reported 'Fault' when they didn't know the cause for fear of being blamed for the false alarm. Also, false alarms that an FRS cannot define are generally attributed to 'Fault' when they should be 'Unknown'. It is expected that more false alarms will be attributed to 'Unknown' in future, and fewer to 'Fault', as SFRS becomes more experienced in the use of the UFAS investigation form.

It is recommended that FRSs should correctly specify the causes of false alarms as 'Unknown' rather than 'Fault' when the false alarm cannot be identified (even if a fault is suspected).

User attitudes to false alarms

It was reported by the specialist investigator that, "On our visits to site immediately after a call to the FRS, it was noted the amount of embarrassment and panic when the site was evacuated and the need to silence the alarm takes priority over identifying the zone or device failure. On some of the sites visited the alarm was reset therefore no investigation could take place."

This demonstrates the attitude of some end users to false alarms. However, by reacting in this way and without the false alarms being investigated, they are likely to reoccur.

Witnessing fire alarm activations in real fires

As well as investigating false alarms, the investigator also witnessed four cases where the fire alarm system operated during a real fire. These were:

– **Shopping centre**: This site had a failure in an electrical timer that controlled the sign outside the shop, causing a fire the middle of the night. The timer completely melted resulting in the optical sensor operating.

– **Homeless shelter**: This fire was caused by a spent cigarette placed in a metal dustbin beside the bed. There was paper in the bin and the smouldering cigarette created enough smoke to set off the optical sensor (see Figure 16).

– **Halls of residence**: A student had lit a scented candle in a glass container. To extend the life of the candle, the student used a piece of string when the wick was running out and then went for a shower. The FRS found the candle and the glass container still lit in the bedroom dustbin.

– **Hospital**: A light fitting failure resulted in smoke reaching the sensor and operated the fire alarm.

Clearly, in these cases, if the FRS had a policy of not responding to unconfirmed fires then the situation would have been a lot worse. These examples demonstrate the benefits of correctly installed detectors and a rapid response by the FRS.

Figure 16: Fire in a bin from a smouldering cigarette

Summary of all recommendations

A total of 35 recommendations have been made which, as well as reducing false alarms, could improve the integrity and reliability of fire detection systems and management processes. The recommendations are summarised below, under the following organisation groups that will have the most responsibility for implementing them:

– Alarm Receiving Centres

– Businesses/End Users/Responsible Persons

– Certification and Inspection Bodies

– Committees for Test Standards and Codes of Practice

– Fire Alarm Contractors

– Fire and Rescue Services

– Fire Risk Assessors

– Research Bodies

– Trade Associations

Alarm Receiving Centres

– Fire alarm contractors and ARCs should check customer names and postcodes for accuracy.

Businesses/End Users/Responsible Persons

– In areas where objects might collide with an MCP, it should be fitted with side impact or other forms of protection.

– MCPs at risk of being triggered should be fitted with protective covers.

– Awareness of the recommendation in BS 7273-4 with regards to the use of green 'break glass' units should be increased.

– Where the ARC connection is provided only for property protection, the use of a time-related system with a 'day/night' arrangement should be considered. This isolates the ARC connection during normal working hours and automatically restores it at the end of the working day.

– Where practical, businesses should be encouraged, through their own fire risk assessment, to implement the use of staff alarms/investigation periods (in accordance with BS 5839-1) before calling the FRS to an automatic fire alarm.

– Logbooks should be easily accessible to responsible persons who should make entries of all events and follow-up investigations.

– The zone plan (see Figure 17) should be periodically reviewed and kept up to date.

– End users/responsible persons should be aware that the fire alarm system integrity is compromised when in fault or when parts of it are isolated (see Figure 17).

Figure 17: Good maintenance – the control panel is in quiescent mode (no faults or isolations), the logbook present and zone plan up-to-date

Certification and Inspection Bodies

- Awareness of the recommendation in BS 7273-4 with regards to the use of green 'break glass' units should be increased.
- Certification and inspection bodies should ensure that fire alarm contractors remind users of their responsibilities during service visits.
- Certification and inspection bodies should require fire alarm contractors to regularly and comprehensively check logbooks as part of the maintenance visit.
- Certification and inspection bodies should require assessors to enquire about the occurrence of false alarms, when they are performing fire risk assessments.

Committees for Test Standards and Codes Of Practice

- During the next BS 5839-1 revision, propose a review of old detectors and the possible need for replacement.
- MCP protection should be reviewed during the next BS 5839-1 revision.
- During the next revision of EN 54-11, incorporating the use of protective covers for MCPs should be proposed.
- During the next revision of BS 5839-1 more robust guidance to prevent false signals to ARC during weekly tests should be proposed.
- Revisions to BS 9251 and BS 5839-1 to strengthen existing guidance on time delays should be proposed.
- During the next revision of BS 5839-1 45.4, a recommendation to check, and if necessary retrospectively update, the zone plan should be included.
- The BS 5839-1 revision should state that fault/isolations should be under strict management control, and that periods of fault and isolation should be kept to a minimum.

Fire Alarm Contractors

- In public areas, where appropriate, MCPs should have protective covers fitted, possibly with break seal protection.
- Areas where objects can collide with an MCP should be fitted with side impact protection or other forms of MCP protection.
- Fire alarm contractors and ARCs should check customer names and postcodes for accuracy.
- Where the ARC connection is provided only for property protection, the use of a time-related system with a 'day/night' arrangement should be considered. This isolates the ARC connection during normal working hours, and automatically restores it at the end of the working day.
- All systems with an automatic connection between the ARC and FRS should be fitted with a robust method of preventing an alarm signal from the premises being sent to the ARC during the weekly test.
- Fire alarm contractors should remind users of their responsibilities, during service visits.
- Fire alarm contractors should ensure that logbooks are being completed regularly and comprehensively as part of their maintenance visits.
- Fire alarm contractors should retrospectively implement the recommendations of BS 5839-1:2013, with regards to zone plans.
- End users/responsible persons should be made aware that the fire alarm system integrity is compromised when in fault or when parts of it are isolated.

Fire and Rescue Services

- Awareness of the recommendation in BS 7273-4 with regards to the use of green 'break glass' units should be increased in FRSs.
- A review of NHS Scotland/DoH guidance should reconsider advice regarding the early operation of MCPs when there is a smell of smoke.
- SFRS should put in place arrangements with ARCs with ex-directory connections, to ensure that correct addresses and postcodes are passed to the appropriate control.
- Where practical, businesses should be encouraged by the FRS to implement the use of staff alarms/investigation periods before calling the FRS to an automatic fire alarm.
- FRSs should request copies of the previous 12 months of log book entries, either at audits or during attendance at false alarms.
- FDFAS control equipment should be checked for fault or isolation disablement conditions, when premises are audited by the FRS or during any operational incident. FRSs should review current operational procedures.
- The exchange of knowledge between FRSs and fire alarm companies should be improved.
- Scottish Government Sector Specific Guidance should be updated with relevant findings from this research work to reduce false alarms.
- FRSs should consider the use of specialist fire alarm investigators to investigate the causes of false alarms.
- FRSs should correctly specify the causes of false alarms as 'Unknown' rather than 'Fault' when the false alarm cannot be identified (even if a fault is suspected).

Fire Risk Assessors

- Whilst performing fire risk assessments, the FRA should enquire as to the previous occurrence of false alarms and, where possible, ensure that appropriate actions are taken to reduce their number.

Research Bodies

- Multi-sensor capabilities, and comparisons between them and single sensor smoke detectors, should be investigated.
- Research should be conducted to characterise the performance capabilities of old, used smoke detectors, taking environmental influences and other risk factors into consideration, to identify any degradation in performance with time.
- A more detailed investigation of sprinkler system/fire detection interactions and fault data is needed before any specific guidance can be proposed.
- Specialist investigations of false alarms reported as 'Fault' or 'Unknown' should be conducted to identify their root causes.

Trade Associations

- There should be consideration of a change to recommendations that support codes of practice, to refer to the potential benefits of certain multi-sensor detectors in providing greater immunity to false alarms.
- The fire alarm industry's awareness of the recommendation in BS 7273-4 with regards to the use of green 'break glass' units should be increased.
- Training bodies should emphasise the responsibility of fire alarm contractors to detail all false alarms experienced during each FDFAS service.
- Guidance should be given to a much wider audience as to what an FDFAS system is capable of doing to minimise false alarms.
- Periodic liaison meetings between BRE, FIA, FPA, BAFE, RISC Authority and SFRS should be held so that SFRS issues and messages can be disseminated.

Further work

Further work adopting the methodology used in this study would benefit from the following guidance:

- The use of additional trained fire alarm investigators is recommended to balance out some of the subjective responses to questions from the questionnaire. The provision of training for all investigators at the same time would ensure a common knowledge base, and a more consistent approach to investigating and reporting false alarms.
- Performing these investigations at different times of the year would be useful for identifying false alarm causes that may be due to seasonal effects, such as insects in summer or smoke from bonfires drifting into buildings in autumn.
- It would be useful to conduct investigations in different geographic regions to identify whether false alarm causes are the same and observed in the same proportions.
- The development of a questionnaire specifically tailored for use by trained fire alarm investigators would be beneficial.

Incorporating these points would make available a more complete and representative dataset of false alarm causes in the UK. This would provide further statistical evidence to support existing or identify new recommendations.

If other further work is planned, an investigation into the use of pre-alarm states is recommended. The aim would be to establish whether there may be benefits from the greater use of pre-alarm states, and whether they are more effective for certain types of detectors.

Guidance on reducing false alarms is available from the FIA website[9].

Conclusions

The intention of this research work was to investigate false alarm causes using a new approach that utilised a combination of anecdotal accounts and detailed analysis of data generated from live false alarms.

By employing a technically competent fire alarm investigator with many years' experience of working with fire detection systems, data was gathered that was both reliable and in a form that enabled useful recommendations to be made.

In the greater Glasgow area, from the last week of November 2014 to first week of April 2015, a total of 65 false alarms were comprehensively detailed. During this time the fire alarm investigator periodically produced detailed qualitative reports which, together with quantitative data from the 65 cases, were used by the research group to support recommendations for reducing false alarms.

A total of 35 recommendations have resulted from this work, and have been grouped under the types of organisation that are considered best placed to take them forward. If these organisations take ownership and implement these recommendations, the occurrence of false alarms will be reduced. For any further work building on the methodology used here, the following guidance is given:

- Use additional fire alarm investigators
- Conduct investigations at other times of the year
- Conduct investigations in other geographic regions
- Revise the questionnaire
- Train the fire alarm investigators.

The false alarm causes observed during this study were, in decreasing order of occurrence: Unknown, Fault, Dust, Cooking, Weekly testing, Accidental activations, Steam, Aerosol and Water ingress.

A detailed investigation of false alarms reported as 'Fault' and 'Unknown' would provide useful information, as these constitute around 35% of all false alarms.

If the issues surrounding MCPs and false signals generated from ARCs could be fixed, this could reduce false alarms by approximately 20% cost savings from dealing with the MCP issues amounting to approximately £147m/year in the UK.

A number of key issues identified from this research project have highlighted the fact that the manner in which Fire Detection and Fire Alarm Systems are procured and maintained often results in major areas of non-compliance with BS 5839-1, including non-compliances that might create the potential for false alarms.

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