



AUTOMATIC FIRE ALARM & DETECTION SYSTEMS

A review and investigation into the levels of false and unwanted activations of signals from automatic fire alarm systems; the standards, approvals and methodologies being adopted to try to affect change; and an investigation into the reliability of new technology and it's potential to contribute to dramatically reduce the problem.

BRIEF

This work was commissioned by ABI to assist with the provision of insurer relevant information to Dame Judith Hackitt's review of building regulations and the Grenfell Inquiry. The work was undertaken by the fire protection association and technically supported by the RISCAuthority membership

Jonathan O'Neill March 2018

ABI Detection Research:

This report, and the underlying work on which it is based, has been prepared and is submitted in accordance with the contract with the Client.

FPA warrants that the report has been prepared with all reasonable skill and care. The Client acknowledges that all possible circumstances in which the report may have some relevance cannot be foreseen at the time the report is prepared.

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It should be acknowledged that the detectors tested represent today's technology and current practice by fire and rescue authorities and as technology moves on and response by fire and rescue services changes the results that have been recorded are likely to become less relevant over time. Where so indicated by FPA any report is to be regarded as expressing the opinion only of FPA and is not to be relied upon as being factually correct.

Review

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1.0	31/01/2018	First Issue
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Summary Report

Fire alarm and detection systems remain a fundamental aspect of means of escape and evacuation strategies however the overwhelming majority (in excess of 75%) of automatically generated fire alarms (AFA) in the UK turn out to be 'false or unwanted'. It is FPA's belief that traditional heat and smoke detectors are the source of the problem – they are poor at exclusively recognising a fire and this is a view which is being increasingly recognised by international academic studies.

New 'multi-sensor' devices are much more discerning with an anticipated performance of 80% believability however there is a general lack of understanding of the capabilities and reliability of this new technology by fire and rescue services and until this is addressed they are unlikely to alter their response. A new communications strategy and a 'You Tube' Digital Media Tool has been produced to begin to tackle this issue.

The current product standard contains no reference to immunity testing, a simple and effective method of assessing a product's capacity to false alarm. The documentation and recording of laboratory-based immunity tests demonstrates the capabilities of this technology and should provide the necessary stimulus for more urgent consideration by Standards making bodies.

1.0 Background & Introduction

- 1.1 The overwhelming majority (in excess of 75%) of automatically generated fire alarms (AFA) in the UK turn out to be 'false' (not sourced from a fire), or 'unwanted' (smoke, but not needing fire appliance attendance). This situation has prompted poor behaviour from all stakeholders: fire services now challenge AFA's or simply do not turn out or respond; insurers see little benefit in detection if their operation does not prompt a response; and owners are switching off systems as production and office time is wasted and punitive measures for false call-outs are introduced.
- 1.2 At the time that the current guidance on Building Regulations was written, only relatively simple (single phenomena) heat or smoke detectors were available for supporting life safety. It is FPA's belief that these are the source of the problem – they are poor at exclusively recognising a fire and this is a view which is being increasingly recognised by international academic studies.
- 1.3 During the past 10 years, 'multi-sensor' devices have entered the market and these are very much more discerning with an anticipated performance of 80% believability – an amount that could radically alter the requirement for the currently adopted poor behaviours by all parties.

2.0 The Research Proposal

2.1 The agreed research proposal was to:

- undertake a literature review to establish progress on standards and recent initiatives to address the issue of false and unwanted alarms and where the market stands on high integrity detection.
- create a communications medium to educate and inform fire and rescue services and end users of the attributes and benefits of high integrity detection systems with aim of changing response standards to systems with an 80-90% guarantee of genuine alarm.
- to assist in the development of a test specification that if satisfied, will qualify equipment capable of high integrity differentiation of potential fire signatures between those that are;
 - real and warrant immediate fire and rescue service response

ABI Detection Research:

- real, but do not require immediate response (such as burnt toast or cigarette smoke)
- not real, such as shower steam, insect infestation, dust etc.

2.2 This work together with an enhanced installation, connection and maintenance standard being developed by the trade should ensure that the fire and rescue services have an 80%-90% expectation that fire signals when actuated are real. In turn, this will allow the degree of certainty required to always provide an appropriate response, with evacuation procedures altered accordingly.

3.0 Results and Conclusions

3.1 The Literature Review demonstrated that fire alarm and detection systems are a fundamental aspect of means of escape and evacuation strategies and their importance is clearly documented in the guidance to the fire safety requirements of Building Regulations and the legislation covering fire safety in occupied buildings.

3.2 The move by fire and rescue services to locally derived attendance standards driven by the Integrated Risk Management Plans has resulted in a divergence of response arrangements, with virtually no two fire and rescue services having common policies for response to automatic fire alarms throughout the whole of the UK and clearly this is problematic for end-users.

3.3 In 2014, when FPA originally lobbied for multi-sensor devices to be mandated in all new high-risk environments, it could have been argued that there were too few suppliers of such equipment at that time for the initiative to gain traction. The situation has now changed, the literature review however, confirmed two barriers to progress remain:

- A general lack of understanding by a range of stakeholders, but particularly from fire and rescue services on the capabilities and reliability of the new technology. If responders have an 80% assurance that an alarm signal from these systems is genuine their response strategies would alter accordingly. A new communications strategy and 'You Tube' Digital Media Tool should begin to address this issue.
- The product standard, whilst comprehensive in the range and scope of signals required to be evaluated, contained no reference to immunity testing, a simple and effective method of assessing a product's capacity to false alarm. The documentation and recording of laboratory-based immunity tests will further demonstrate to stakeholders the capabilities of this technology and should provide the necessary stimulus for more urgent consideration by Standards making bodies.

3.4 This study has demonstrated that whilst the technology which could virtually eliminate false alarms is now widely available, its attributes are not generally well known and until they are fire and rescue services will be unlikely to alter their response. The Digital Media Tool (<https://www.youtube.com/watch?v=JrJUjZ5akh0&feature=youtu.be>) will provide a mechanism to educate; and it is hoped that the work on immunity tests will compliment and support the recent research released by the BRE Trust and FIA and accelerate the introduction of immunity tests into standards.

4.0 Possible Next Steps

Deliverable	Possible Target & Exploitation Path	Target Date
Literature Review & 'You Tube' Digital Media Tool	Educate HM Inspectorate of Constabulary and Fire & Rescue Services (HMICFRS) on the scale of the problem and the reliability of this technology and encourage them to put pressure on fire and rescue services to change response policies for systems which incorporates these types of detectors	May 2018 or as agreed with ABI.
	Educate Fire & Rescue Services on the reliability of this technology – initially through the National Fire Chiefs Council (NFCC) Unwanted Alarms Group - Next Meeting June 2018	May – July 2018 or as agreed with ABI.
	Gain commitment from fire & rescue services to alter response standards (where multi sensor devices installed) and update RISCAuthority response tool	September 2018 or as agreed with ABI.
	Release to YouTube channel and broadcast media.	ASAP
Literature Review & Scenario recreation of comparative system performance – Immunity Tests	Release report to Dame Judith Hackitt's Review – Due late Spring	April 2018 or as agreed with ABI.
	Release Review to BRAC and ADB review team – with a view to effecting change in Building Regulations.	April 2018 or as agreed with ABI.
	Release Review to Sir Martin Moore Bick's Public Inquiry	April 2018 or as agreed with ABI.
	Release to BSI, BRE and other standards making bodies	April 2018 or as agreed with ABI.
Full Report	Conduct a series of webinars to ABI members, RISCAuthority, Fire & Rescue Services, Building Control Authorities, End Users (particularly poor performing in respect of false alarms) and high-risk occupancies	April 2018 or as agreed with ABI.

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**ABI Post Grenfell
Research Specification
Workstream 2: Detection
Systems - Main Report**



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Section One - Introduction & Background

1.0 Introduction

1.1 Following the Grenfell Tower tragedy, the Fire Protection Association proposed fourteen potential research themes that it considered valid in addressing fire safety and resilience issues across the UK built environment as follows:

<ul style="list-style-type: none"> • Clarity and interpretation • Scope • Engagement • Competency, Supervision, Control, and Authorisation • Combustible Materials • Imperfect World • Standards 	<ul style="list-style-type: none"> • Detection and Evacuation • Engineered solutions • Data • Awareness • Impact of other parts of Building Regulations • Sprinklers • Consequences of previous BR reviews and legislative changes
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1.2 These themes were considered by ABI’s and RISCAuthority’s memberships and ABI funding was provided to deliver on three fronts with timelines designed to allow for influencing the Inquiry and Hackitt review as follows:

- Cladding Standards: The adequacy of the current cladding testing regimes to deliver high levels of fire safety under real world conditions.
- Detection & Evacuation: The effectiveness of detection and associated evacuation procedures: furthering the FPA campaign for high-integrity detection systems in high risk, high hazard and commercial applications.
- Residential Sprinkler Systems: The standards and relative performance of sprinkler systems specified for residential applications with a view to ensuring quality in operation and function.

1.3 Background

1.3.1 Building Regulations have traditionally been focussed on the general requirement of ‘evacuation before collapse’. However, for a range of reasons, stay-put evacuation policies are being used which, if not properly justified in terms of the building’s compartmentation strategy and resilience to fire, could be more harmful than beneficial. A possible driver for the stay-put policy might be the incredibly unreliable performance of automatic fire detection systems. Automatically generated fire alarm signals are over 95% likely to be false (not stemming from fire or smoke (shower steam etc.)) or unwanted (smoke based, but not something requiring an FRS response (burnt toast or smoking)). A stay-put policy might reduce the inconvenience associated with false and unwanted alarms but does not correct the core issue of poor alarm performance. There are few areas of life-safety where there is such tolerance to poor supporting system performance.

1.3.2 In January 2004 a meeting was held at the House of Commons to discuss a way forward in addressing the high incidence of falsely generated and unwanted automatic fire alarm signals and the non or reduced turnout policies some Fire Authorities were having to adopt to manage their resources.

Chaired by Chris Hanks, then General Manager of Allianz Insurance and Chairman of RISC Authority, the meeting was attended by representation from insurers, FPA as their technical advisors, the Chief Fire Officers Association (CFOA), the fire industry through what is now the Fire Industry Association (FIA), government ministers and civil servants with responsibility for our building regulations. Commitments were made at that meeting to collaboratively work towards a viable solution and whilst there have been a number of interesting and well-meaning initiatives aimed at addressing this problem all that has happened in the intervening period is that stakeholders have adopted measures to 'manage the deficiency' rather than seek a long-term solution:

- Fire Authorities have adopted sundry methods to determine the nature of the alarm before turning out that results in inevitable delay in attendance
- The fire alarm industry has attempted to preserve system reputation by advising customers to take additional measures to check the validity of the alarm
- Insurers have reduced greatly their view on the benefit that might be received from F&RS response and indeed the logic of installing automatic fire alarm (AFA) systems is now being called into question by them and their customers
- Worst offending end-users, faced with charging for false alarm call outs, are likely in many incidences to disable their fire alarm systems entirely.

1.3.3 Over 95% of all fire alarm signals generated from AFA systems are false or unwanted. The methods being adopted by all stakeholders to cope with the 'presumption of falsity' benefit no-one, have considerably increased turnout times for fire and rescue services responding to alarms and can only result in higher commercial fire losses and reduced safety.

1.3.4 The Fire Industry Association in conjunction with BAFE and the National Fire Chiefs Council are currently working on a 'Gold Standard' for fire alarm and detection systems. This will go some way to addressing current issues regarding system reliability. However, as demonstrated in pure property or asset protection scenarios, 'reliability' in fire detection inevitably leads to the use of devices that can sample multiple fire emissions. Valid fire fingerprinting "species" include heat, smoke, carbon monoxide, and light (visible, UV, and IR). In isolation, none of these will ever describe the presence of fire with great reliability, but by combining them the potential for false alarms reduces dramatically with every introduced species. A sensor capable of simultaneous measurement of heat, smoke and carbon monoxide instantly becomes discerning enough to not trigger on the presence of cigarette smoke, steam production from a shower, burning of the morning toast, or use of vehicles within the protected space, but it will respond to a fire.

1.3.5 In pursuit of reliable detection systems, the industry has responded, and these devices are readily available in a format suitable for "drop-in" detector replacement to many modern alarm systems commonly in use in the commercial environment, requiring additionally only a reprogramming of the alarm panel. Widespread adoption of such systems appears to be restricted due to the fact that these are not pure life safety systems, and there is therefore currently a lack of a technical specification.

1.4 Research Proposal

The research proposal is to:

ABI Detection Research:

- undertake a literature review to establish progress on standards and recent initiatives to address the issue of false and unwanted alarms and where the market stands on high integrity detection
- create a communications medium to educate and inform fire and rescue services and end users of the attributes and benefits of high integrity detection systems with aim of changing response standards to systems with an 80-90% guarantee of genuine alarm.
- to assist in the development of a test specification that if satisfied, will qualify equipment capable of high integrity differentiation of potential fire signatures between those that are;
 - real and warrant immediate fire and rescue service response
 - real, but do not require immediate response (such as burnt toast or cigarette smoke)
 - not real, such as shower steam, insect infestation, dust etc.

This work together with the 'gold standard' being developed by the trade should ensure that the fire and rescue services have an 80%-90% expectation that fire signals when actuated are real. In turn, this will allow the degree of certainty required to always provide an appropriate response, with evacuation procedures altered accordingly.

1.5 False & Unwanted Alarms

For the purposes of this document:

1.5.1 An unwanted alarm stems from stimuli that are associated with fires, but from events that do not at that time warrant delivery of a fire appliance. These might include, but are not limited to:

- Cigarette smoke
- Car exhaust products
- Burnt toast
- Normal cooking activities that might be smoky (grilling bacon), demand occasional flaming (flambéing), or generate a lot of heat
- Welding, grinding and manufacturing activities that may produce visible fire signatures (UV and IR) during normal processes

1.5.2 A false alarm stems from stimuli that are not associated with fires, but from events and materials that may trick the sensor into believing there is a fire. Again, these do not warrant delivery of a fire tender and might include, but are not limited to:

- Steam from washing, cooking and cleaning activities
- Dust from cleaning, manufacturing, and building activities
- Aerosols from deodorants, vaping, cleaning and decontamination activities

1.5.3 Insurers' active participation in a false alarm issues caused by intruder detectors in the 1980's where police response was similarly threatened resulted in a regime where the problem has largely been eliminated and response is reasonably uniform across the UK.

2.0 Section Two - Literature Review & Bibliography

2.1 Standards & Codes of Practice

PD 6531:2010 - Queries and interpretations on BS 5839 1 – (BSI 2010)

BS 5839 1: 2017- Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises (BSI 2017)

BS EN 54-31: 2014 - Fire detection and fire alarm systems – Part 31: Multi-sensor fire detectors – Point detectors using a combination of smoke, carbon monoxide and optionally heat sensors (BSI 2014)

BS EN 54-29: 2015 - Fire detection and fire alarm systems – Part 29: Multi-sensor fire detectors – Point detectors using a combination of smoke and heat sensors (BSI 2015)

BS EN 54-30: 2015 - Fire detection and fire alarm systems – Part 30: Multi-sensor fire detectors – Point detectors using a combination of carbon monoxide and heat sensors (BSI 2105BS 5839-1:2017)

BS5839-6:2013 - Fire detection and fire alarm systems for buildings. Code of practice for design, installation, commissioning and maintenance of systems in domestic premises (BSI 2013)

LPS 1014: Issue 5.3 - Requirements for certificated fire detection and alarm system firms (BRE 2014)

BAFE Fire Protection Industry Scheme, Reference SP203 Part 1 - Version 7: September 2016 For the Design, Installation, Commissioning & Maintenance of Fire Detection and Fire Alarm System – (BAFE 2016)

2.2 Research Papers

Developments in fire detection and fire alarm systems – R. Chagger (BRE 2009)

Review of Fire Detection Problem – NK. Fong Hong Kong Polytechnic University (International Journal on Engineering Performance Based Fire Codes – 2010)

Briefing Paper - The causes of false fire alarms in buildings - R. Chagger, D. Smith (BRE 2014)

Code of Practice Best Practice for Summoning a Fire Response via Fire Alarm Monitoring Organisations (CFOA 2014)

CFOA Guidance for the Reduction of False Alarms & Unwanted Fire Signals (CFOA 2014)

Briefing Paper - Live investigations of false fire alarms - R. Chagger (BRE 2015)

Report No 243 – 15 RM – Multisensor detector capabilities and comparative performance with optical smoke detectors – R. Chagger (BRE 2017)

Abstract False Alarms of Fire Detection and Fire Alarm Systems in selected European Countries - Sebastian Festag, Lance Rütimann Euralarm, Zug, Switzerland (NFPA 2017).

Fire and rescue incident statistics: England, year ending September 2017 Statistical Bulletin 04/18 (Home Office 2018)

2.3 Other Publications

The Fire Precautions Act 1971

The Regulatory Reform (Fire Safety Order) 2005

Fire Risk Management in the Workplace FSB22 (Fire Protection Association 2006)

The Building Regulations 2010 Fire Safety Approved Document B Volume 2 Buildings other than dwelling houses 2006 Edition (NBS 2006)

RI11 Report to Insurers - Fire & rescue service response to calls originating from automatic fire alarm systems (RISCAuthority 2012)

Essentials of Fire Safety Management FSB50 (Fire Protection Association 2014)

Fire Alarm & Detection Systems FSB9 (Fire Protection Association 2015)

2.4 Overview of Findings

2.4.1 The Literature Review demonstrated that fire alarm and detection systems are a fundamental aspect of means of escape and evacuation strategies and their importance is clearly documented in the guidance to the fire safety requirements of Building Regulations 2010 (Approved Document B) which governs the design of new and refurbished buildings. Furthermore, the guidance written in support of the legislation covering fire safety in occupied buildings, (The Regulatory Reform (Fire Safety) Order 2005), similarly recognises the importance of early fire detection and alarm, as did its predecessor, The Fire Precautions Act 1971. It is unsurprising therefore, that this fundamental pillar of fire safety strategy is underpinned by a comprehensive suite of standards which cover the detectors themselves (BS EN 54) and their design, installation, commissioning and servicing (BS 5839) and great strides have been made in respect of both the independent accreditation of installers and of the equipment.

2.5 Testing and Accreditation

2.5.1 Whilst the Standard for Fire Alarm and Detection Products is not a mandated Standard in the Construction Products Regulation (CPR) which has been such a major driver for the certification of products in the construction sector; compatibility testing to the requirements of EN 54 (the relevant standard) is becoming more important and specifiers around Europe are asking for test reports to show systems comprising of all the components of a fire alarm system work satisfactorily with fire alarm panels.

2.5.2 The majority of fire alarm and detection systems in the UK are installed to the relevant part of the British Standard 5839 – which states *“The reliability of the system to perform its functions on demand will be governed by the reliability of individual components. In general, it is advisable that all components, such as manual call points, detectors, control and indicating equipment and fire alarm devices, comply with relevant British Standards, and have undergone type testing to these standards. It is advisable to use components having certification under a recognised product certification scheme (comprising third -party certification of product conformity against a relevant standard), based on testing and continuing surveillance, together with assessment of the manufacturer’s quality assurance systems against BS EN ISO 9000.”*

2.5.3 This strong endorsement of independently third party accredited and tested products plus the introduction of CPR have resulted in much of the equipment for fire alarm and detection systems sold

in the UK being third party accredited. The LPCB/BRE scheme (LPS1014) requires the use of such equipment whereas the BAFE scheme (SP203-1) does not.

2.6 Accreditation of installers

2.6.1 The two schemes that exist both recognise the importance of providing compliant fire detection and alarm systems and therefore assist in minimising false alarms. The Loss Prevention Certification Board LPS1014 scheme comprises of more than 50 firms engaged in the design, installation, commissioning and servicing of fire detection and alarm systems.

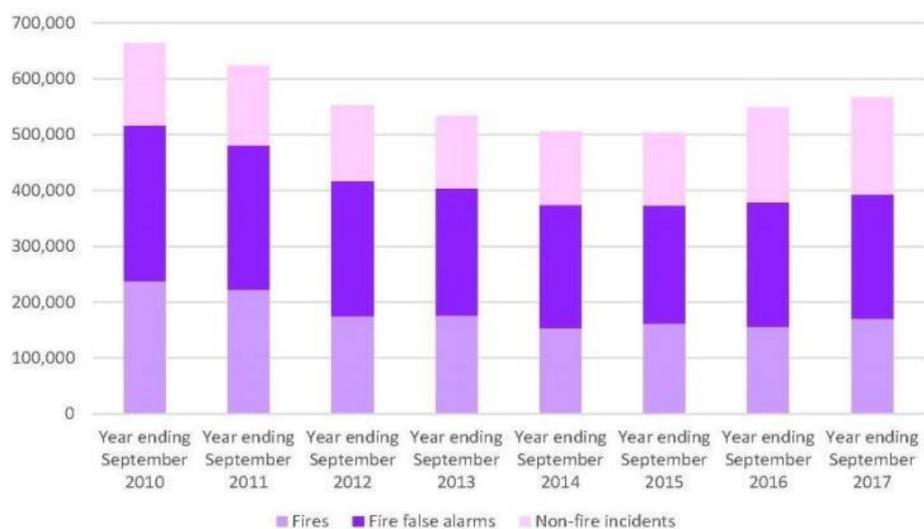
2.6.2 Recognising that not all companies undertake, design, installation and commissioning and even if they do the nature of contracting will often mean that different firms will be commissioned to undertake different elements of the process; the BAFE Fire Detection and Alarm Systems SP203-1 is a modular scheme. In line with industry practice and demand therefore, the scheme has been split into four modules. System Design, Installation, Commissioning/Handover and Maintenance. There are currently some 200 BAFE registered fire alarm installers.

2.6.3 Whilst there is a widely held belief that the use of competent third party accredited installers should greatly assist in the reduction of false and unwanted alarms, there are no large or major studies to justify this theory. The Chief Fire Officers Association (CFOA), now the National Fire Chiefs Council (NFCC) working with the Fire Industry Association (FIA - the trade association representing the majority of manufacturers and installers of fire detection and alarm equipment) and others including end users have made several attempts in recent years to introduce protocols and codes of practice, centred on the need for properly tested and accredited equipment, installed and maintained by third party accredited installers, similar to the approach the Association of Chief Police Officers (ACPO) have taken with intruder systems and installers. Unfortunately, the move to locally derived attendance standards driven by the Integrated Risk Management Plans has resulted in a divergence of response arrangements, with virtually no two fire and rescue services having common policies to response to automatic fire alarms throughout the whole of the UK. Clearly this is problematic for end-users with anything but a local presence; it makes gathering evidence on the effectiveness of policies such as the effect of the use of third party accredited equipment and installers and appears to have had no discernible impact on the levels of false or unwanted alarms.

2.7 The Scale of the Problem

The most recent government statistics reported that fire and rescue services attended 222,997 fire false alarms in the year ending September 2017, a small increase compared with the previous year (222,222).

Table 5: Total incidents attended by type of incident, England; year ending September 2010 to year ending September 2017



Source: FIRE0102

Source: Fire and rescue incident statistics: England, year ending September 2017 Statistical Bulletin 04/18 (Home Office 2018)

2.8 Smoke Detection

2.8.1 It is FPA and RISCAuthority’s view that the root of the problem is the detection devices themselves. Whilst they are called ‘smoke detectors’ and do indeed respond to smoke, they respond to other stimuli too, and of course not all smoke originates from a source that demands F&RS attendance. In short, the current installed ‘single species’ measurement technology is not providing an alert that is believable enough to commit scant F&RS resources to, or benefit any of the other stakeholder groups, and as such this is seen as the single most important factor that needs addressing in this ABI / FPA study.

2.8.2 At the time that the current guidance on Building Regulations was written, only relatively simple (single phenomena) heat or smoke detectors were available for supporting life safety. It is FPA’s belief that these are the source of the problem – they are poor at exclusively recognising a fire and this is a view which is being increasingly recognised by international academic studies.

2.8.3 During the past 10 years, ‘multiple species’ devices have entered the market, and these are very much more discerning with an anticipated performance of 80%-90% believability – an amount that could radically alter the requirement for the currently adopted poor behaviours by all parties.

2.8.4 In 2014 FPA lobbied hard for these devices to be mandated in all new high-risk environments but there were too few suppliers of such at this time for the initiative to gain traction. The situation has now changed, and this project sought to bring together the three biggest providers with like-minded influential representatives from the Fire & Rescue Service to promote their requirement in any future review of building regulation.

2.8.5 The literature review confirmed two barriers to progress:

- A general lack of understanding by a range of stakeholders, but particularly from fire and rescue services on the capabilities and reliability of the new technology. If responders have an 80%

assurance that an alarm signal from these systems is genuine their response strategies would alter accordingly.

- The product standard, whilst comprehensive in the range and scope of signals required to be evaluated, contained no reference to immunity testing, a simple and effective method of assessing a product's capacity to false alarm.

This project has sought to begin to develop strategies to address both.

2.9 Multi Sensor Detectors

2.9.1 A dependable fire alarm provides the best possibility of early intervention which will have significant benefits for the safety of personnel and preservation of property and business viability. Fires accelerate as they grow; within the space of 2 to 5 minutes an incident may change from one where the F&RS may have an opportunity to control the fire at source, saving the building and where appropriate the business; to one where the only job left to do is protect adjacent properties from radiated heat and direct fire spread.

2.9.2 'Reliability' in fire detection inevitably leads to the use of devices that can sample multiple fire emissions. Valid fire fingerprinting species include 'heat', 'smoke', 'carbon monoxide', and 'light' (visible, UV, and IR). In isolation, none of these will describe the presence of fire with great reliability, but if they are combined the potential for false alarms reduces dramatically with every introduced species. A sensor capable of simultaneous measurement of heat, smoke and carbon dioxide instantly becomes discerning enough to not trigger on the presence of a cigarette smoker, steam production from a shower, burning of the morning toast, or use of vehicles within the protected space, but it will respond to a fire.

2.9.3 In pursuit of reliable detection systems, industry has responded and these devices are readily available in a format for drop in detector replacement to many modern alarm systems commonly in use in the commercial environment requiring only in addition reprogramming of the alarm panel. FPA has investigated the detectors in depth and found them to be highly dependable for reliable alarm provision.

2.10 Immunity tests

2.10.1 The European product standards for smoke detectors comprehensively specify, test methods and performance criteria for products used in fire detection systems installed in buildings and whilst they are quite correctly prescriptive in the performance of tests needed to trigger a response they are silent on the factors or scenarios that should not. Research confirms that the majority of false or unwanted alarms are caused by a reasonably small number of common encountered scenarios to which modern multi sensor equipment, detects / monitors but will only alarm when a combination of factors determines the need.

2.10.2 Until recently work on these 'immunity' tests had been restricted to a small number of academic institutions in the US and Germany and manufacturers own facilities and there were concerns about the repeatability of such tests. A newly published project sponsored by the FIA and the BRE Trust has confirmed work originally undertaken by the University of Duisberg Essen and suggests a higher degree of repeatability and expresses confidence that this could be incorporated into standards relatively soon.

2.10.3 From the outset one of the aims of this ABI sponsored research was to assist the development of a test specification that if satisfied, will qualify equipment capable of high integrity differentiation of potential fire signatures between those that are:

- Real, and warrant immediate fire and rescue service response
- real, but do not require immediate response (such as burnt toast or cigarette smoke)
- not real such as shower steam, bug infestation, dust etc.

This work together with the 'gold standard' being developed by the trade was designed to ensure that the fire and rescue services should have an 80%-90% expectation that fire signals when actuated are real. In turn, this will allow the degree of certainty required to in order for them to always provide an appropriate response, with evacuation procedures altered accordingly. The benefits to insurers will be reliable, robust systems that should ensure immediate fire and rescue response, leading more effective containment of fire.

3.0 Section Three - Development and Production of Educational Video

3.1 Introduction & Background

3.1.1 As already outlined, the literature review demonstrated some misunderstandings, particularly from some key decision makers in the fire and rescue services, as to the causes of false and unwanted alarms which in turn were resulting in proposed solutions which on their own are likely have a little or limited opportunity for success.

3.1.2 Stakeholders appeared to be uninformed as to the attributes and potential benefits of systems with multi-sensor detectors, their reliability and particularly their reaction to scenarios which are responsible for the majority of false or unwanted alarms. This confirmed the requirement for the need of the proposed final deliverable of this study being a well-crafted Digital Media Tool suitable for media release that will show how the newer, yet current, technologies could solve the prevailing detection issues.

3.1.3 Using side-by-side demonstrations of multi-sensor (MS) devices against current single sensor (SS) systems in easily identifiable environments (kitchen, workplace, bathroom etc.), the aim was to demonstrate the immunity strengths of MS systems over SS systems; their response in each case being placed within the context of the complete call-management regime for a given Alarm Receiving Centre (ARC) / Fire and Rescue Service (FRS).

3.1.4 This phase of the project was divided into:

- development of the storyboard
- laboratory, off-site filming, and slide filming to full production

3.2 Storyboard development

3.2.1 The final storyboard included

- Description of present position in respect of fire alarm management given current performance statistics
- Discussion on consequence of delay
- Visual run-through of an alarm being generated from a real event, transmitted, and the challenge routes that may occur through to point of launch of a fire appliance
- Repeat of visual run through for a false or unwanted alarm stimuli
- Clarification of what a Multi-Sensor detector is in comparison to current Single-Sensor device
- Clarification that MS devices may give a local-alarm (or pre-alarm) based upon any of the sensors passing a threshold (no reduced local capability to alarm), but a combination of sensors must trigger to provide an alarm of high enough confidence to call out the fire service.
- Definition of 'high-integrity alarm signal' and recognition of routes for transmission where high quality alarms may be kept separate from regular systems and therefore responded to differently (in that they are more believable)
- Comparative performance of MS systems and SS systems in recognisable environments i.e.
 - Hotel room – shower steam vs. real fire
 - Student accommodation – smoking vs. real fire
 - Industrial facility – welding vs real fire

- Commercial Kitchen – smoke vs. real fire
- Discussion of the technology readiness levels MS vs. SS

3.3 Hotel room – shower steam challenge

This recreated a typical hotel room with en-suite shower room.

3.3.1 False alarm scenario

- MS and SS detector heads will be placed in the main room
- Steam be created from hot shower with dividing door open
- Upon steam reaching the detector heads:
 - The SS system alarms locally and signals for automatic FRS response – call challenging may then ensue
 - The MS system alarms locally but does not signal for automatic FRS response
- Message: The MS system does not unnecessarily call for FRS response
- Message: The MS system confidently states the requirement for an FRS response without the need for call challenging

3.4 Student accommodation – smoking vs. real fire

This recreates a typical student room.

3.4.1 False alarm scenario

- MS and SS detector heads will be placed in the main room
- Students smoking in the room
- Upon smoke reaching the detector heads:
 - The SS system alarms locally and signals for automatic FRS response – call challenging may then ensue
 - The MS system alarms locally but does not signal for automatic FRS response
- Message: The MS system does not unnecessarily call for FRS response

3.4.2 Real alarm scenario

- MS and SS detector heads will be placed in the main room
- Fire stated in main room from cigarette in contact with readily combustible material – such as waste paper bin
- Upon smoke / heat / CO reaching the detector heads:
 - The SS system alarms locally and signals for automatic FRS response – call challenging may then ensue
 - The MS system alarms locally and signals for automatic FRS response on the high-integrity signal line – FRS respond immediately – circumnavigate call challenging
- Message: The MS system confidently states the requirement for an FRS response without the need for call challenging

3.5 Industrial facility – welding creating dust and smoke

Proposal is to recreate a typical industrial workshop.

3.5.1 False alarm scenario

- MS and SS detector heads will be placed in the main workshop area
- Dust and smoke shall be created from welding activity
- Upon dust or smoke reaching the detector heads:
 - The SS system alarms locally and signals for automatic FRS response – call challenging may then ensue
 - The MS system alarms locally but does not signal for automatic FRS response
- Message: The MS system does not unnecessarily call for FRS response

3.5.1 Real alarm scenario

- MS and SS detector heads will be placed in the main workshop area
- Fire stated on combustible material via spark / arc
- Upon smoke / heat / CO reaching the detector heads:
 - The SS system alarms locally and signals for automatic FRS response – call challenging may then ensue
 - The MS system alarms locally and signals for automatic FRS response on the high-integrity signal line – FRS respond immediately – circumnavigate call challenging
- Message: The MS system confidently states the requirement for an FRS response without the need for call challenging

3.6 Commercial kitchen smoke

Illustrative only - demonstrating with voiceover the capability of multi-sensor technology for this application.

3.7 Filming and production

The resulting Digital Media Tool is suitable for media release and shows how the newer, yet current, technologies could solve the prevailing detection issues. Using side-by-side demonstrations of multi-sensor (MS) devices against current single sensor (SS) systems it clearly establishes the immunity strengths of MS systems over SS systems.

The tool can be viewed at <https://www.youtube.com/watch?v=JrJUjZ5akh0&feature=youtu.be>

4.0 Section Four - Scenario recreation of comparative system performance

4.1 Background & Introduction

4.1.1 The Literature Review demonstrated that there is a general recognition from a broad range of stakeholders that false and unwanted alarms remain at unacceptable levels and this affects response levels of fire and rescue services which in turn can influence approaches to evacuation. Successive well-intentioned and logical initiatives to reduce or eliminate the problem which have generally focused on the quality of the design, installation and maintenance of installations have failed for a variety of reasons including the introduction of local response standards for fire and rescue services.

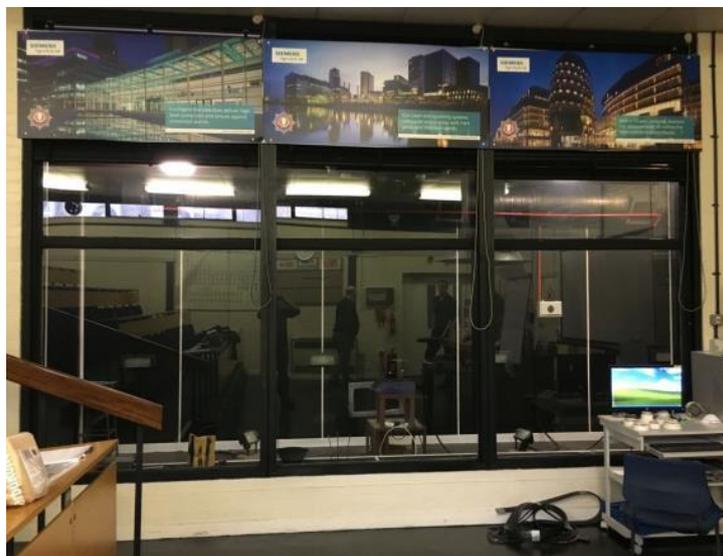
4.1.2 However, until very recently little has been done to design a suite of tests that replicate the common causes of false or unwanted alarms (steam, dust etc) or to introduce these into the product standards. One of the key deliverables of this project was to undertake and document several laboratory immunity demonstration tests, using both conventional and multi-sensor detectors and to offer this evidence to standards bodies to accelerate their acceptance into the tests specification for detector heads.

Description of test facility and detectors evaluated

4.2. Test facility

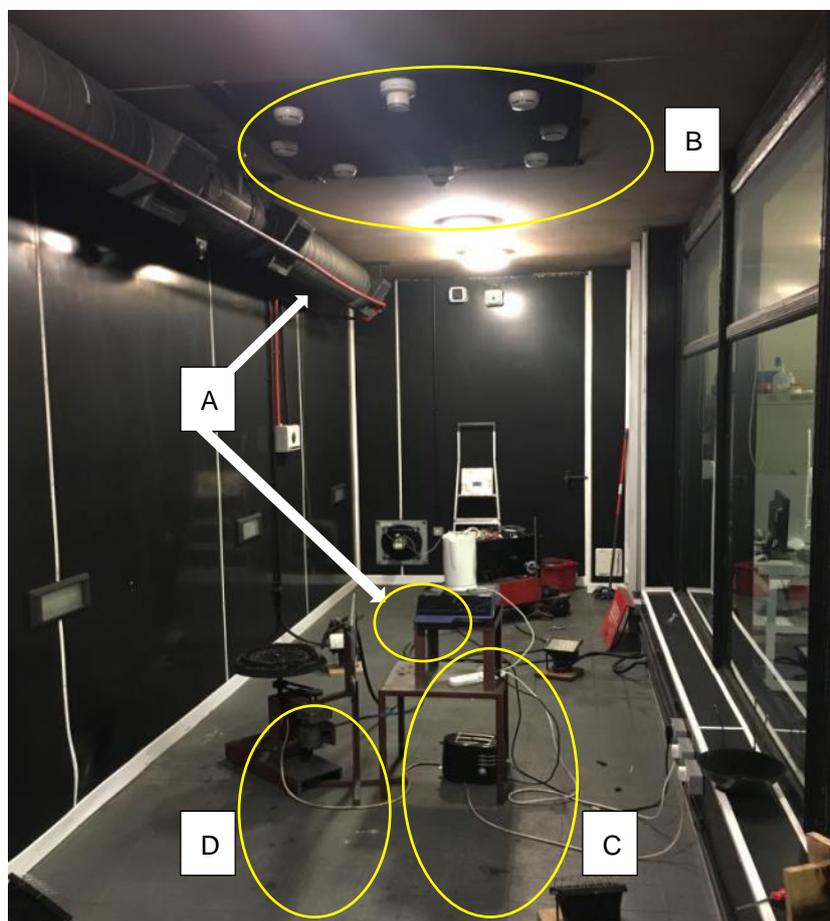
4.2.1 The tests reported here were conducted within a dedicated smoke detector demonstration facility located at the Fire Service College, north Gloucestershire. The facility was made available for in this work by Siemens Building Technologies to whom it belongs.

4.2.2 The facility comprises a fully enclosed compartment, a controllable ventilation system, a number of interchangeable ceiling mounted detectors, a control system for remote activation of test equipment inside the compartment, and a computer for displaying and logging the detector alarm outputs. The enclosure has a single entrance at one end and is glazed along one side to allow demonstrations/tests to be witnessed easily. Electrical equipment within the enclosure including all lighting, ventilation, hotplate, welding equipment, toaster and kettle (for steam generation) can all be remotely activated from the control cabinet outside. The facility is illustrated in the following photographs.





Demonstration facility with control and data logging equipment



Inside of test compartment

- A: Smoke extraction (high level) and compartment ventilation (low level)
- B: Smoke detectors mounted at centre of compartment ceiling
- C: Support frame for hotplate, heptane, steam and toaster demonstrations
- D: Rotating welding platform

The smoke extraction system was operated for several minutes prior to the start of each test and again after the test to ensure the enclosure was clear of smoke.

4.3 Smoke detectors evaluated

4.3.1 For the purpose of these demonstration tests a total of four distinct types of detector were selected, including two conventional single sensor devices, an 'intelligent' single sensor device and a multi-sensor device. The detectors chosen are:

- F910: A conventional ionization smoke detector
- R970: A conventional, single sensor, optical smoke detector (forward scatter)
- FDO 241: An 'intelligent' single sensor optical fire detector (forward scatter)
- FDOOT241: An 'intelligent' multi sensor optical fire detector (forward & backward scatter plus heat)

4.3.2 The FDO241 and the FDOOT241 are addressable fire detectors from Siemens' *Sintenso S-LINE Intelligent Detectors* equipment range and both incorporate their ASA technology ('advanced signal analysis').

4.3.3 The fire detection algorithms of both of these detectors can be configured to optimize their performance for different types of environments. Whilst the selected configuration effects the detector's sensitivity to different stimuli, the detectors still comply with the requirements of EN54 – 7 (*Fire detection and fire alarm systems. Smoke detectors. Point detectors using scattered light, transmitted light or ionization*) regardless of which configuration is chosen.

- Configuration 'Clear' Detector setup for sensitive/fast response in clean environments (e.g. offices, sleeping accommodation)
- Configuration 'Moderate' Detector setup for medium response, suitable for most environments
- Configuration 'Harsh' Detector setup for where immunity to false alarms is critical (e.g. harsh environments such as workshops, or where detection is linked to a suppression system)

4.3.4 For the purpose of this work detectors each of the above configurations were considered. The following detectors were mounted on the compartment ceiling and used throughout the demonstration tests:

- F910: Basic ionisation smoke detector
- R970: Basic optical smoke detector (forward scatter)
- FDO 241: Optical (forward scatter) – configuration 'Clear'
- FDO 241: Optical (forward scatter) – configuration 'Moderate'
- FDO 241: Optical (forward scatter) – configuration 'Harsh'
- FDOOT 241: Optical (forward & back scatter) and Heat – configuration 'Clear'
- FDOOT 241: Optical (forward & back scatter) and Heat – configuration 'Moderate'
- FDOOT 241: Optical (forward & back scatter) and Heat – configuration 'Harsh'



Siemens R970 optical smoke detector



Siemens F910 Ionisation smoke detector

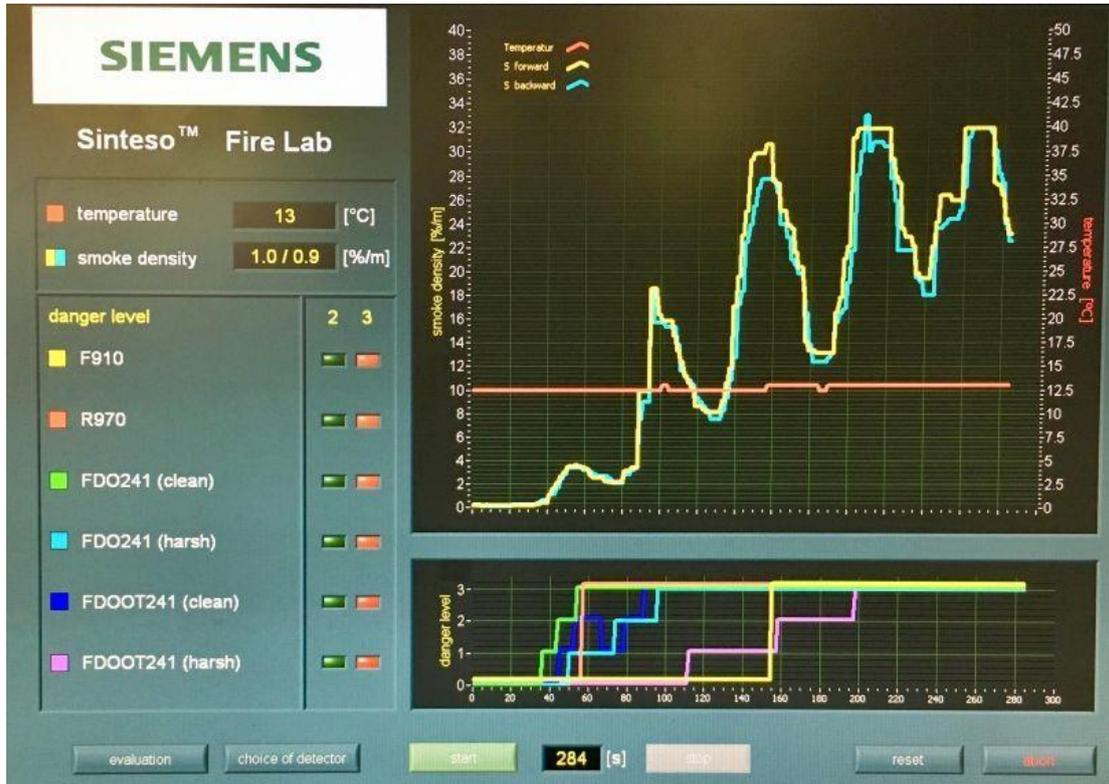


Both the FDO241 and FDOOT241 use the same enclosure.

4.3.5 The control and monitoring system used for these tests reports the outputs of the FDO241 and FDOOT241 according to three danger (threat) levels, namely;

- | | |
|----------------|--|
| Danger level 1 | Not reported on the alarm systems control panel, but used in this facility to demonstrate that the sensor has detected something but does not yet consider it to represent a fire risk |
| Danger level 2 | This is reported on the control panel as a pre-alarm event |
| Danger level 3 | This is reported on the control panel as a full fire alarm event |

This demonstration system is also used to display and record the temperature and smoke levels (from both forward and backscatter sensors) detected by one of the FDOOT241 units. This provides a useful indication of the conditions that the detectors are subjected to during each scenario. The image below is a screen-shot of the proprietary Siemens software used with this facility. This data was extracted following each demonstration test and is presented in the body of this report.



Sinteso Fire Lab output screen at end of smouldering wood test

4.4 Summary of demonstration tests conducted

The response of all the detectors to the following six scenarios was evaluated through a series of demonstrations as described and numbered below. It was not the intention to repeat or attempt to mimic the scenarios used in the educational Digital Media Tool but to replicate common real-world examples where pre-fire and false alarm events lead to false alarms and to test the detector performance against each.

Fire / pre-fire scenarios	False alarm scenarios
1: Overheating/smouldering of a combustible material	3: Normal welding activity
2: Ignition of a flammable liquid	5: Generation of steam
4: Welding activity leading to ignition of a flammable material	6: Use of a toaster

Demonstration tests

4.5 Demonstration 1 – Beechwood sticks on hotplate

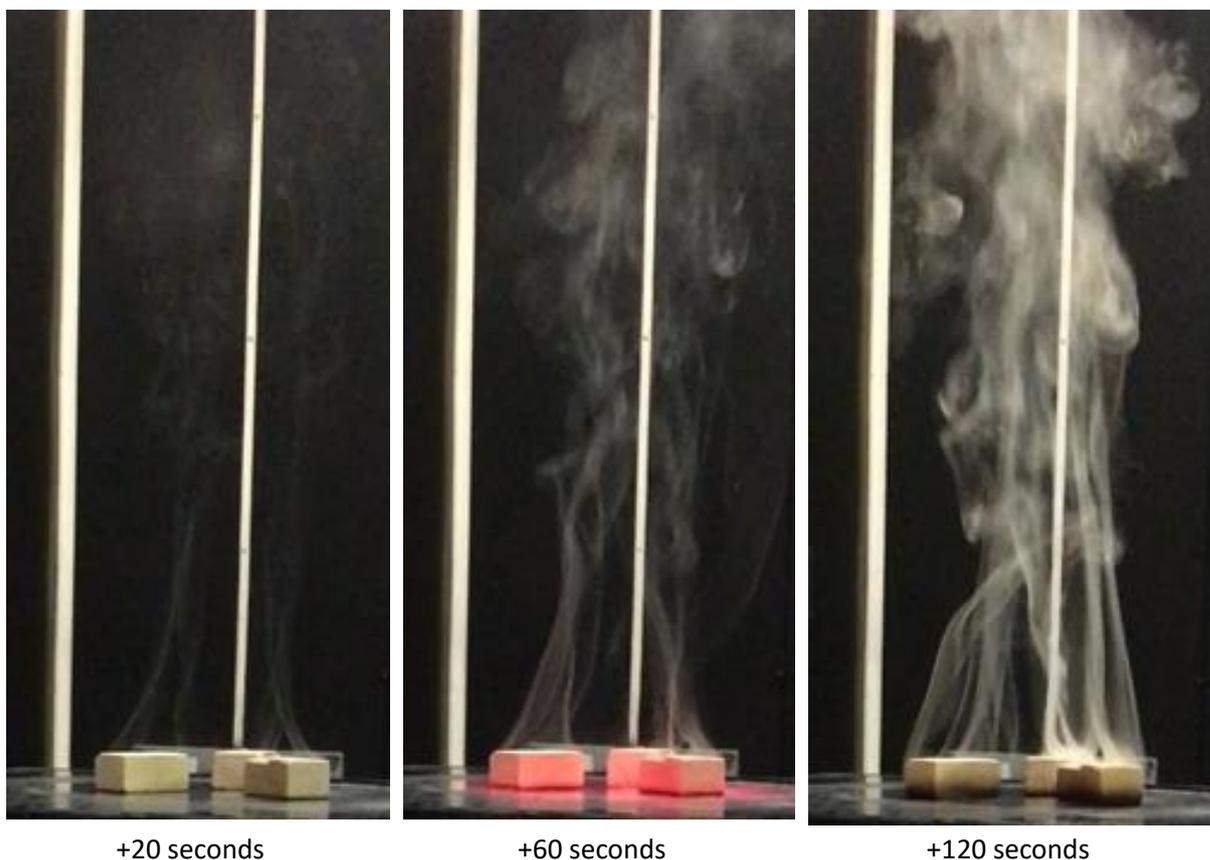
4.5.1 Three small pieces of beechwood were placed directly on top of an electric hotplate, supported on a framework positioned centrally within the compartment, directly below the detectors. The hotplate was activated, set to a high level and allowed to heat the sticks. The data logger was activated at the point when the first thin wisps of smoke could be seen rising from the wood (after approximately 1 minute of heating). At first the smoke was observed to rise quite slowly although this increased during the test as more smoke was produced and the wood/hotplate heated up. No flames were seen during

the test, but the base of the sticks where noted as being charred at the end of the test.



Sections of wood on electric hot plate

The following images illustrate the smoke produced during the test.



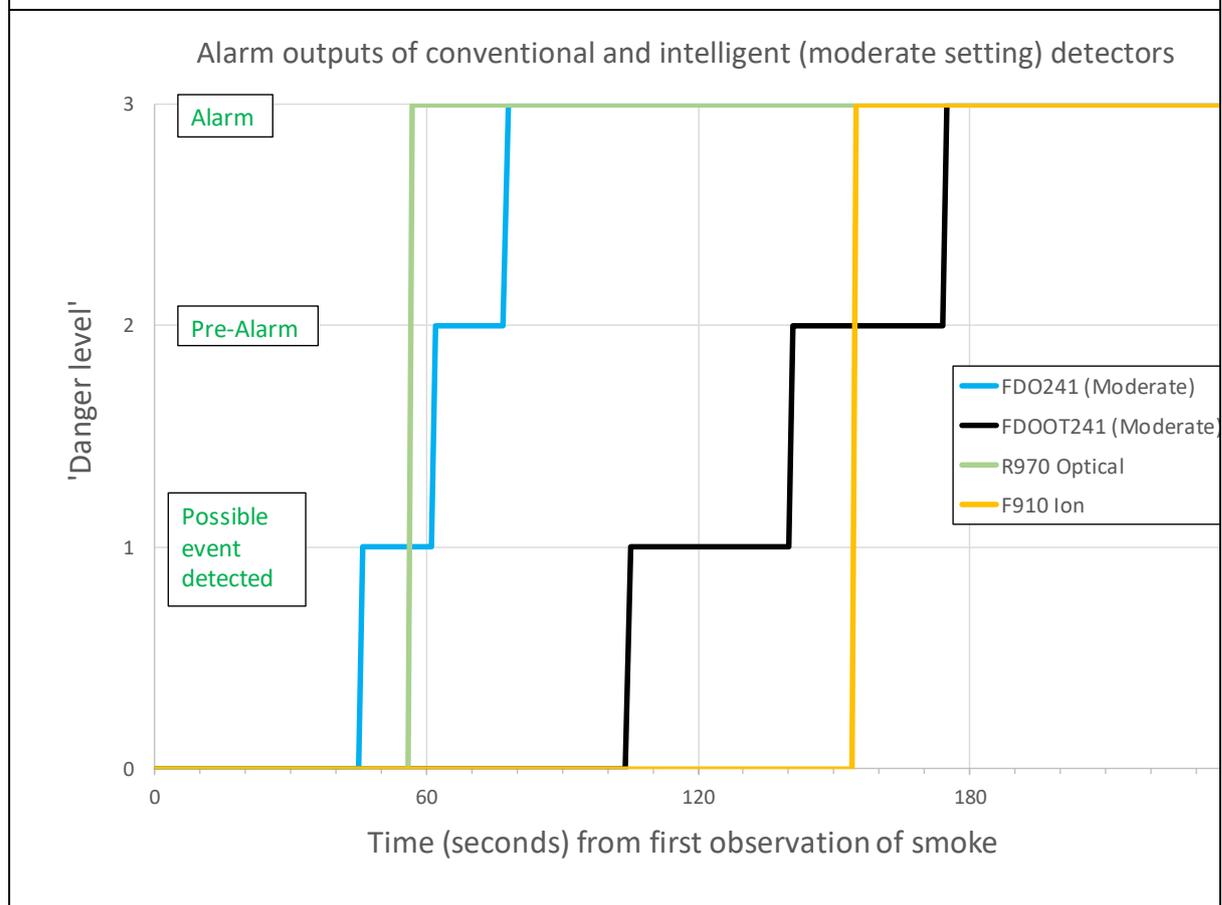
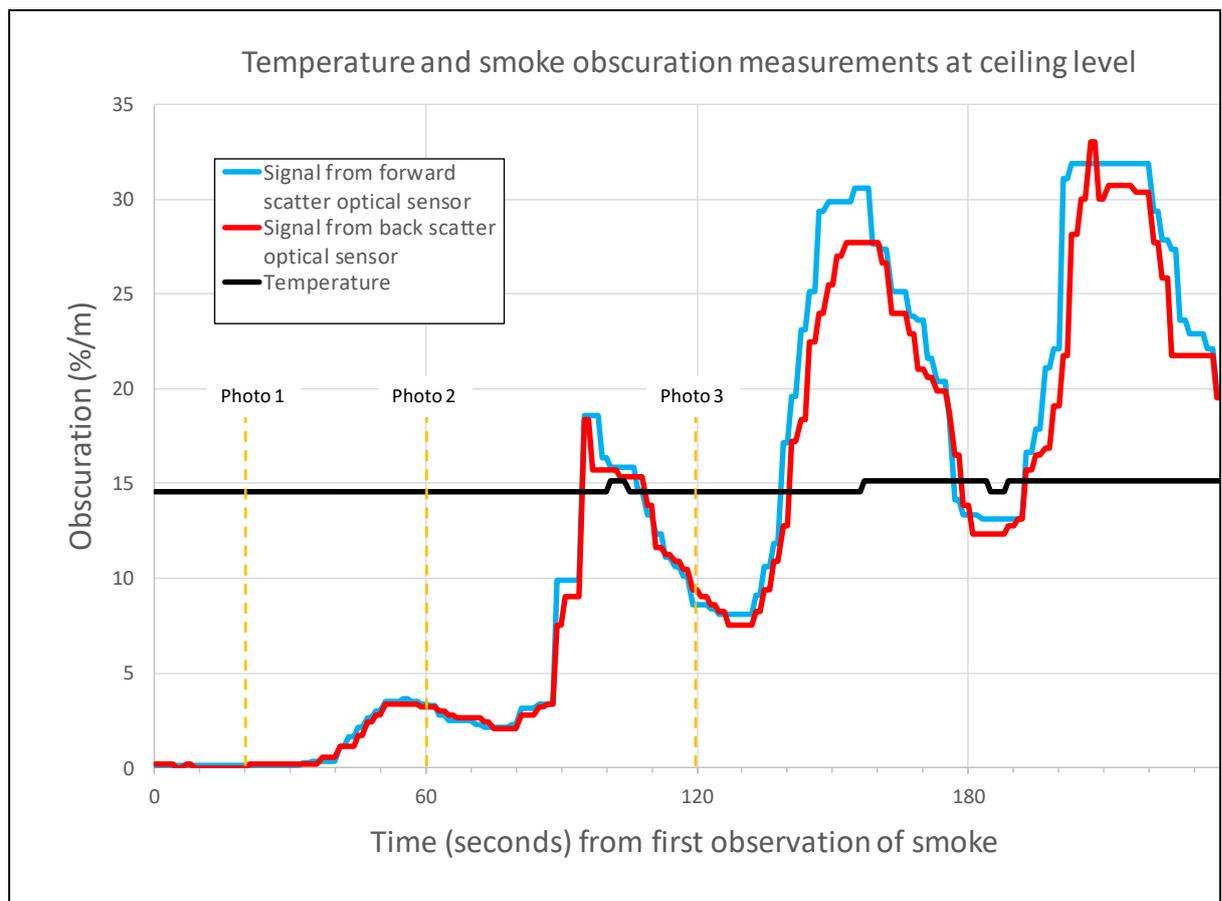
Smoke produced by heated wood sticks (time after smoke first visibly discernible)

4.5.2 All of the detectors went into alarm during the test, in the order:

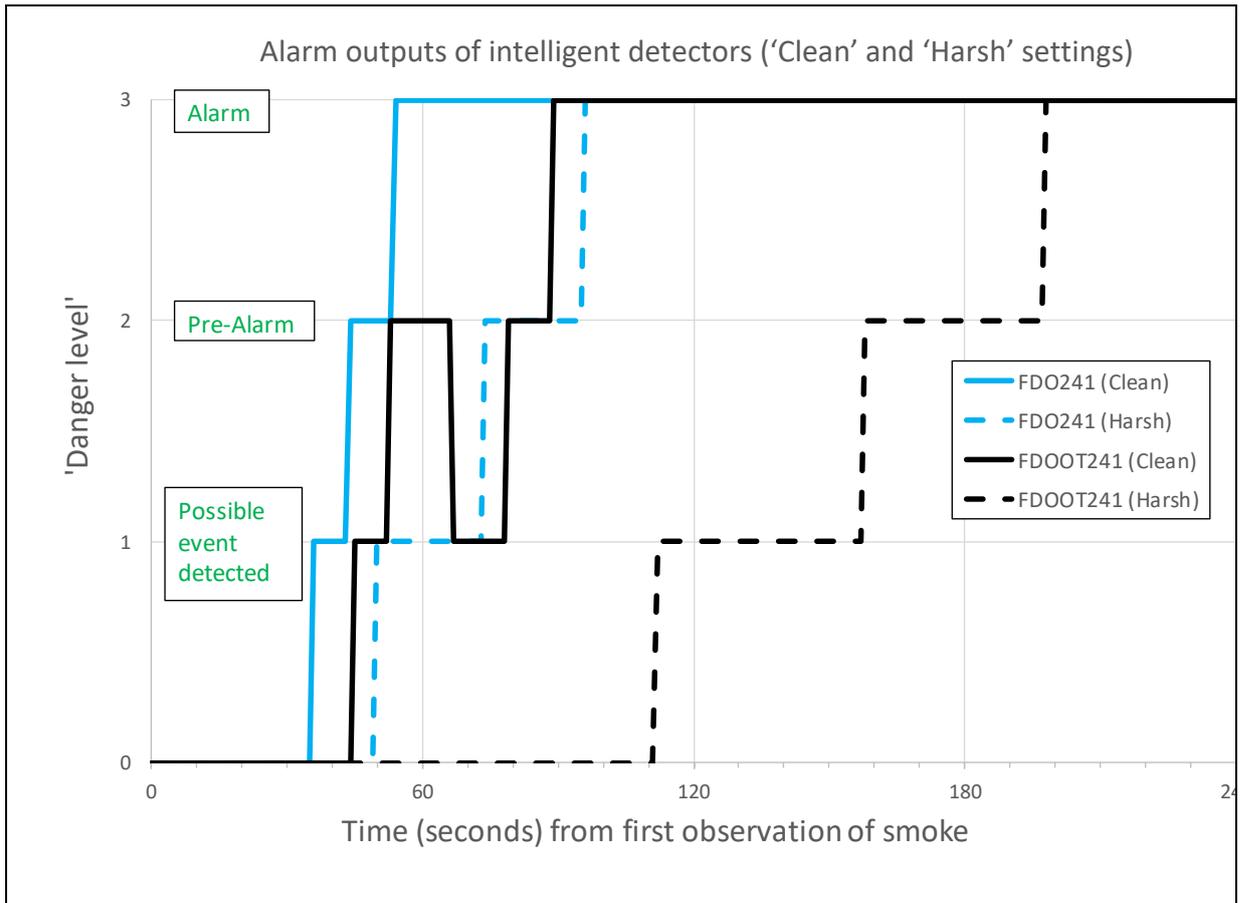
- FDO241 (Clean) and R970 optical first, at just under 1 minute
- FDO241 (Moderate & Harsh) and FDOOT241 (Clean) between 1min 10 and 1min 30sec
- FDOOT (Moderate & Harsh) and F910 ionisation between approximately 2min 30 and 3min 20sec

The following graphs show the recorded output of each of the sensors during the test. The times at

which the above images of smoke were captured are highlighted.



Outputs of detectors and sensing elements during smouldering wood test



Outputs of detectors and sensing elements during smouldering wood test

4.6 Demonstration 2 – small heptane tray fire

4.6.1 A small quantity of heptane (60ml) was placed in a steel bowl and located centrally within the enclosure on top of the hotplate (which was turned off for this test). Once ignited the fuel burned for just under 1.5 minutes and released sufficient heat to ensure that the smoke produced rose rapidly to the ceiling for the test duration.



Metal bowl containing 60ml of heptane positioned on hotplate (turned off)

The images below illustrate the smoke produced during the test.



+5 seconds



+30 seconds



+60 seconds

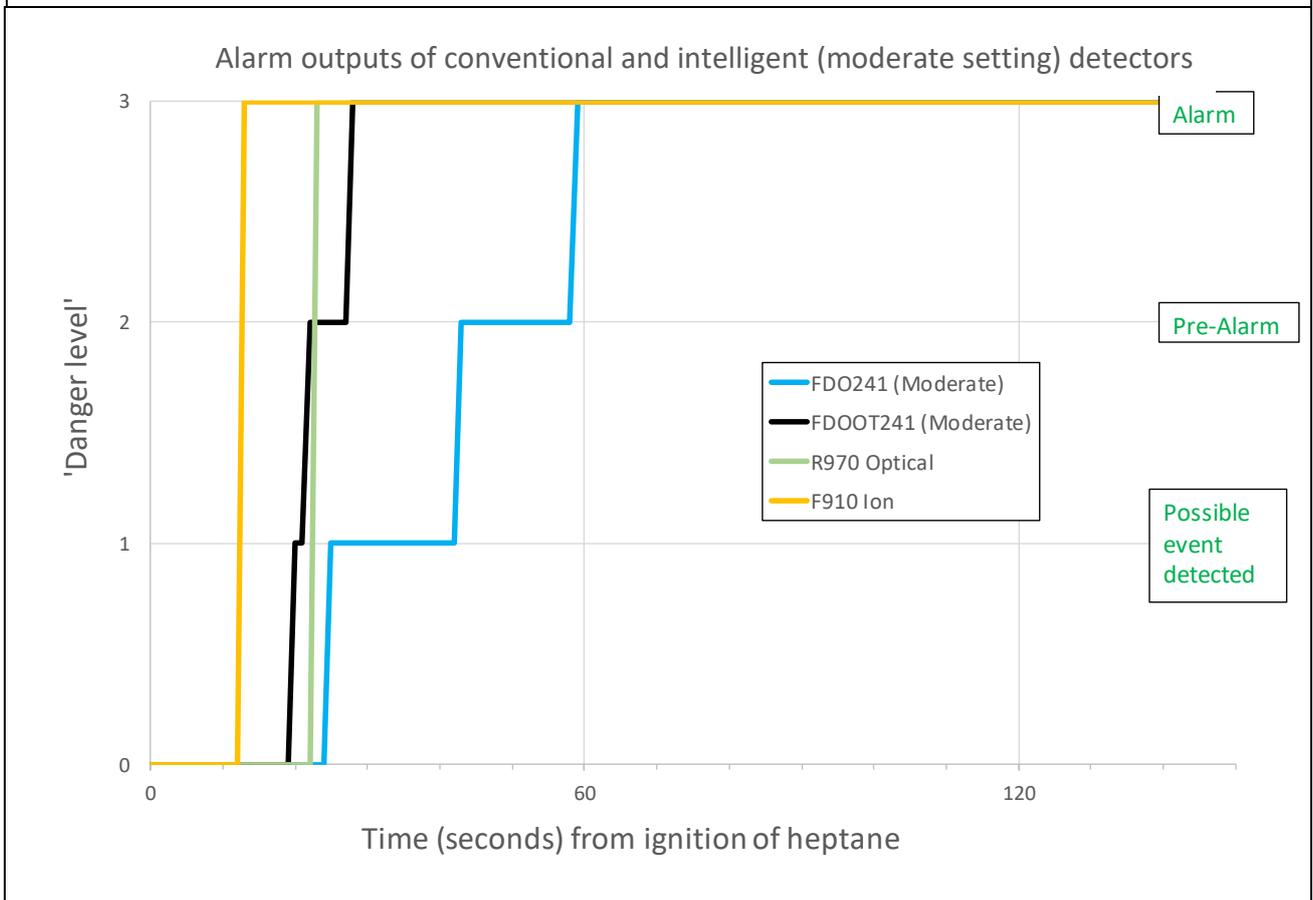
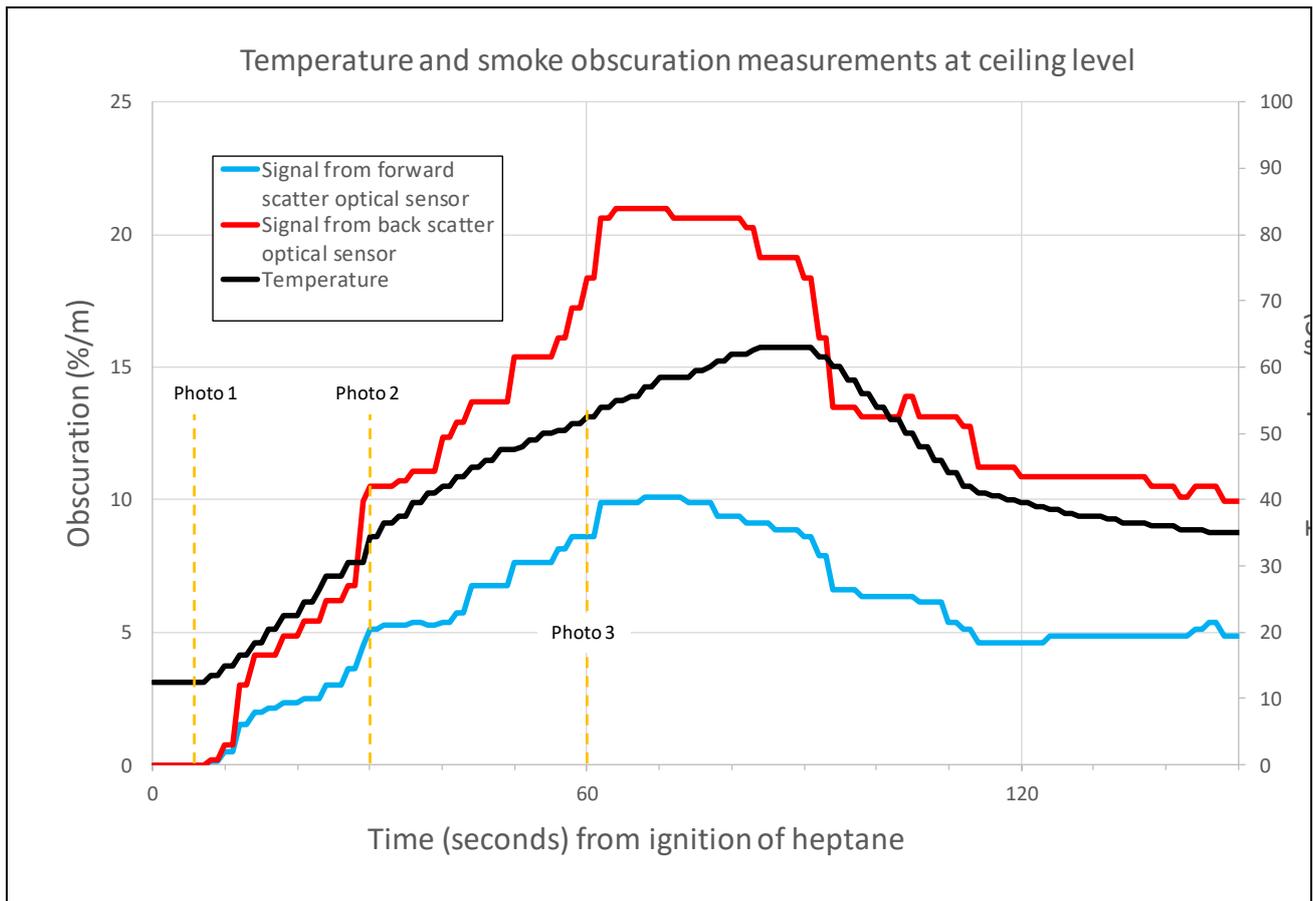
Smoke produced by small bowl of burning heptane (time after ignition)

4.6.2 All of the detectors went into alarm during the test, in the order:

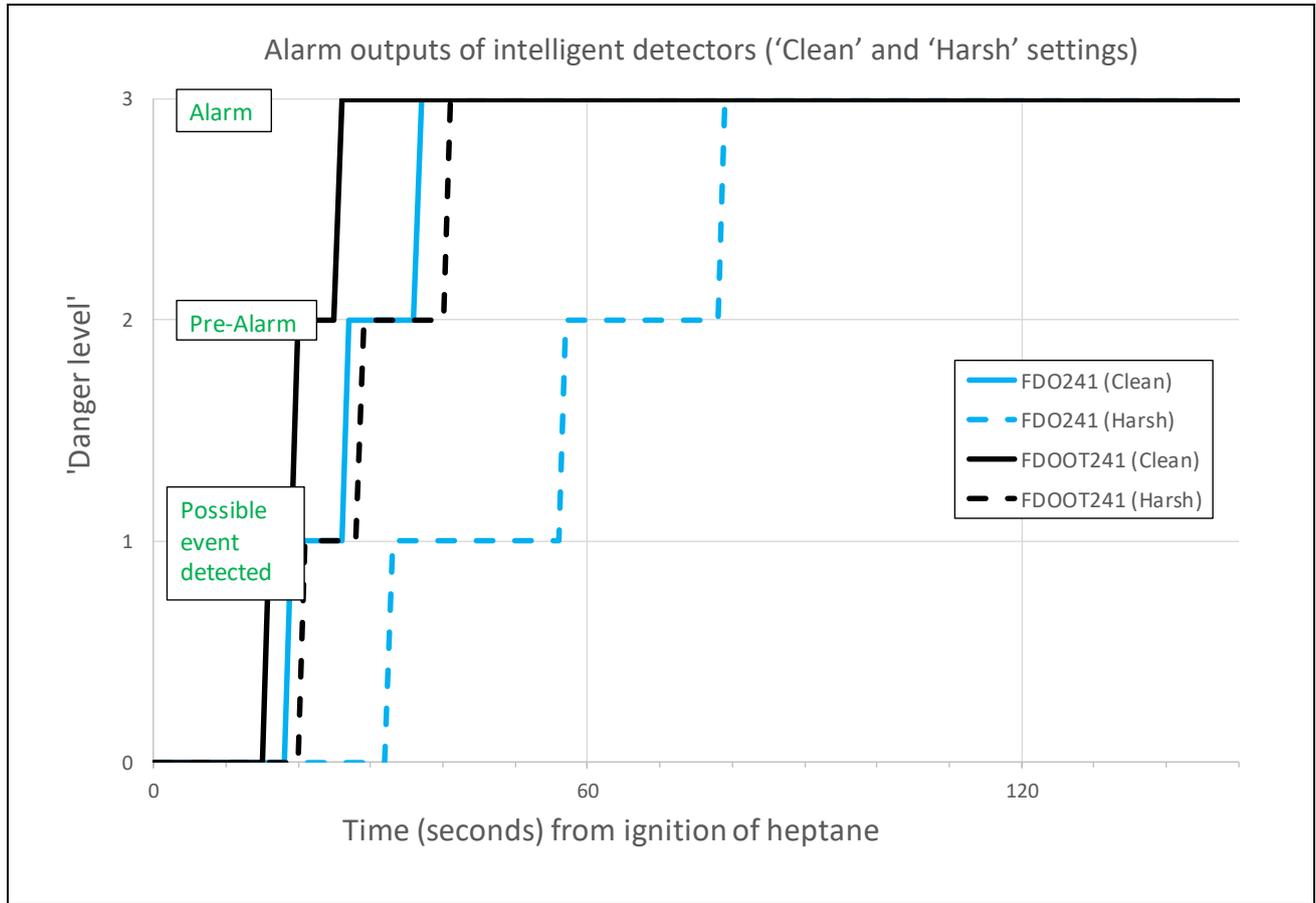
- R970 optical, F910 ionisation and FDOOT241 (Clean, Moderate & Harsh) within 40 seconds of ignition
- FDO241 (Moderate) at 1min and finally the FDO241 (Harsh) at 1min 20sec

The following graphs show the recorded output of each of the sensors during the test. The times at

which the above images were captured are highlighted.



Outputs of detectors and sensing elements during heptane pool fire test



Outputs of detectors and sensing elements during heptane pool fire test

4.7 Demonstration 3 – welding activity

4.7.1 For this test a round metal plate, earthed and connected to an electric motor, is located slightly offset from the centre of the floor and set to rotate slowly. The outlet nozzle of a remotely located MIG welding unit is sited in such a way that when the welding wire is extruded it comes into contact with the rotating metal plate, as illustrated below (plate rotates clockwise). Since the surface of the plate is very rough the welding process progresses as a series of bursts of arcing, releasing a mixture of hot sparks and smoke (which rises slowly).



Rotating metal plate and welding nozzle

The images below illustrate the sparks and smoke produced during the test.



+10 seconds



+30 seconds



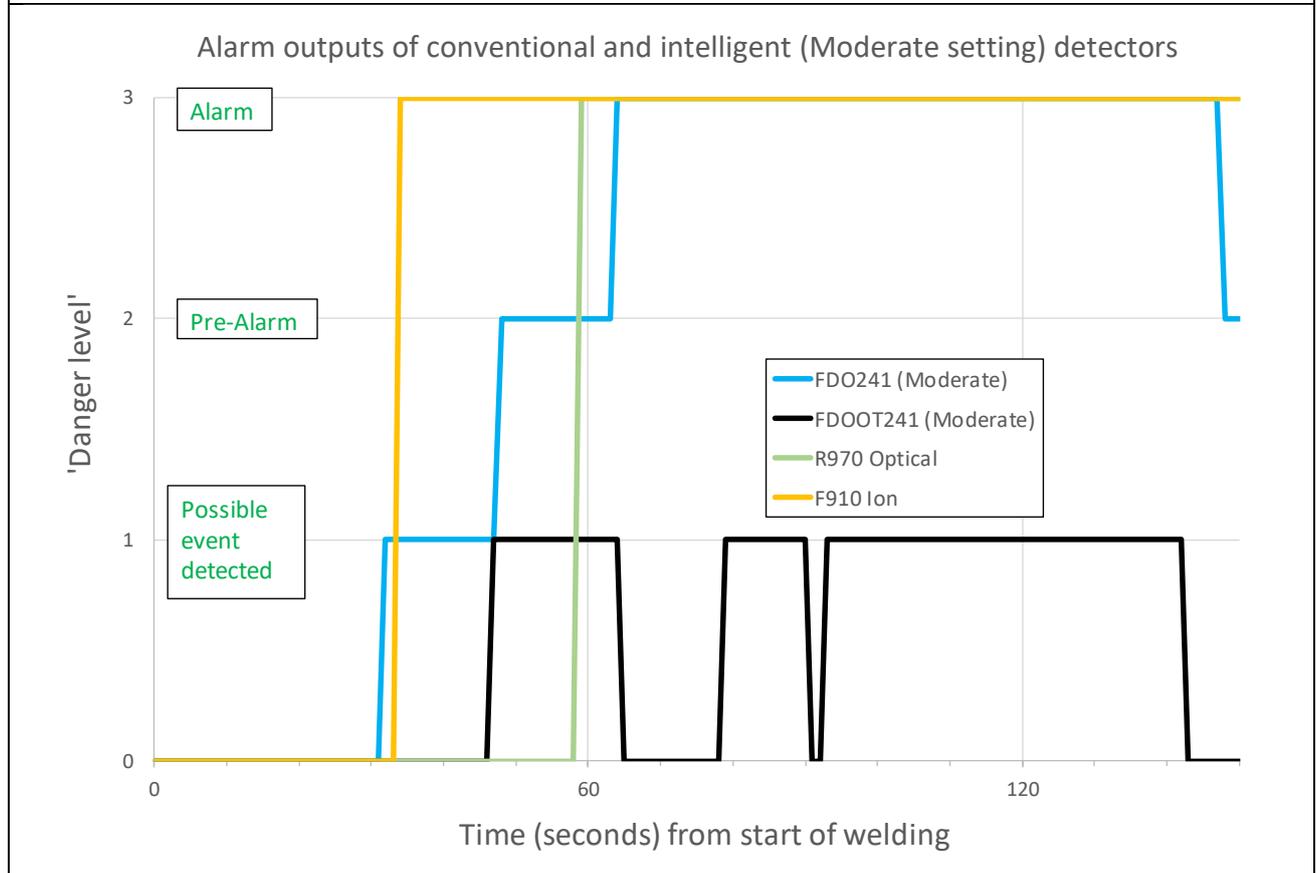
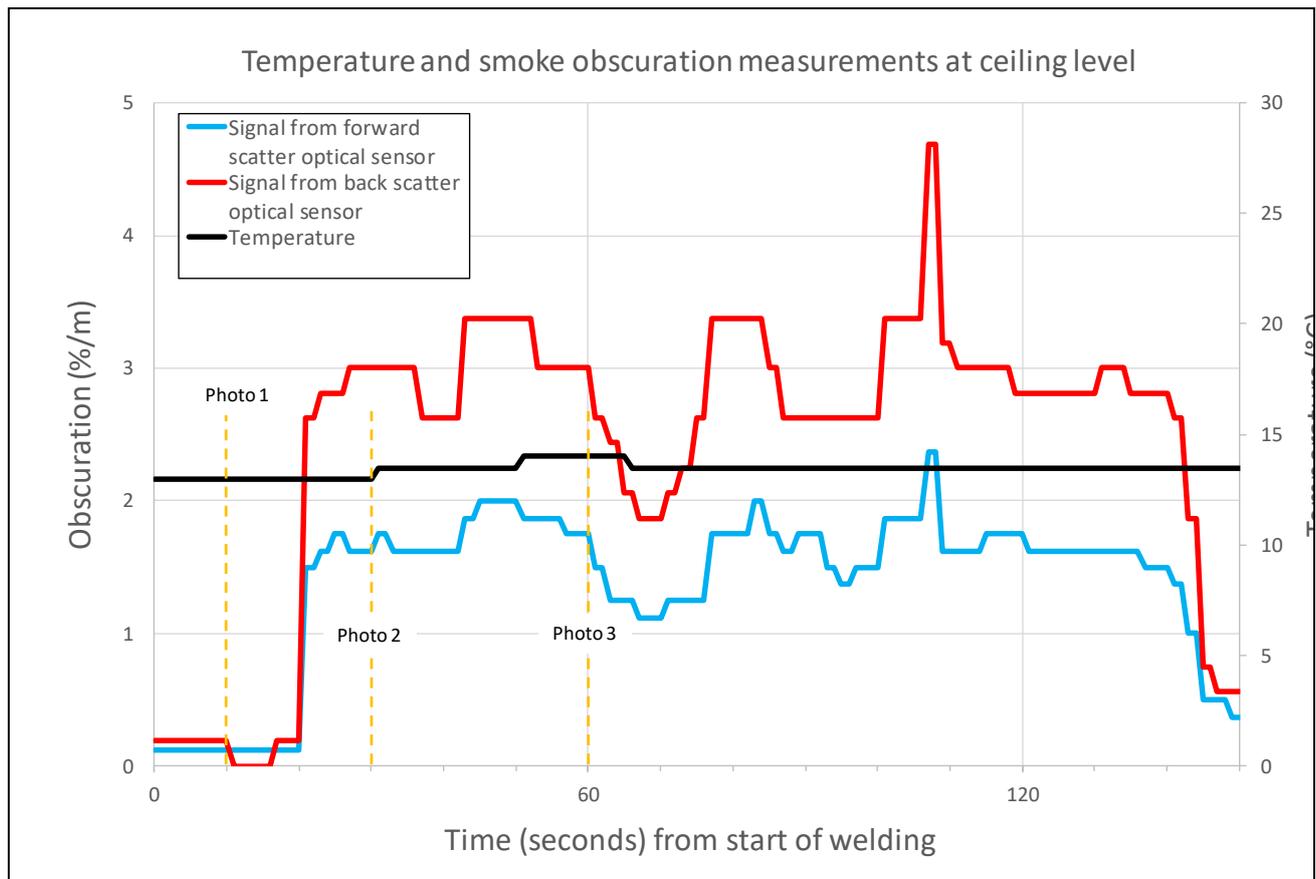
+60 seconds

Smoke produced during welding activity (time after welder switched on)

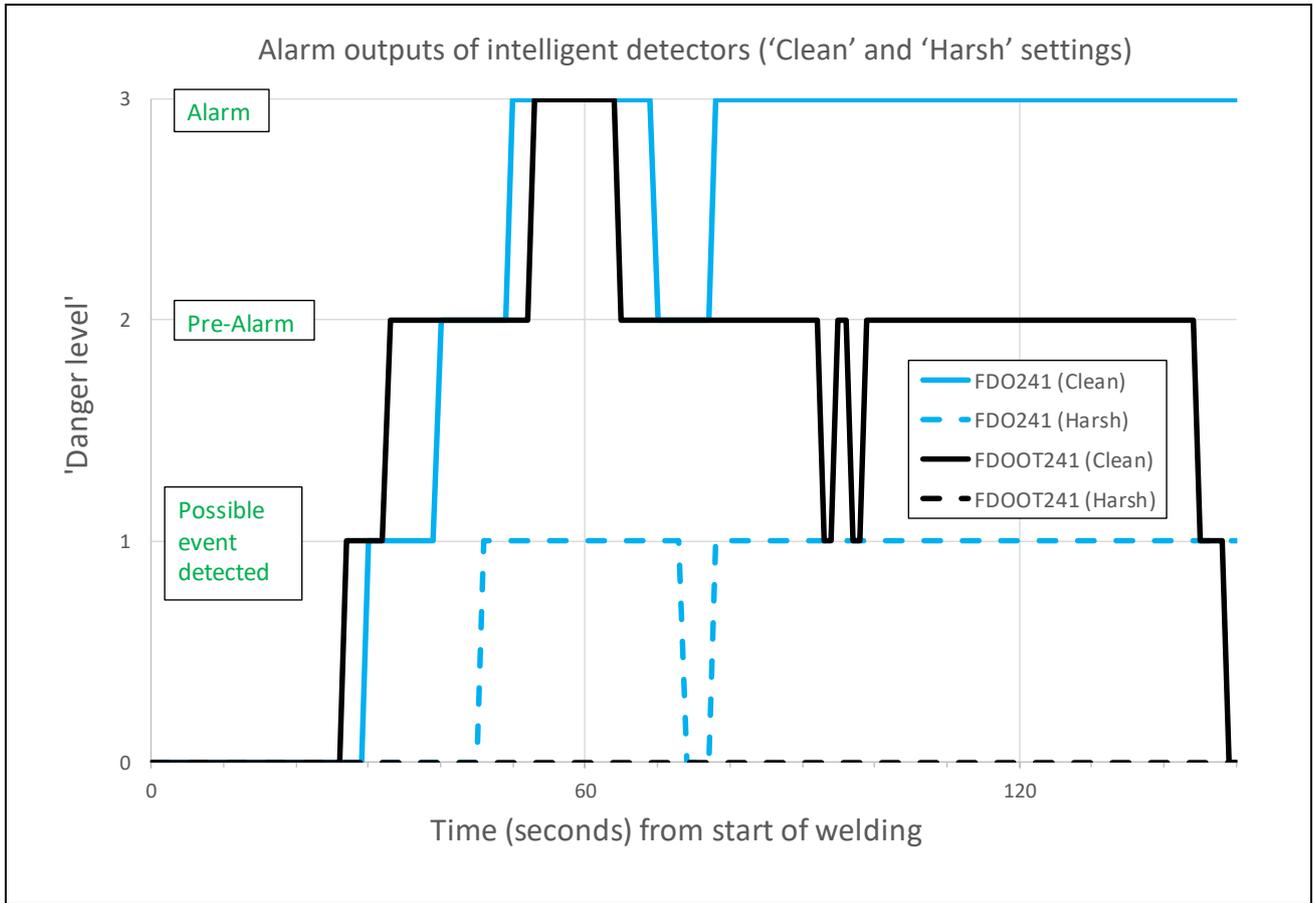
4.7.2 Some, but not all of the detectors went into alarm during the test, in the order:

- F910 ionisation, after 34 seconds of welding
- R970 optical and FDO241 (Clean & Moderate), between 50 and 64 seconds
- FDO241 (Harsh) did not go into alarm at all
- FDOOT241 (Clean) briefly went into alarm for 10 seconds after 50 seconds. The FDOOT241 (Moderate & Harsh) did not go into alarm at all

The following graphs show the recorded output of each of the sensors during the test. The times at which the above images were captured are highlighted.



Outputs of detectors and sensing elements during welding operation test



Outputs of detectors and sensing elements during welding operation test

4.8 Demonstration 4 – welding activity leading to ignition of a tray of heptane

4.8.1 This test was conducted as per Demonstration 3 with the exception that after two minutes a tray containing heptane was moved into close proximity of the welding sparks. The fuel ignited after several seconds and continued to burn for just over two minutes.



5 seconds before ignition of heptane



5 seconds after ignition of heptane



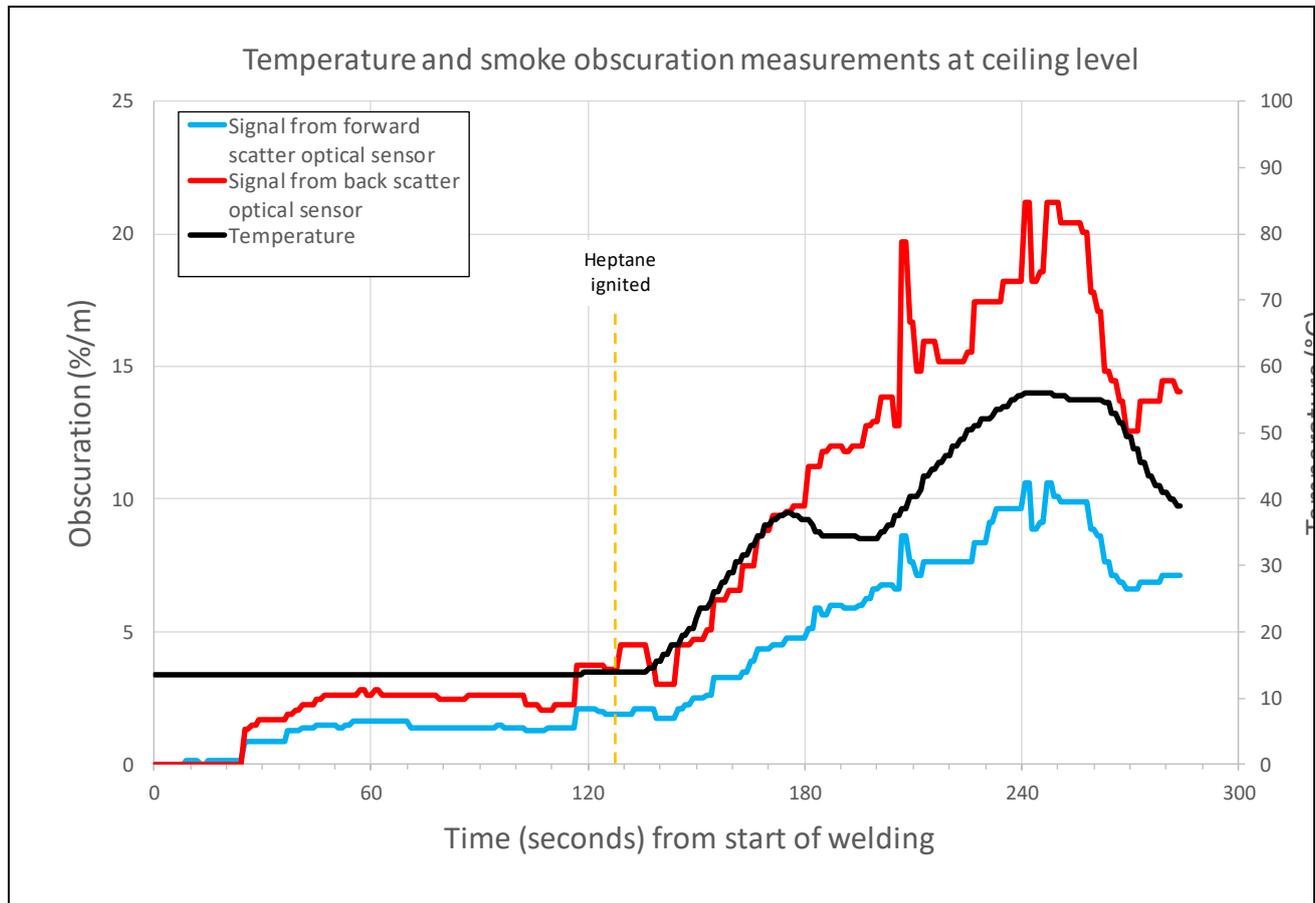
30 seconds after ignition of heptane

Smoke produced during welding activity and subsequent ignition of heptane.

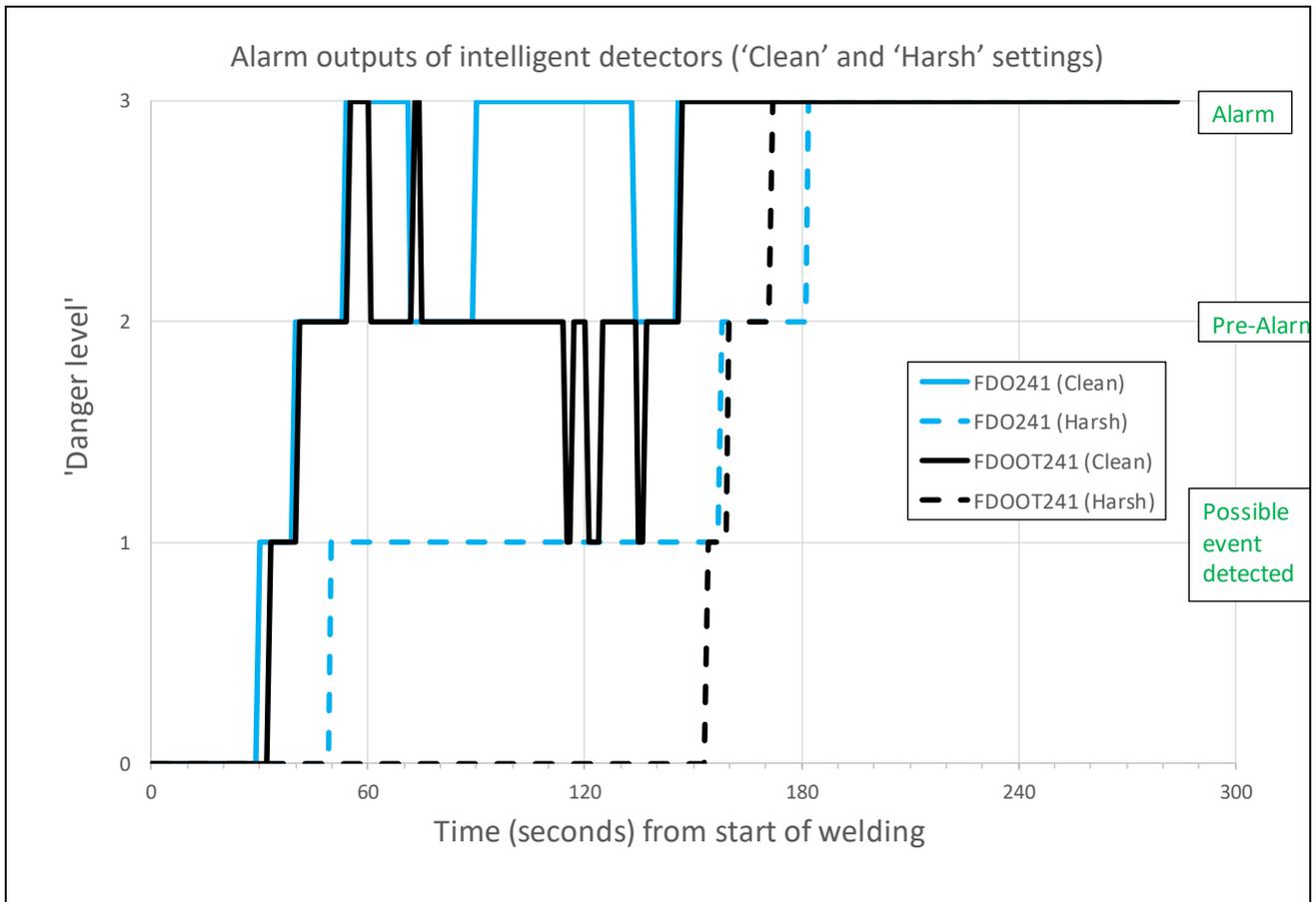
4.8.2 All of the detectors went into alarm during the test, in the order:

- F910 ionisation first, FDO241 (Clean) and FDOOT241 (Clean), between 35 and 55 seconds
- FDO241 (Moderate) and FDOOT241 (Moderate) after 2min and 2½min respectively
- FDO241 (Harsh) and FDOOT241 (Harsh) after 2min 52sec and 3min 2sec respectively

The following graphs show the recorded output of each of the sensors during the test.



Outputs of detectors and sensing elements during welding operation and heptane ignition test



Outputs of detectors and sensing elements during welding operation and heptane ignition test

4.9 Demonstration 5 – steam generation

4.9.1 To generate steam for this test a standard domestic kettle was half filled and placed on the centrally positioned hotplate (turned off). The kettle lid was removed to prevent its auto shutoff from operating. The kettle was switched on and allowed to boil for several minutes. After reaching a rolling boil (at which point the data logging was activated) little steam was initially produced but this increased rapidly and within 30 seconds a steady output was reached which rose quickly to the ceiling.



Kettle located centrally in enclosure, below detectors



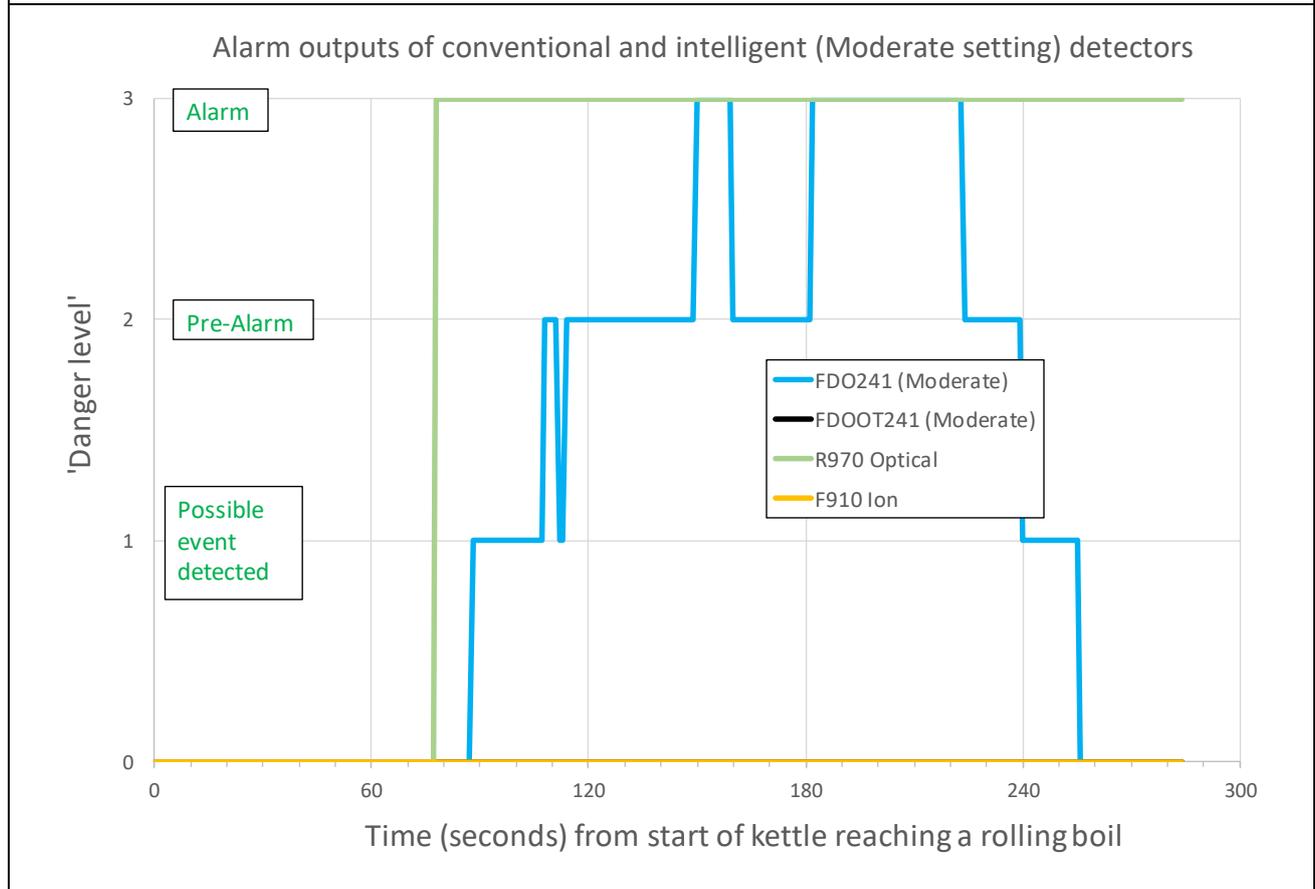
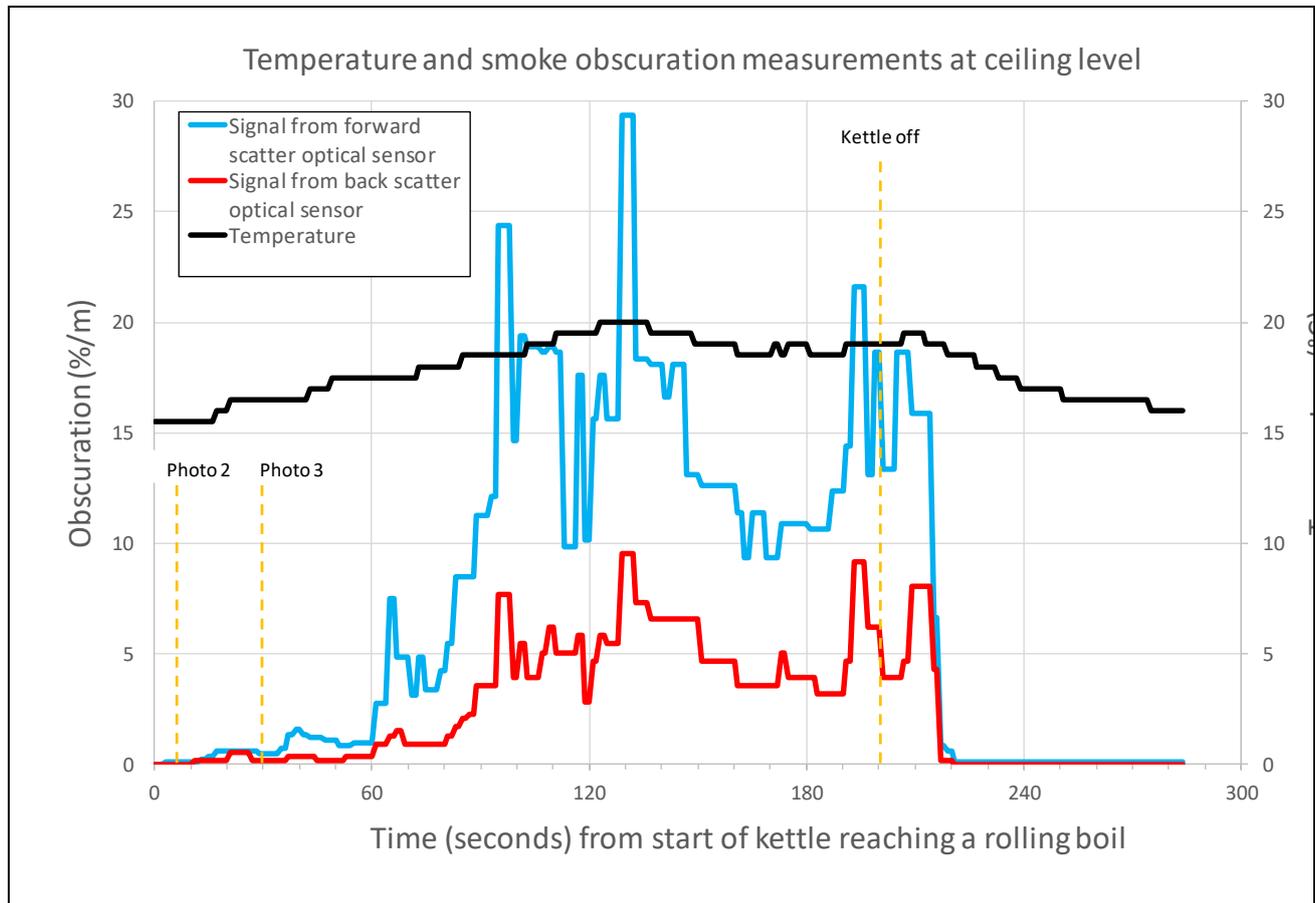
5 seconds before start of rolling boil 5 seconds after start of rolling boil 30 seconds after start of rolling boil

Steam produced by electric kettle allowed to boil continuously

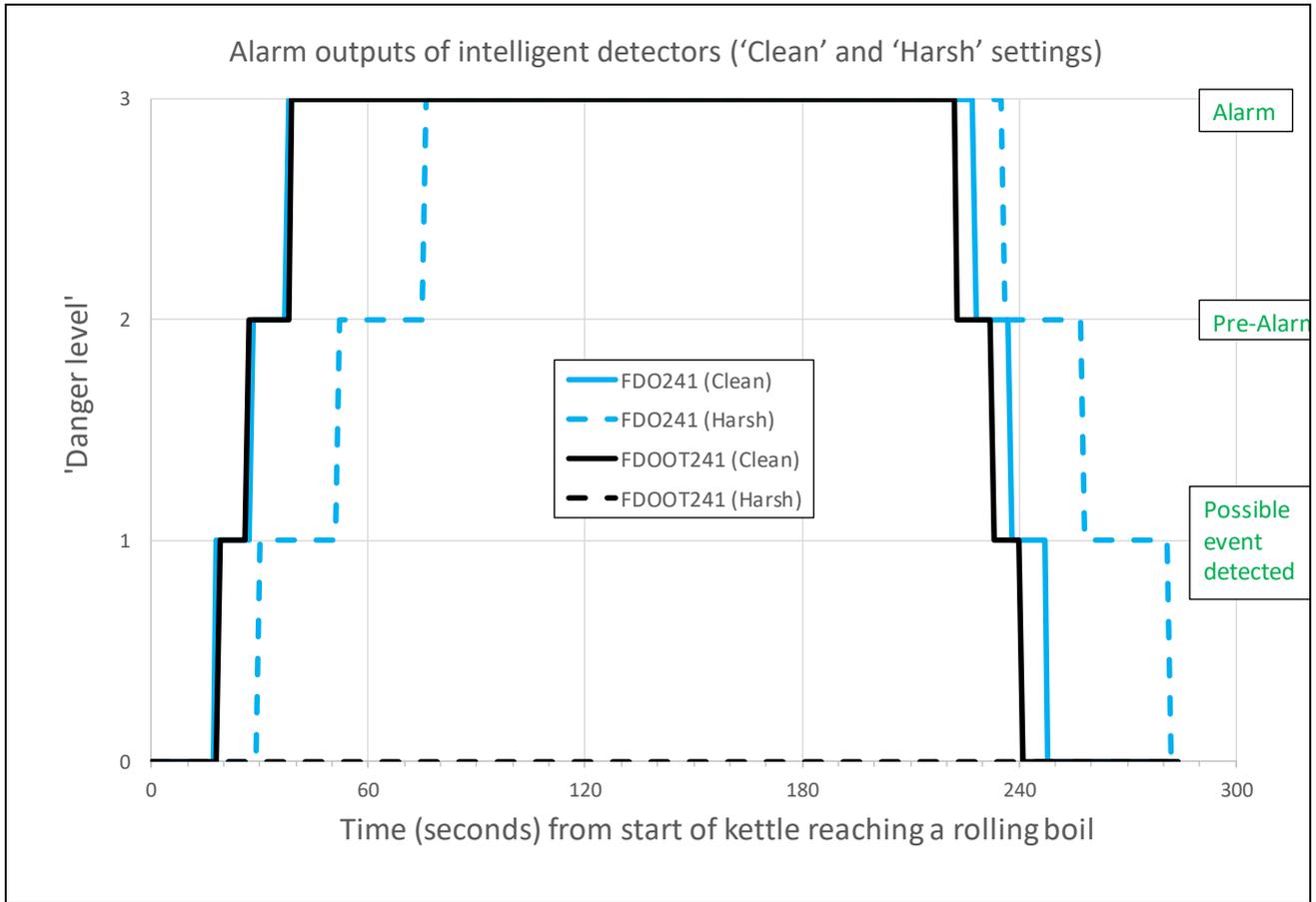
4.9.2 Some, but not all of the detectors went into alarm during the test, in the order:

- FDO241 (Clean) and FDOOT (Clean) after 39sec
- R970 optical and FDO241 (Harsh) after 76sec and 78sec respectively
- FDO241 (Moderate) after 2½ min
- The F910 ionisation detector did not go into alarm at all
- The FDOOT241 (Moderate & Harsh) did not go into alarm at all

It is not clear why the FDO241 (Harsh) went into alarm quicker than the FDO241 (Moderate). The following graphs show the recorded output of each of the sensors during the test. The times at which the above images were captured are highlighted.



Outputs of detectors and sensing elements during steam generation test



Outputs of detectors and sensing elements during steam generation test

4.10 Demonstration 6 – toaster

4.10.1 As for the steam test (Demonstration 5), the toaster was positioned on top of the hot plate (not turned on). The lever used for lowering bread into the toaster and activating the heating elements was locked in the downwards position using some wire. This ensured that the thermal shutoff was overridden, and that bread placed into the toaster could be heated continuously.



Toaster located centrally in enclosure, on top of hotplate

4.10.2 Although the main purpose of this scenario was to demonstrate the risk of false alarms arising from normal ‘toasting activity’, the test was allowed to progress beyond this to a point where an actual fire risk could reasonably be considered to have arisen. Several minutes after completion of this test, once the smoke had sufficiently cleared to allow re-entry to the enclosure, the ‘toast’ was removed and examined. It was found to be heavily charred, with its central portion completely carbonised and glowing red, quite definitely representing a potential fire threat that would warrant an alarm.

4.10.3 Trying to decide at what point this transition occurred inevitably entails a rather subjective assessment. However, it can be stated with confidence that up to 4½ minutes into the test there was clearly no smoke or other visible by-products exiting the toaster. Similarly, by 6½ minutes into the test there was a very significant quantity of smoke being produced.

4.10.4 All of the detectors went into alarm during the test, in the order:

- F910 ionisation activated first after 3min 56sec
- FDO241 (Clean) and FDOOT241 (Clean) after 5min 22sec and 5min 37sec respectively
- R970 optical, FDO241 (Moderate), FDOOT241 (Moderate) and FDO241 (Harsh) between 5min 50sec and 6min 5sec
- FDOOT241 (Harsh) after 6min 26sec

4.10.5 The sequence of photographs following illustrate the smoke produced during the test. Graphs show the recorded output of each of the sensors and the times at which the above images were captured are highlighted.

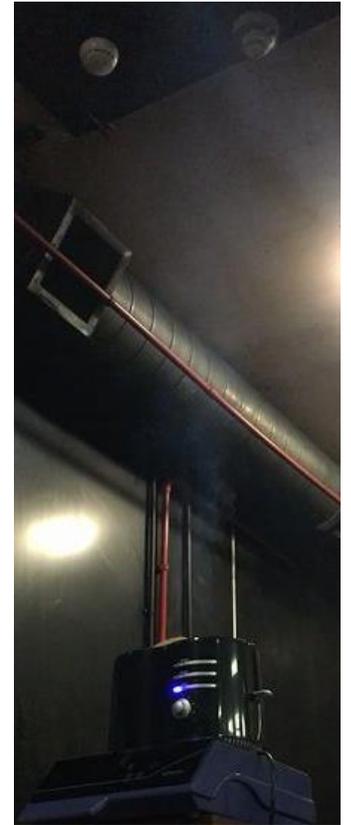
ABI Detection Research:



Point at which ionisation detector activated (no obvious smoke)



Very thin whips of smoke becoming clearly visible by eye



30 seconds after smoke becoming clearly visible by eye



60 seconds after smoke becoming clearly visible by eye

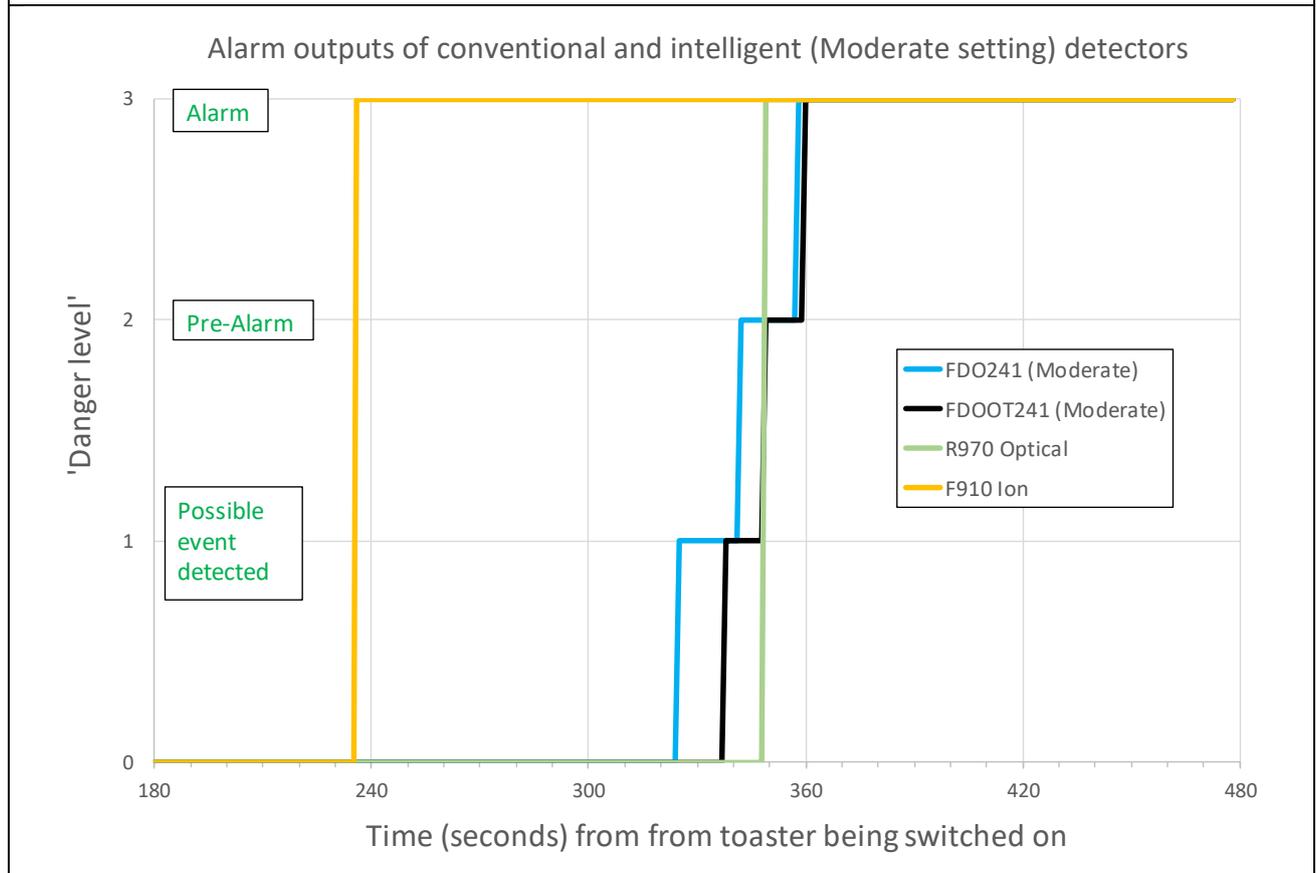
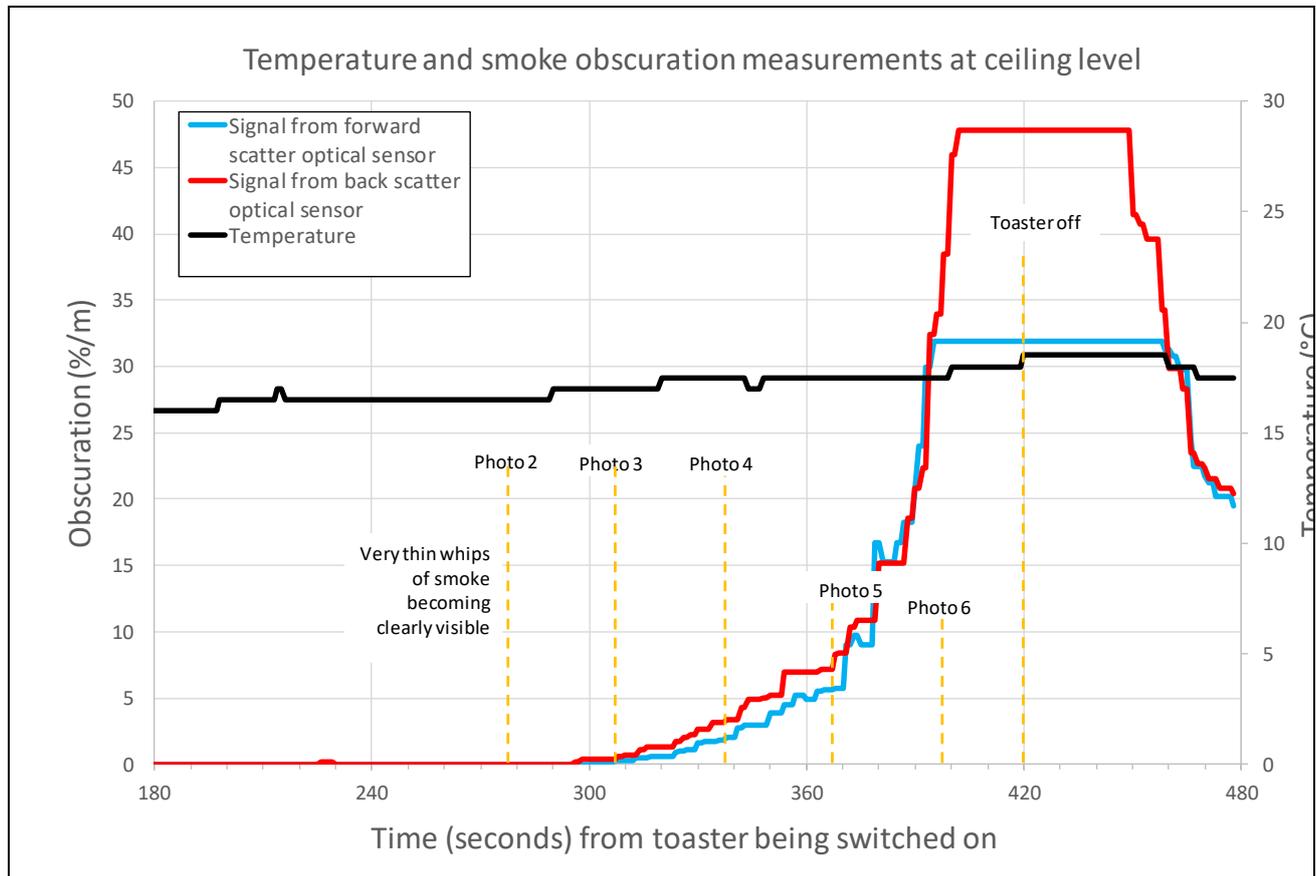


90 seconds after smoke becoming clearly visible by eye

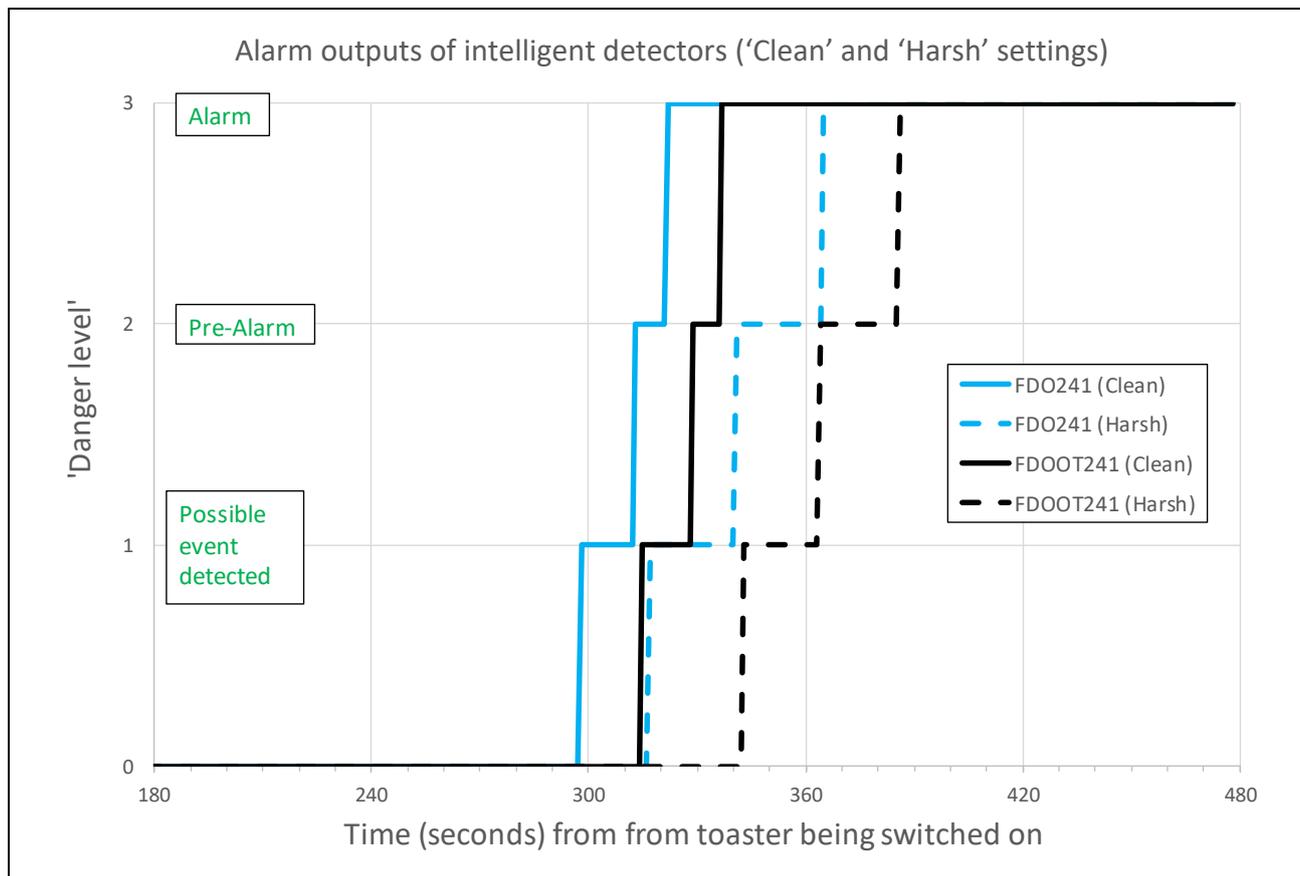


120 seconds after smoke becoming clearly visible by eye

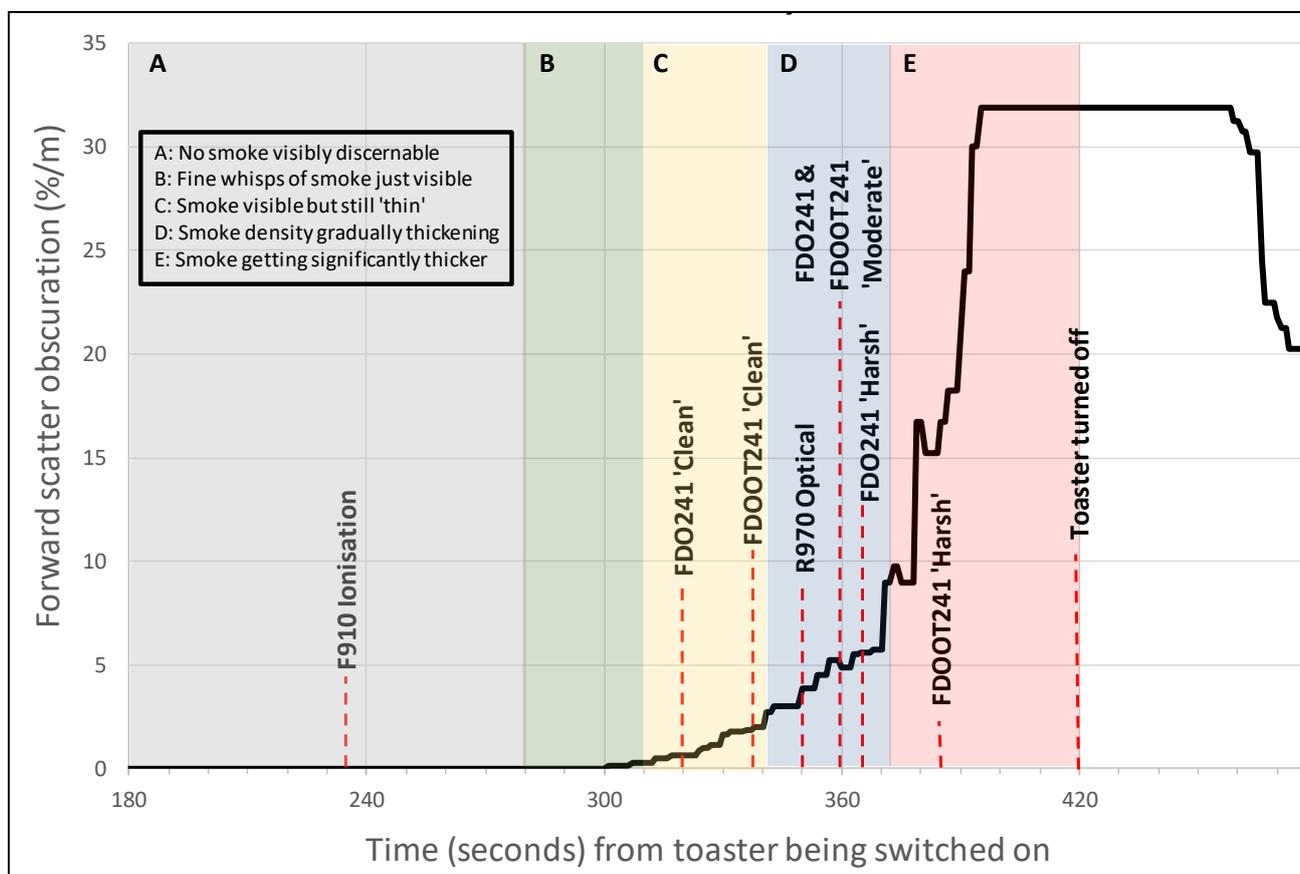
Smoke produced when bread continuously heated in toaster



Outputs of detectors and sensing elements during toast overheating test



Outputs of detectors and sensing elements during toast overheating test



Alarm activation times of detectors with a subjective assessment of smoke density, during the toaster test

4.11 Summary observations

4.11.1 The following tables summarise the responses of each detector during the demonstration tests. Unwanted responses to false alarm stimuli are coloured in red and appropriate responses to real threat stimuli are coloured in green, to help provide an overview of the suitability of the detectors’ responses. Responses that were somewhat ambiguous/open to interpretation (during later stages of the toaster test) are coloured amber.

Stimulus	F910 Ionisation	R970 Optical
Welding	Alarmed within 1 minute	Alarmed within 1 minute
Steam	No Alarm	Alarm
Toasting bread	Alarmed - Very early alarm when no visible smoke present	Alarmed – in later stages of test when visible smoke present and getting denser
Smouldering wood	Alarmed after 2.5 minutes	Alarmed within 1 minute
Heptane	Alarmed within ½ minute	Alarmed within ½ minute
Welding with heptane tray	Alarmed before heptane ignited	Alarmed after heptane ignited

Summary of responses – conventional single sensor detectors

Stimulus	FDO241 (Clean)	FDO241 (Medium)	FDO241 (Harsh)
Welding	Alarmed within 1 minute	Alarmed just after 1 minute	No Alarm or Pre-Alarm
Steam	Alarmed within 1 minute	Alarmed after 2.5 minutes	Alarmed just after 1 minute
Toasting bread	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed – in later stages of test when visible smoke present and getting denser
Smouldering wood	Alarmed within 1 minute	Alarmed just after 1 minute	Alarmed after 1.5 minutes
Heptane	Alarmed within 1 minute	Alarmed after 1 minute	Alarmed within 1.5 minutes
Welding with heptane tray	Alarmed before heptane ignited	Alarmed before heptane ignited	Alarmed after heptane ignited

Summary of responses – programmable ‘intelligent’ single sensor optical detector in various configurations

Stimulus	FDOOT241 (Clean)	FDOOT241 (Medium)	FDOOT241 (Harsh)
Welding	Alarmed within 1 minute	No Alarm or Pre-Alarm	No Alarm or Pre-Alarm
Steam	Alarmed within 1 minute	No Alarm or Pre-Alarm	No Alarm or Pre-Alarm
Toasting bread	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed in final stages of test when significant smoke present
Smouldering wood	Alarmed after 1.5 minutes	Alarmed just before 3 minutes	Alarmed after 3 minutes
Heptane	Alarmed within ½ minute	Alarmed within ½ minute	Alarmed within 1 minute
Welding with heptane tray	Alarmed before heptane ignited	Alarmed after heptane ignited	Alarmed after heptane ignited

Summary of responses – programmable ‘intelligent’ multi sensor optical detector in various configurations

Stimulus	F910 Ionisation	R970 Optical	FDOOT241 (Medium)	FDOOT241 (Harsh)
Welding	Alarmed within 1 minute	Alarmed within 1 minute	No Alarm or Pre-Alarm	No Alarm or Pre-Alarm
Steam	No Alarm	Alarm	No Alarm or Pre-Alarm	No Alarm or Pre-Alarm
Toasting bread	Alarmed - Very early alarm when no visible smoke present	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed in final stages of test when significant smoke present
Smouldering wood	Alarmed after 2.5 minutes	Alarmed within 1 minute	Alarmed just before 3 minutes	Alarmed after 3 minutes
Heptane	Alarmed within ½ minute	Alarmed within ½ minute	Alarmed within ½ minute	Alarmed within 1 minute
Welding with heptane tray	Alarmed before heptane ignited	Alarmed after heptane ignited	Alarmed after heptane ignited	Alarmed after heptane ignited

Comparison of the responses of the two conventional detectors and the best performing ‘intelligent’ multi sensors

Section Four - Scenario recreation of comparative system performance

Comparison of the responses of all the detectors tested

Stimulus	F910 Ionisation	R970 Optical	FDO241 (Clean)	FDO241 (Medium)	FDO241 (Harsh)	FDOOT241 (Clean)	FDOOT241 (Medium)	FDOOT241 (Harsh)
Welding	Alarmed within 1 minute	Alarmed within 1 minute	Alarmed within 1 minute	Alarmed just after 1 minute	No Alarm or Pre-Alarm	Alarmed within 1 minute	No Alarm or Pre-Alarm	No Alarm or Pre-Alarm
Steam	No Alarm	Alarm	Alarmed within 1 minute	Alarmed after 2.5 minutes	Alarmed just after 1 minute	Alarmed within 1 minute	No Alarm or Pre-Alarm	No Alarm or Pre-Alarm
Toasting bread	Alarmed - Very early alarm when no visible smoke present	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed – in later stages of test when visible smoke present and getting denser	Alarmed in final stages of test when significant smoke present
Smouldering wood	Alarmed after 2.5 minutes	Alarmed within 1 minute	Alarmed within 1 minute	Alarmed just after 1 minute	Alarmed after 1.5 minutes	Alarmed after 1.5 minutes	Alarmed just before 3 minutes	Alarmed after 3 minutes
Heptane	Alarmed within ½ minute	Alarmed within ½ minute	Alarmed within 1 minute	Alarmed after 1 minute	Alarmed within 1.5 minutes	Alarmed within ½ minute	Alarmed within ½ minute	Alarmed within 1 minute
Welding with heptane tray	Alarmed before heptane ignited	Alarmed after heptane ignited	Alarmed before heptane ignited	Alarmed before heptane ignited	Alarmed after heptane ignited	Alarmed before heptane ignited	Alarmed after heptane ignited	Alarmed after heptane ignited

4.11.2 In summary, the simple tests reported here demonstrate the differences in response to false alarm stimuli (unwanted alarms) between conventional single sensor detectors, programmable 'intelligent' single sensor detectors and programmable 'intelligent' multisensory detectors.

- Both conventional detectors were susceptible to steam and welding activity, and the ionisation detector also responded very rapidly to the toaster (well before any visible smoke was evident). The optical (R970) detector did not alarm during the toaster test until continuous visible smoke was being produced, and so could be considered to have correctly alarmed in that instance.
- The FDO241 programmable 'intelligent' single sensor detectors configured for 'clean' and 'medium' environments responded to the false alarm stimuli used here, similarly to the conventional detectors. However, the unit programmed for 'harsh' environments was slightly more discerning and did not respond to the welding activity.
- Whilst the FDOOT241 set to 'Clean' performed similarly to the conventional and detectors, the units set to both 'Medium' and 'Harsh' performed significantly better and showed a good level of immunity to the false alarm stimuli without compromising the speed with which they detected the real fire threats.

4.11.3 These simple demonstrations show clearly the potential benefits of utilising 'intelligent' detectors fitted with multiple sensing elements. However, they also illustrate that it is important for the algorithms (configurations) used with such detectors to be carefully tailored to the type of environment in which the detectors will be located, to ensure both immunity to false alarms as well as a rapid response to real fire threats.

4.11.4 However, until very recently little has been done to design a suite of tests that replicate the common causes of false or unwanted alarms (steam, dust etc) or to introduce these into the product standards. One of the key deliverables of this project was to undertake and document several laboratory immunity demonstration tests, using both conventional and multi-sensor detectors and to offer this evidence to standards bodies to accelerate their acceptance into the tests specification for detector heads. These results will be forwarded to the British Standards Institute (BSI) and to the Building Research Establishment (BRE) as it compliments work they have recently undertaken on behalf of the BRE Trust and the Fire Industry Association (FIA) and should assist in the early publication of revised standards incorporating immunity tests for false and unwanted alarms.

5.0 Concluding Remarks

- 5.1** There is a general consensus across the fire and insurance sectors that at 220,000 per annum the levels of false and unwanted alarms emanating from fire alarm and detection systems is too high. False and unwanted alarms waste fire and rescue service resources; cause unnecessary and expensive disruption to end-users which can result in the loss of confidence in systems and has seen some systems switched off.
- 5.2** As fire alarm and detections systems are so closely embedded into the evacuation strategies and procedures developed to meet the requirements of Building Regulations and Fire Safety Law their use is widespread and there are well established third party accreditation schemes for manufacturers and installers. The product standards and testing regimes however remain silent on the causes of false alarms.
- 5.3** This study has demonstrated that whilst the technology which could vitally eliminate false alarms is now widely available, its attributes are not generally well known and until they are fire and rescue services will be unlikely to alter their response. The Digital Media Tool will provide a mechanism to educate; and it is hoped that the work on immunity tests will compliment and support the recent research released by the BRE Trust and FIA and accelerate the introduction of immunity tests into standards.

5.4 Next Steps

Deliverable	Possible Target & Exploitation Path	Target Date
Literature Review & 'You Tube' Media Tool	Educate HM Inspectorate of Constabulary and Fire & Rescue Services (HMICFRS) on the scale of the problem and the reliability of this technology and encourage them to put pressure on fire and rescue services to change response policies for systems which incorporates these types of detectors	May 2018 or as agreed with ABI.
	Educate Fire & Rescue Services on the reliability of this technology – initially through the National Fire Chiefs Council (NFCC) Unwanted Alarms Group - Next Meeting June 2018	May – July 2018 or as agreed with ABI.
	Gain commitment from fire & rescue services to alter response standards (where multi sensor devices installed) and update RISCAuthority response tool	September 2018 or as agreed with ABI.
	Release to YouTube channel and broadcast media.	ASAP
Literature Review & Scenario recreation of comparative system performance – Immunity Tests	Release report to Dame Judith Hackitt's Review – Due late Spring	April 2018 or as agreed with ABI.
	Release Review to BRAC and ADB review team – with a view to effecting change in Building Regulations.	April 2018 or as agreed with ABI.
	Release Review to Sir Martin Moore Bick's Public Inquiry	April 2018 or as agreed with ABI.
	Release to BSI, BRE and other standards making bodies	April 2018 or as agreed with ABI.
Full Report	Conduct a series of webinars to ABI members, RISCAuthority, Fire & Rescue Services, Building Control Authorities, End Users (particularly poor performing in respect of false alarms) and high-risk occupancies	April 2018 or as agreed with ABI.

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