Breaking the “Standard” cycle: The case for electronic activation

21st IWMA Conference Madrid

Plumis

Agenda

Yusuf Muhammad
Chief Design Officer

1. Mechanical activation and the fire industry
2. Why we need innovation?
3. The automotive and aerospace industry
4. The fire engineering case for electronic activation

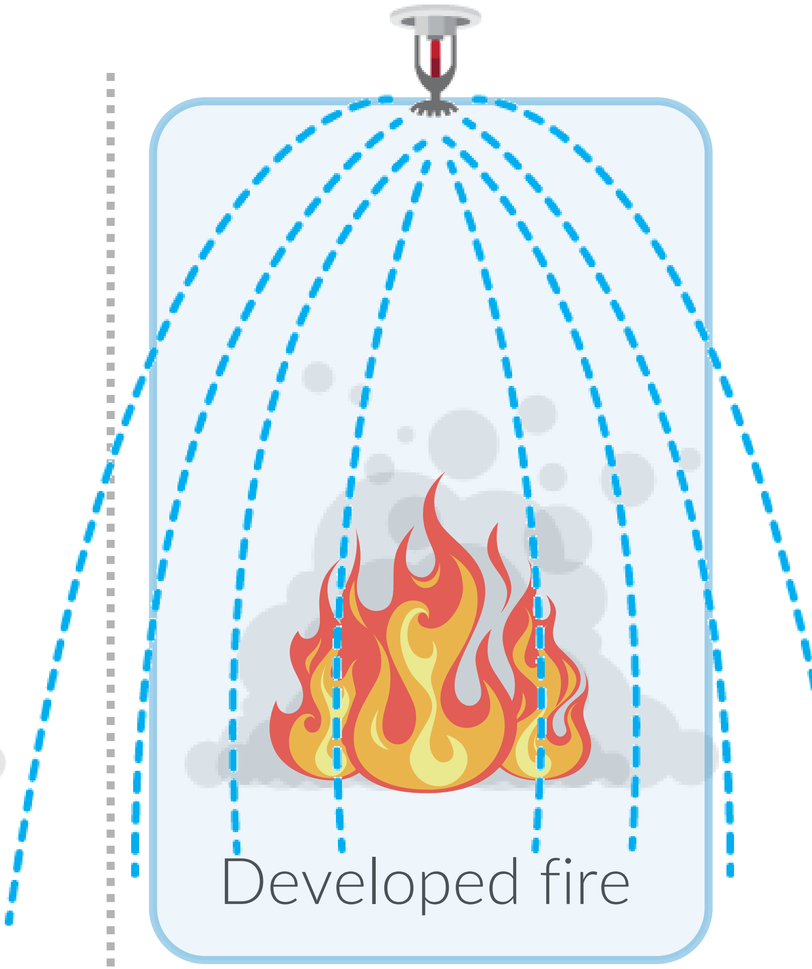
Plumis

Mechanical activation

Pre incident

Incipient stage

Growing fire



Developed fire

Plumis

Objective of Active Fire Suppression

Adequate level of occupant safety

Limiting physical damage to the building

Facilitation of firefighting

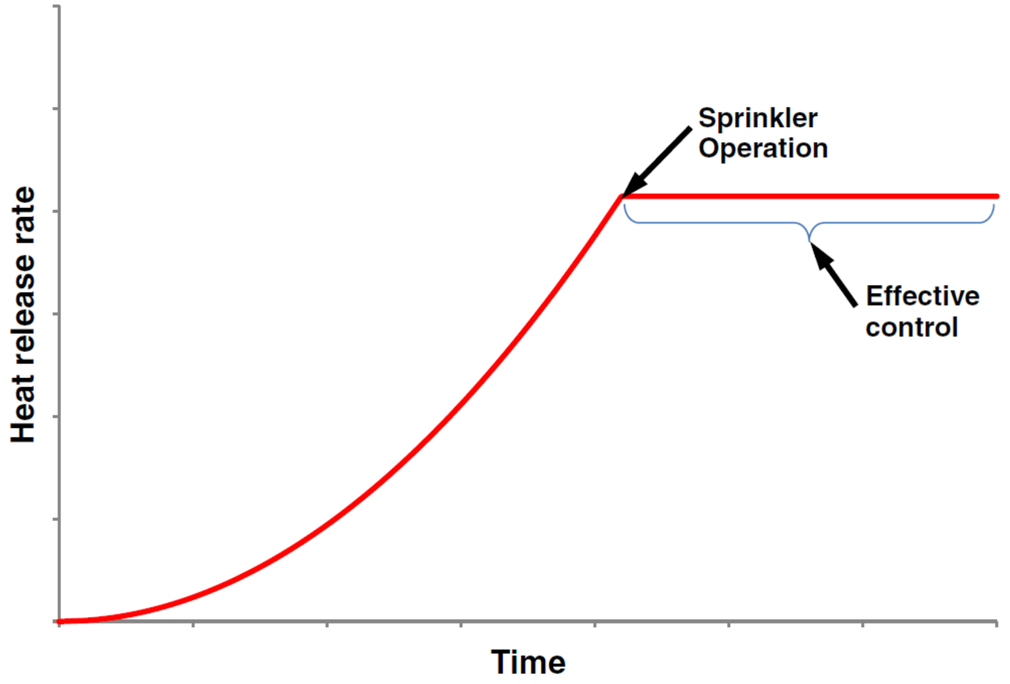


Figure 2 A commonly assumed heat release rate curve for sprinkler fire control.

Plumis

How do we gauge performance?

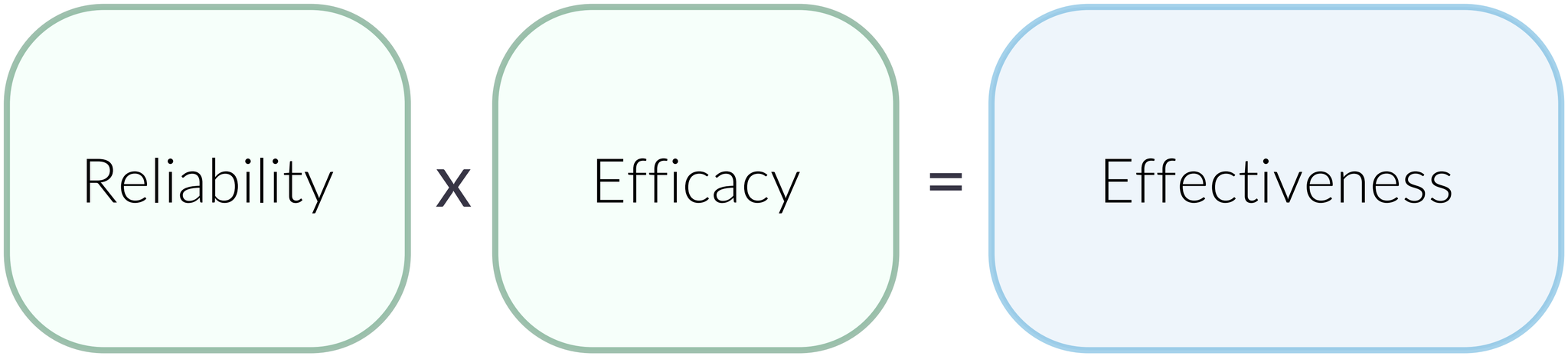
Reliability the probability that a sprinkler system will activate and supply water to a fire demand

Efficacy the probability that the sprinkler system will affect the development of the fire as specified in the system design objectives

Effectiveness the overall performance of the sprinkler system, combining both the reliability and efficacy

Plumis

How do we gauge performance?



Plumis

A review of sprinkler system effectiveness

Frank et al. Fire Science Reviews 2013, 2:6
http://www.firesciencereviews.com/content/2/1/6

Fire Science Reviews
a SpringerOpen Journal

REVIEW Open Access

A review of sprinkler system effectiveness studies

Kevin Frank[1*], Neil Gravestock[2], Michael Spearpoint[1] and Charles Fleischmann[1]

Abstract

A lack of information on the effectiveness of fire safety systems, including sprinklers, has been noted as being a limiting factor in the development of performance-based fire safety design. Of the fire safety systems available, sprinkler operation has been studied most extensively. This paper reviews the information currently available on sprinkler effectiveness in fires. Two approaches are generally taken for estimating sprinkler effectiveness: component-based approaches using a fault tree or similar method and system-based approaches using fire incident data where sprinklers were present. In this paper, sprinkler system component data and effectiveness estimates from system-based studies have been compiled and tabulated, with a comparison of the merits of the two approaches. Recommendations for using the data for design purposes are made, including considerations for uncertainty and using a hybrid system/component approach for specific sprinkler system comparisons. These recommendations provide input on the reliability of systems in the development of performance-based fire safety design methods.

Keywords: Sprinklers; Effectiveness; Reliability; Suppression

Introduction

Building fire safety design involves evaluation of the likelihood and consequences or risk of potential fire events that may impact the fire safety objectives of the building. Objectives are set by regulation and/or by the owner and/or user and/or insurer of the building. These objectives universally include an adequate (but usually unquantified) level of safety for the occupants of the building, some facilitation of firefighting should a fire occur in the building, and some limitation of the physical damage that would result from a fire in the building.

Systems are commonly installed in buildings to provide a cost-effective mitigation of the risk to life safety and/or property destruction, etc. The contribution and interactions of each of the systems towards achieving the objectives should be known. This either requires historical data that directly addresses effectiveness or historical data on the reliability of the system (the probability that the system will operate as required at any time) and on the effect of the correctly operating system (the efficacy) on each of the objectives that it is intended to address. Some systems, while positive in relation to some objectives, may be negative in relation to other objectives.

In the move towards risk- and performance-based fire safety design (Notarianni and Fischbeck 1999) identified *"7 major barriers to determining and documenting achievement of agreed upon levels of fire safety"*, one of which was that *"no standardized methods exist to incorporate reliability of systems."* At an October 2006 meeting in Wellington, New Zealand, the International Forum of Fire Research Directors which includes members from the Building Research Association of New Zealand (BRANZ), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the National Institute of Standards and Technology (NIST), FM Global, the National Research Council of Canada (NRCC), and the Society of Fire Protection Engineers (SFPE) among others, listed as 2 of their top 5 research priorities (Grosshandler 2006):

- *"to improve our ability to predict the impact of active fire protection systems on the fire growth and fate of combustion products; and*
- *to estimate the various contributions to uncertainty and to incorporate them into hazard and risk analyses"*

*Correspondence: kfrank81@gmail.com
[1]University of Canterbury, Christchurch, New Zealand
Full list of author information is available at the end of the article

Max — 95%

Ineffective 1 in 20

Min — 70%

Ineffective 3 in 10

Plumis

Performance Benchmark

95% - 70% effectiveness

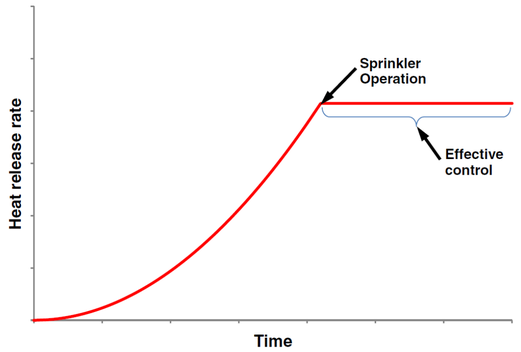


Figure 2 A commonly assumed heat release rate curve for sprinkler fire control.

Plumis

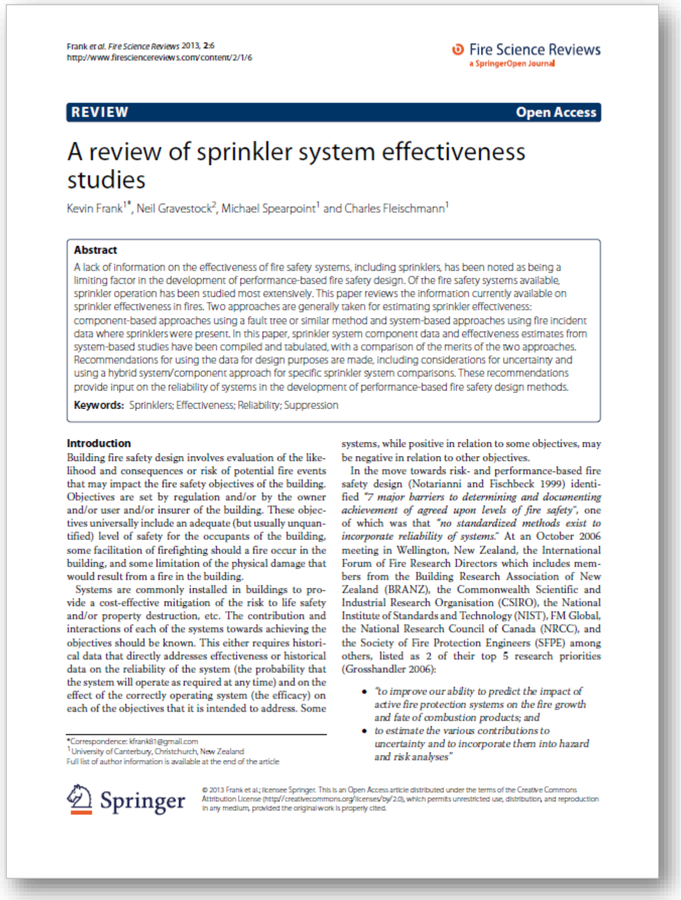
Why do we need innovation?

1882

Today

Plumis

A review of sprinkler system effectiveness



Frank et al. Fire Science Reviews 2013, 2:6
http://www.firesciencereviews.com/content/2/1/6

Fire Science Reviews
a SpringerOpen Journal

REVIEW Open Access

A review of sprinkler system effectiveness studies

Kevin Frank[1*], Neil Gravestock[2], Michael Spearpoint[1] and Charles Fleischmann[1]

Abstract

A lack of information on the effectiveness of fire safety systems, including sprinklers, has been noted as being a limiting factor in the development of performance-based fire safety design. Of the fire safety systems available, sprinkler operation has been studied most extensively. This paper reviews the information currently available on sprinkler effectiveness in fires. Two approaches are generally taken for estimating sprinkler effectiveness: component-based approaches using a fault tree or similar method and system-based approaches using fire incident data where sprinklers were present. In this paper, sprinkler system component data and effectiveness estimates from system-based studies have been compiled and tabulated, with a comparison of the merits of the two approaches. Recommendations for using the data for design purposes are made, including considerations for uncertainty and using a hybrid system/component approach for specific sprinkler system comparisons. These recommendations provide input on the reliability of systems in the development of performance-based fire safety design methods.

Keywords: Sprinklers; Effectiveness; Reliability; Suppression

Introduction

Building fire safety design involves evaluation of the likelihood and consequences or risk of potential fire events that may impact the fire safety objectives of the building. Objectives are set by regulation and/or by the owner and/or user and/or insurer of the building. These objectives universally include an adequate (but usually unquantified) level of safety for the occupants of the building, some facilitation of firefighting should a fire occur in the building, and some limitation of the physical damage that would result from a fire in the building.

Systems are commonly installed in buildings to provide a cost-effective mitigation of the risk to life safety and/or property destruction, etc. The contribution and interactions of each of the systems towards achieving the objectives should be known. This either requires historical data that directly addresses effectiveness or historical data on the reliability of the system (the probability that the system will operate as required at any time) and on the effect of the correctly operating system (the efficacy) on each of the objectives that it is intended to address. Some systems, while positive in relation to some objectives, may be negative in relation to other objectives.

In the move towards risk- and performance-based fire safety design (Notarianni and Fischbeck 1999) identified *"7 major barriers to determining and documenting achievement of agreed upon levels of fire safety"*, one of which was that *"no standardized methods exist to incorporate reliability of systems."* At an October 2006 meeting in Wellington, New Zealand, the International Forum of Fire Research Directors which includes members from the Building Research Association of New Zealand (BRANZ), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the National Institute of Standards and Technology (NIST), FM Global, the National Research Council of Canada (NRCC), and the Society of Fire Protection Engineers (SFPE) among others, listed as 2 of their top 5 research priorities (Grosshandler 2006):

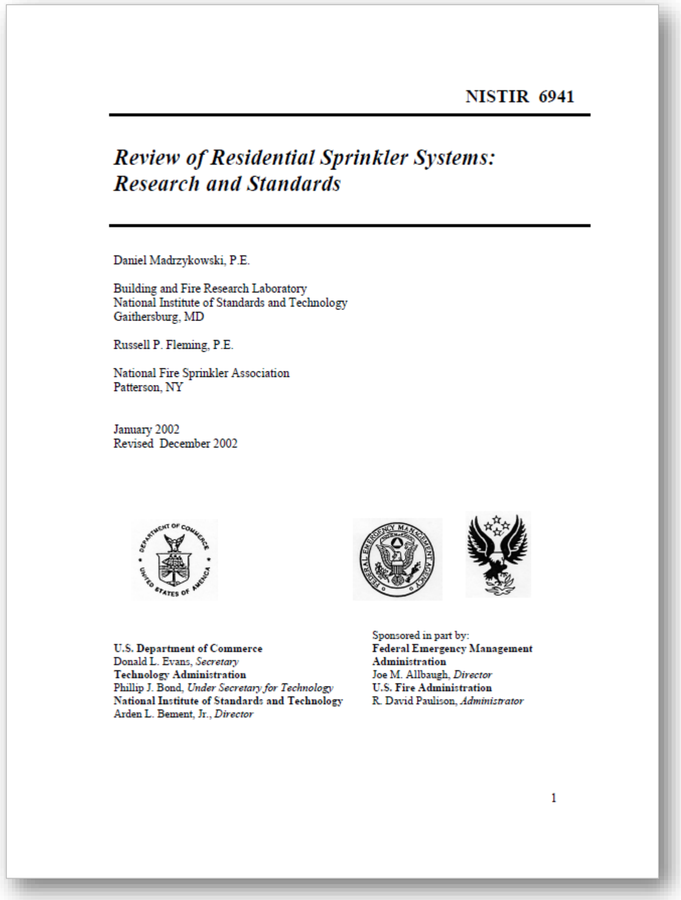
- *"to improve our ability to predict the impact of active fire protection systems on the fire growth and fate of combustion products; and*
- *to estimate the various contributions to uncertainty and to incorporate them into hazard and risk analyses"*

*Correspondence: kfrank81@gmail.com
[1]University of Canterbury, Christchurch, New Zealand
Full list of author information is available at the end of the article

'a "100% effective" sprinkler system would not equate to a 100% reduction in loss, because a fire must be present and reach sufficient size to activate the sprinkler system'

Plumis

An appraisal of the ODPM



NISTIR 6941

Review of Residential Sprinkler Systems: Research and Standards

Daniel Madrzykowski, P.E.

Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD

Russell P. Fleming, P.E.

National Fire Sprinkler Association
Patterson, NY

January 2002
Revised December 2002

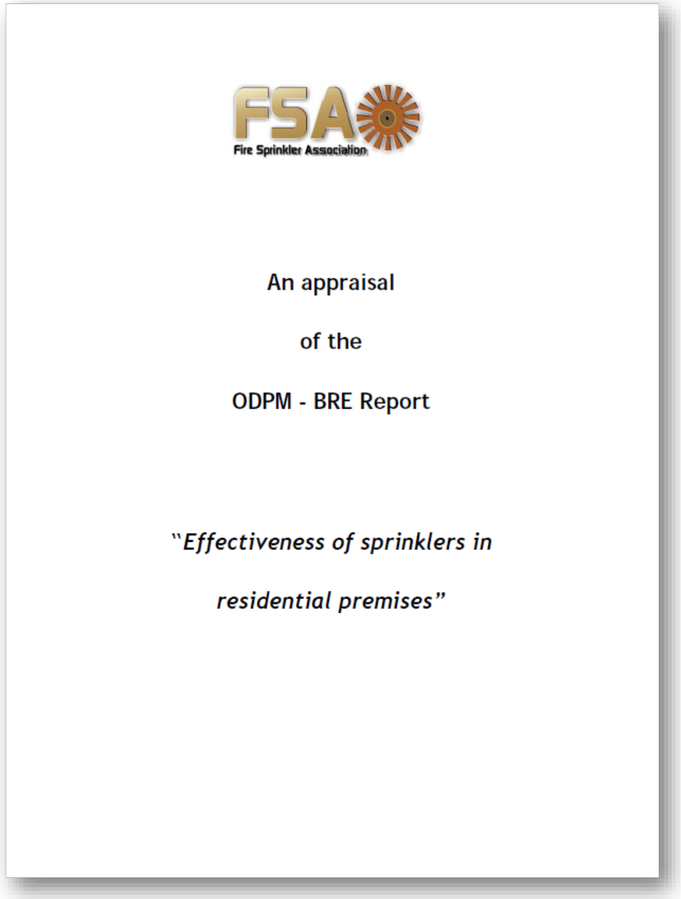
U.S. Department of Commerce
Donald L. Evans, *Secretary*
Technology Administration
Phillip J. Bond, *Under Secretary for Technology*
National Institute of Standards and Technology
Arden L. Bement, Jr., *Director*

Sponsored in part by:
Federal Emergency Management Administration
Joe M. Allbaugh, *Director*
U.S. Fire Administration
R. David Paulison, *Administrator*

‘The research showed that a more sensitive sprinkler was needed to respond faster to both smouldering and fast-developing residential fires’

Plumis

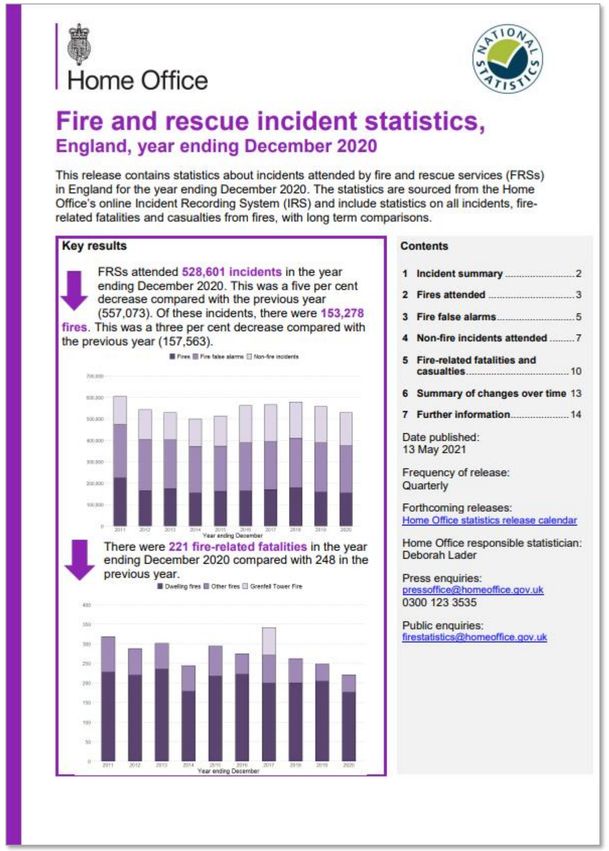
An appraisal of the ODPM



'The house fires used in these tests were all of a slow-growing type that produced a lot of smoke but limited heat'

Plumis

Examining fire service data



Home Office

Fire and rescue incident statistics,
England, year ending December 2020

This release contains statistics about incidents attended by fire and rescue services (FRSs) in England for the year ending December 2020. The statistics are sourced from the Home Office's online Incident Recording System (IRS) and include statistics on all incidents, fire-related fatalities and casualties from fires, with long term comparisons.

Key results

FRSs attended **528,601 incidents** in the year ending December 2020. This was a five per cent decrease compared with the previous year (557,073). Of these incidents, there were **153,278 fires**. This was a three per cent decrease compared with the previous year (157,563).

Fires Fire false alarms Non-fire incidents

Year ending December

There were **221 fire-related fatalities** in the year ending December 2020 compared with 248 in the previous year.

Dwelling fires Other fires Grenfell Tower Fire

Year ending December

Contents

Date published:
13 May 2021

Frequency of release:
Quarterly

Forthcoming releases:
Home Office statistics release calendar

Home Office responsible statistician:
Deborah Lader

Press enquiries:
pressoffice@homeoffice.gov.uk
0300 123 3535

Public enquiries:
firestatistics@homeoffice.gov.uk

156 injuries and 5 deaths that occurred in sprinklered buildings between 2013 and 2018

All of which were outside the life saving design parameters of the technology

Plumis

Automotive Efficacy

Electronic cost as % of total car cost

"80% of innovation is electronic"

Active- Passive Safety
Green Powertrain
Radar / Vision
Infotainment

Airbag
ABS / ESP
Body Electronics
Multiplexing

Electronic Fuel Injection

1%

2.5%

1950 1960 1970 1980 1990 2000 2005 2010 2030

Plumis

Automotive Reliability

- Oil change every 1,500 miles
- Solely mechanical components
- Visual inspection
- Repair of failures

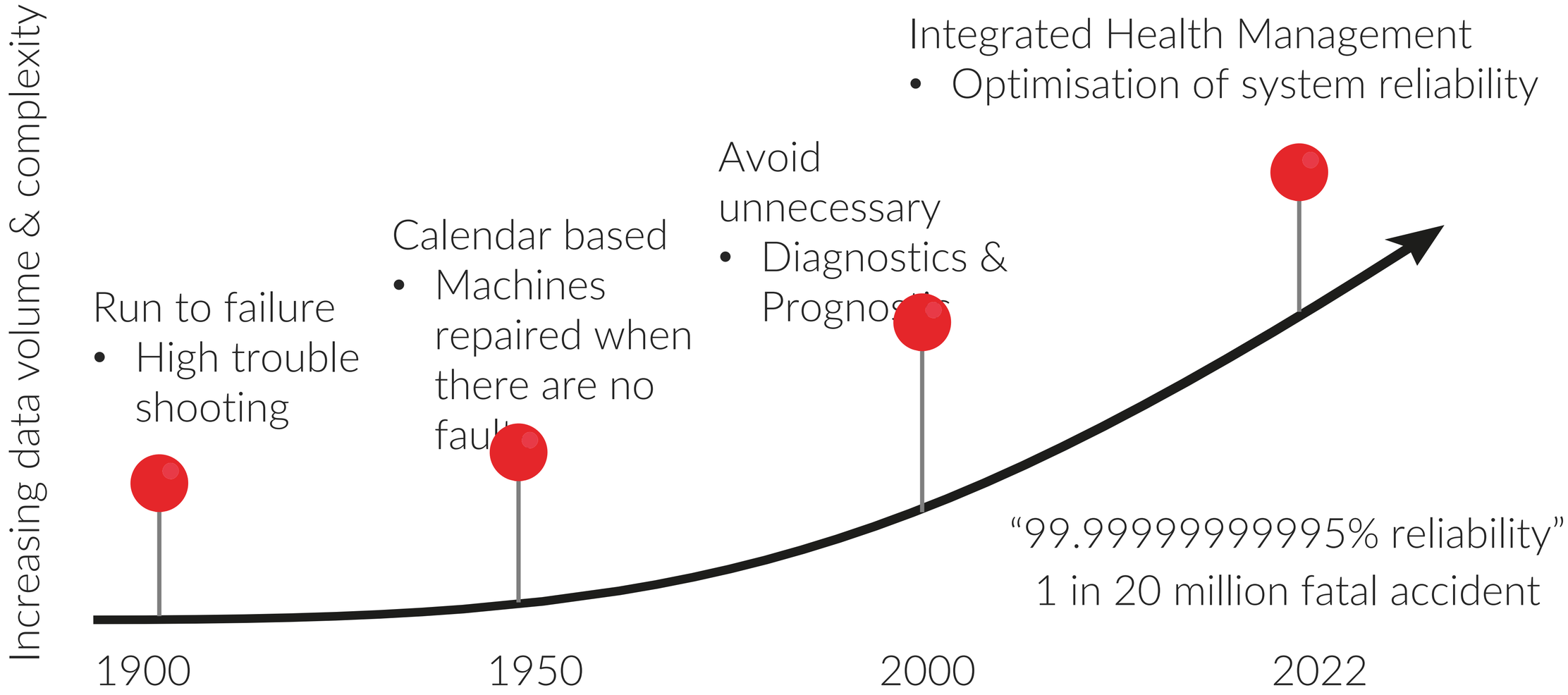
- Service interval of 15,000+ miles
- Networked electronic and mechatronic systems
- Diagnostics
- Exchange of components

Increased complexity

1950 1960 1970 1980 1990 2000 2005 2010 2022

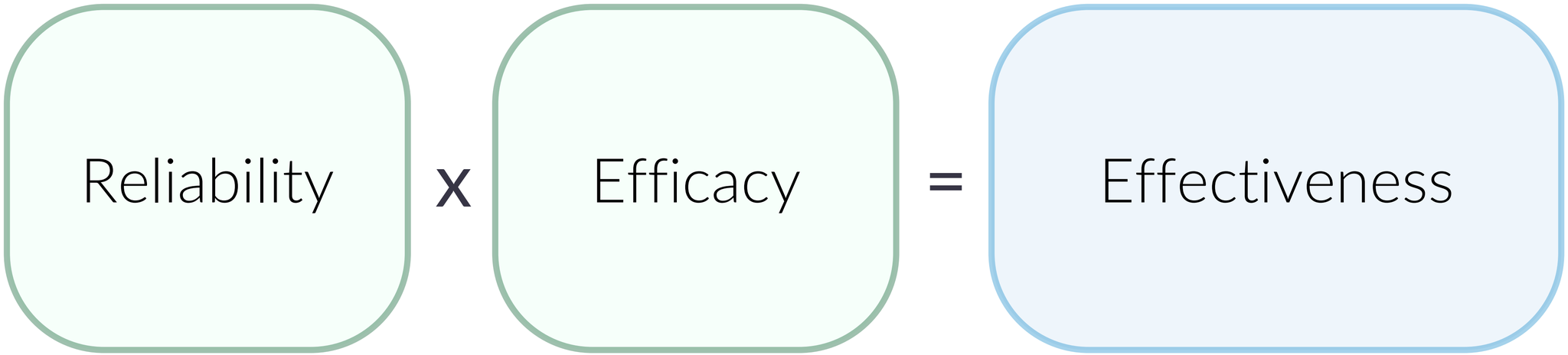
Plumis

Aerospace Maintenance



Plumis

First principal thinking



Plumis

Objective of Active Fire Suppression

Adequate level of safety for the occupants

Some limitation of the physical damage to the building

Some facilitation of firefighting

Plumis

Objective of Active Fire Suppression

Adequate level of safety for the occupants

Some limitation of the physical damage to the building

Some facilitation of firefighting

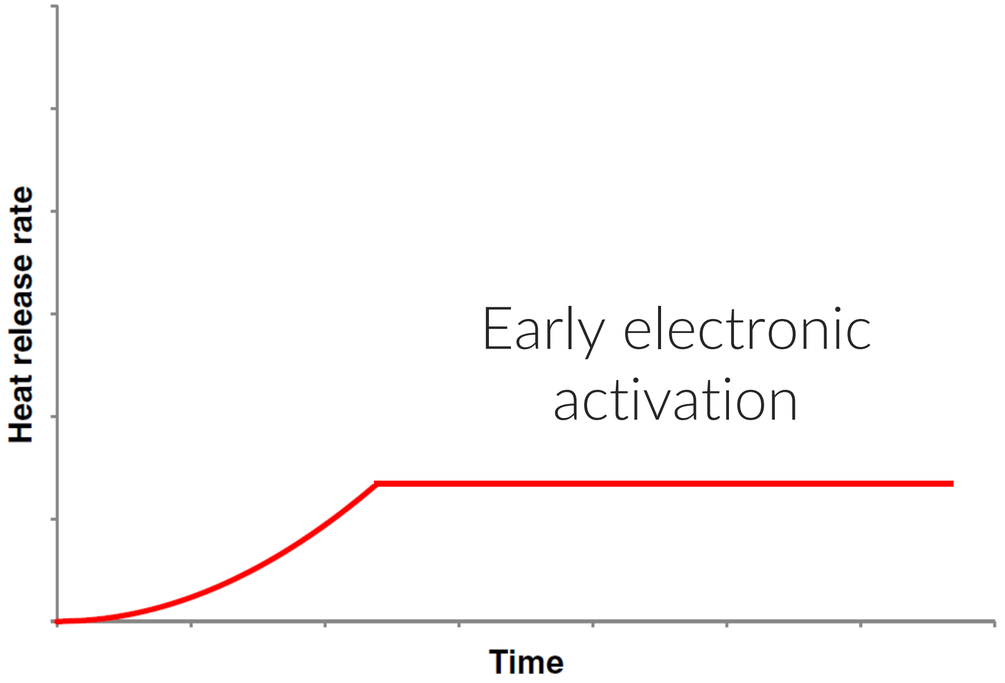


Figure 2 A commonly assumed heat release rate curve for sprinkler fire control.

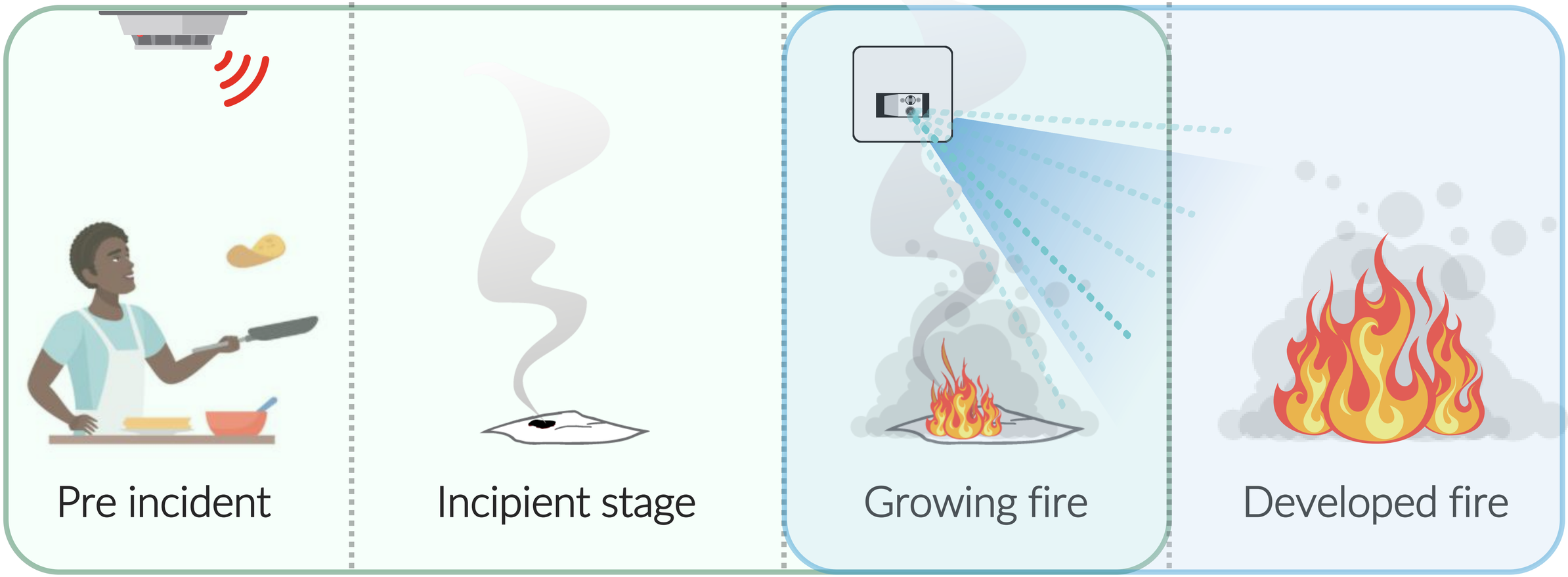
Plumis

Automist Smartscan

Electronically controlled
targeted watermist

Plumis

Electronic activation



Plumis

Automist Smartscan Hydra

Sidewall Sprinkler

Fire Safety Journal 130 (2022) 103592

Contents lists available at ScienceDirect

Fire Safety Journal

journal homepage: www.elsevier.com/locate/firesaf

Replicating the activation time of electronically controlled watermist system nozzles in B-RISK

M. Spearpoint [a,*], C. Hopkin [b], Y. Muhammad [c], W. Makant [c]

[a] OFR Consultants, Manchester, UK
[b] Ashton Fire, Manchester, UK
[c] Plumis Ltd., London, UK

ABSTRACT

This paper presents two series of enclosure fire experiments in which the activation time of electronically controlled watermist system nozzles and concealed sprinklers have been obtained. The first series experiments were aligned to the procedure given in the BS 8458 standard whereas the second series were configured to give slower growing fires than in the standard test.

The activation of the two systems have been simulated in the B-RISK zone fire model. Activation characteristics for the concealed sprinklers have been taken from elsewhere in the literature. Representative activation characteristics for the electronically controlled watermist system nozzles have been determined. The selection of these characteristics has required a balance between the results from the two experimental series. By using an effective response time index of 20 $m^{\frac{1}{2}}s^{\frac{1}{2}}$ and an effective conductivity factor of 0.25 $m^{\frac{1}{2}}s^{-\frac{1}{2}}$ the predicted activation times are on average 14% slower across all of the enclosure fires.

1. Introduction

1.1. Background

A report on a recent a study on the causes of fire fatalities and serious fire injuries in Scotland and potential solutions to reduce them [1] suggested that *"More needs to be done in terms of reliable early detection and suitable intervention, to either delay the development of the fire or to notify people – using technology – so they can take suitable action at the early stages of the fire."* Automatic water fire suppression systems (AWFSS), such as sprinklers and watermist, provide a means to protect lives and property by both detecting a fire and then controlling or extinguishing it.

Shielded fire scenarios present a challenge to suppression systems when compared to cases in which the fire is open to the suppression medium. In the report by BRE [2] it was noted that *"Sprinkler protection was not found to be a complete panacea, slow-growing and shielded fires can be a problem."* Similarly, previous work by Grosshandler et al. [3] on using water mist to protect computer cabinets found that suppressing these fires in obstructed locations is challenging.

This paper reports on two series of enclosure experiments in which the activation of a watermist system with electronically controlled nozzles has been measured. Series A consisted of BS 8458 [4] fire test configurations and Series B were ad-hoc enclosure experiments in which the fire source was configured to give a longer development time in comparison with those in Series A, as well as considering the impact of shielding the fire. In addition to the watermist system, the Series B experiments also included measuring the activation time of concealed residential sprinkler heads.

In this paper the measured activation times of the watermist system and the concealed sprinklers have been compared. The B-RISK zone model [5] has then been used to reproduce the experiments as closely as possible, comparing simulation outputs to data for system activation time. As part of this, representative thermal sensitivity properties for the watermist system have been identified through a parametric analysis, assuming that the system can be represented as an equivalent sprinkler head. For the concealed sprinkler heads, the activation properties have been taken from the previous work of Hopkin and Spearpoint [6], with the aim to verify whether their recommended design parameters for concealed heads align with the experiments.

1.2. Electronically controlled nozzles

The concept of using an electronic means of activating a AWFSS rather than using the traditional thermally responsive elements has been discussed in the literature. Magnone et al. [7] consider the challenges posed by modern warehouse storage requirements and how ceiling-only mounted sprinklers that are electronically activated by detection and control system can provide a viable suppression solution. Kopylov et al.

* Corresponding author.
E-mail address: michael.spearpoint@ofrconsultants.com (M. Spearpoint).

https://doi.org/10.1016/j.firesaf.2022.103592
Received 24 January 2022; Received in revised form 14 March 2022; Accepted 10 April 2022
Available online 22 April 2022

Peer-reviewed fire engineering research

The measured activation times of a concealed sprinkler head is 2.0 to 13.7 times slower than those using an electronic nozzle system

Plumis

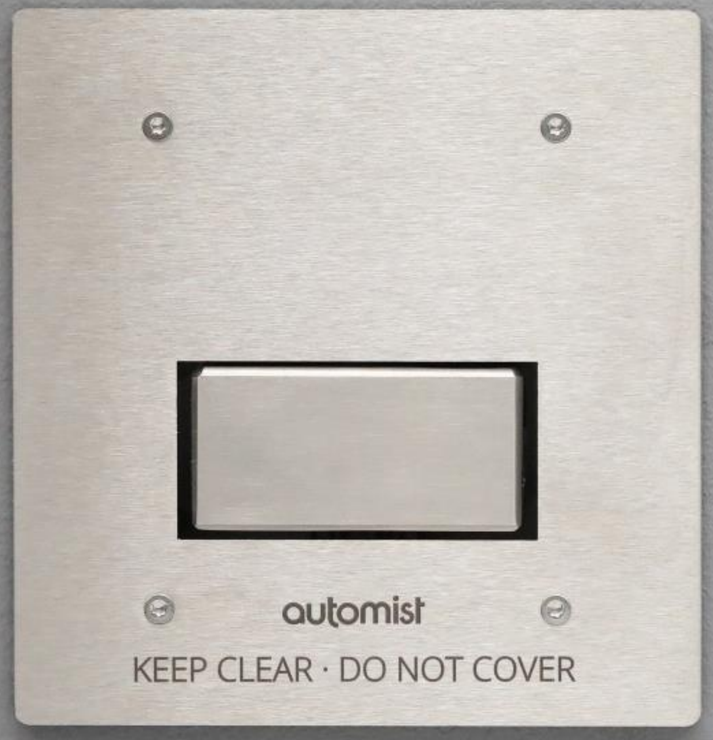
Performance based design

Reliability **x** Efficacy **=** Effectiveness

40?%

2-14 x faster than a concealed fire sprinkler

Plumis



Thank you for listening

founder@plumis.us