

Note that the pictures are for illustration purpose: the study concern building fires. The building usually hides the actions of the firefighters!



Standard nozzle  
approach



Perimeter  
approach



Maximum flow  
approach

## Three different modes of firefighting

# Three different modes of firefighting


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## Three Different Fire Suppression Approaches Used by Fire and Rescue Services

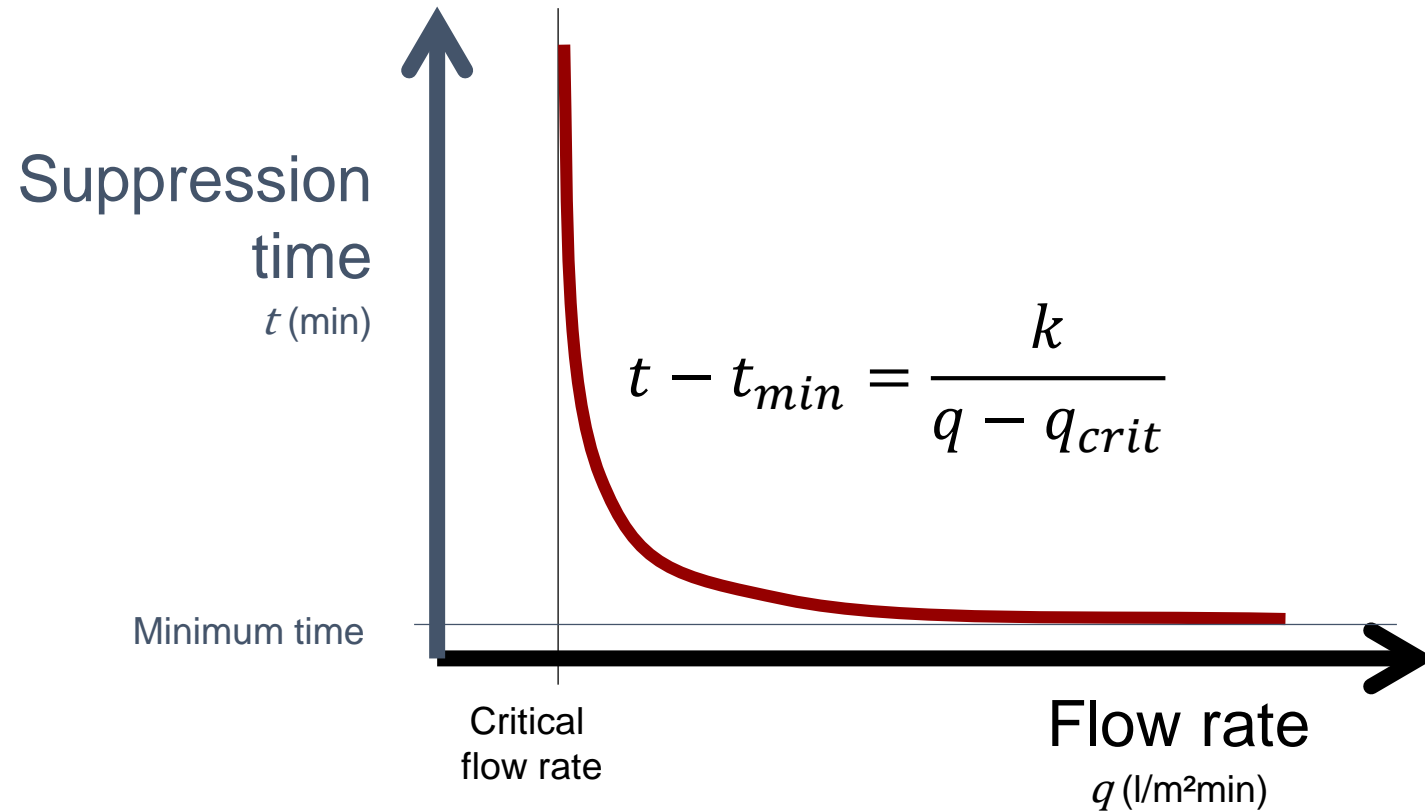


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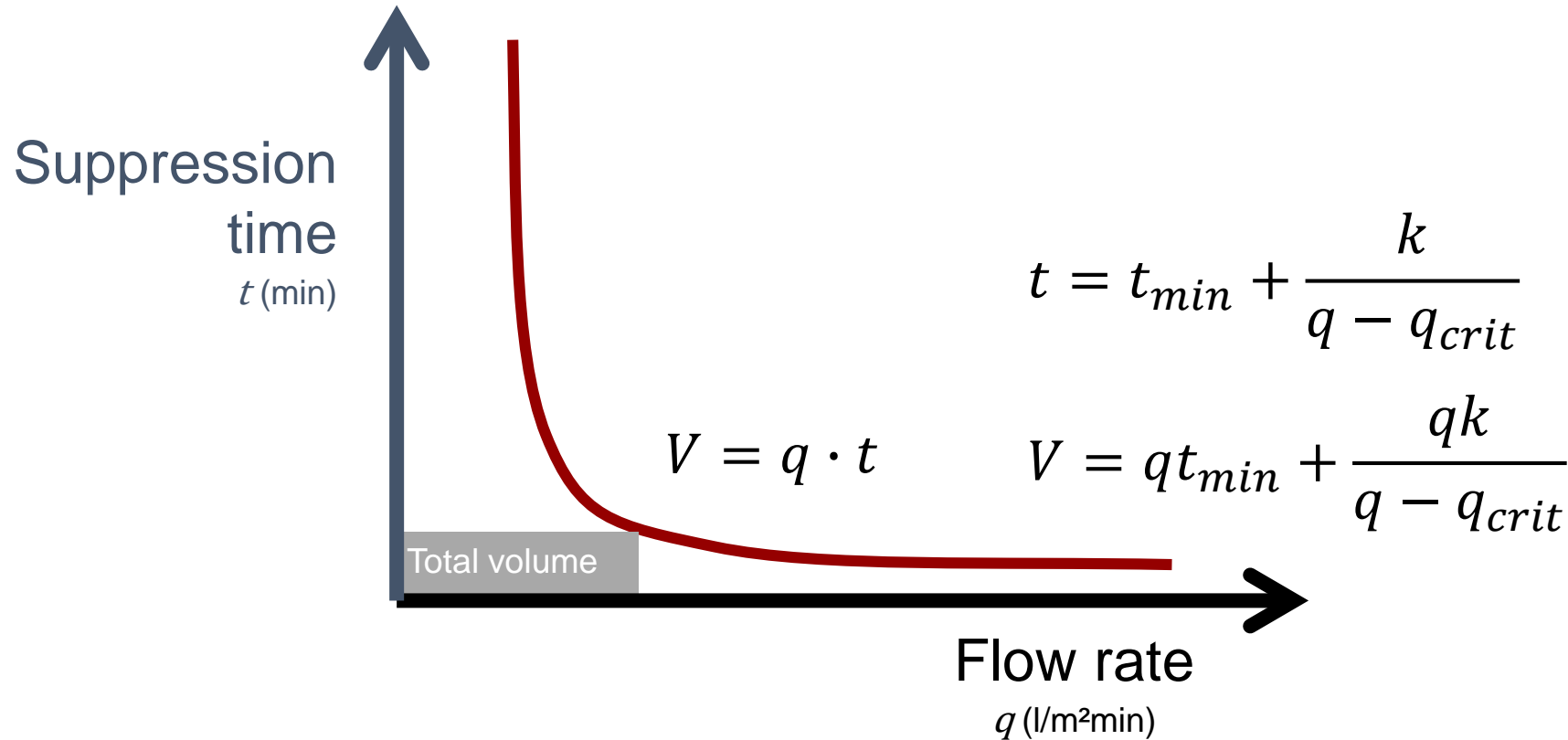
Received: 15 February 2018/Accepted: 22 November 2018

**Abstract.** This paper describes the three different fire suppression approaches used by the Fire and Rescue Services (FRS) in Sweden.

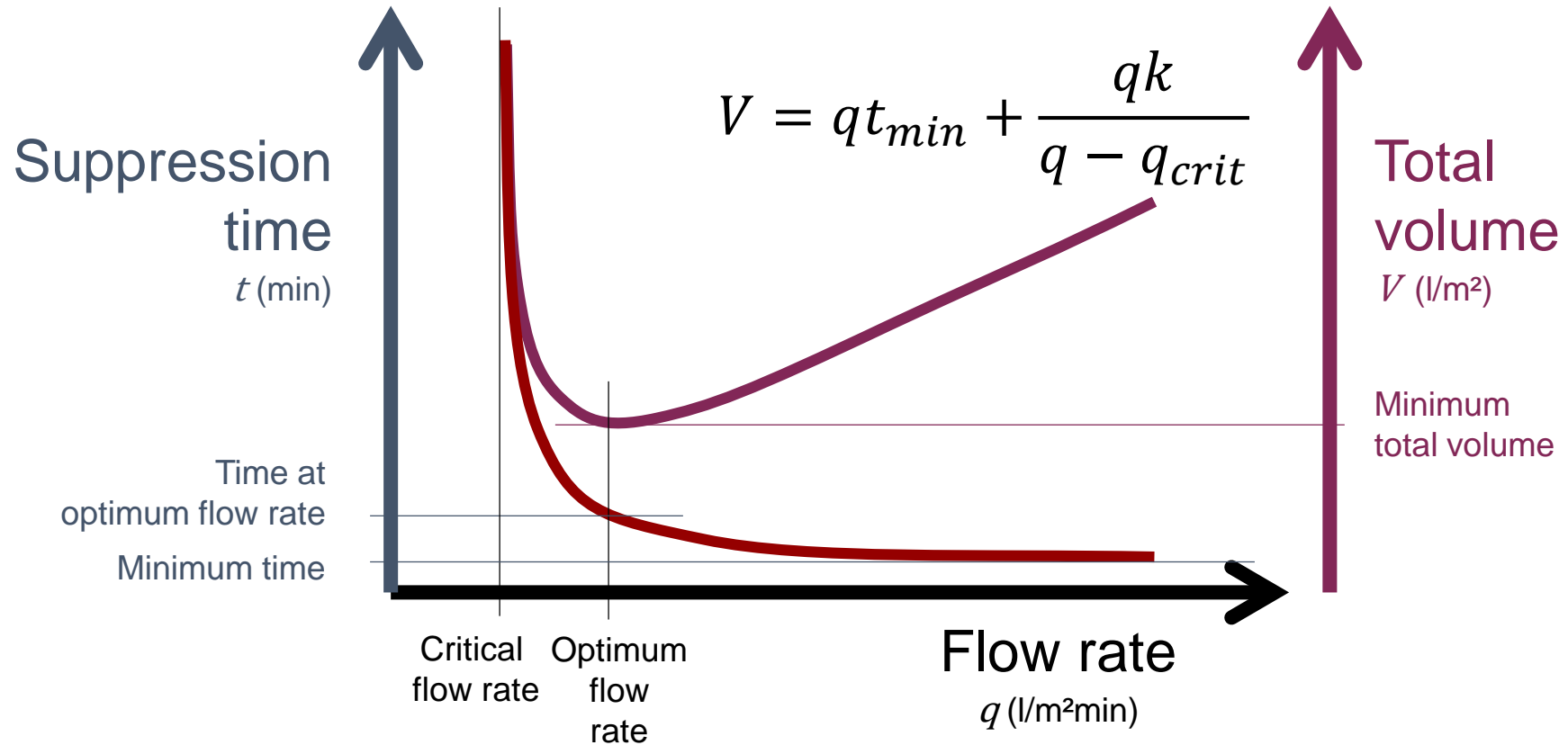
# Critical flow rate and optimum flow rate for fire suppression



# Critical flow rate and optimum flow rate for fire suppression



# Critical flow rate and optimum flow rate for fire suppression



# Interflam -99

## FIRE BRIGADE USE OF WATER

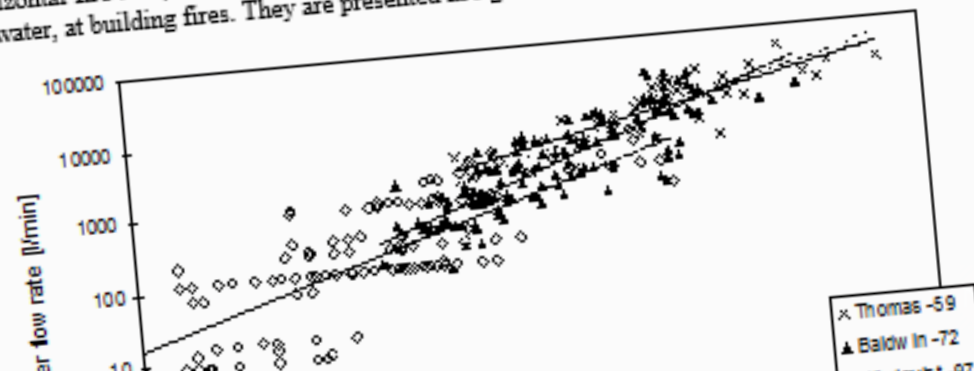
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### INTRODUCTION

Water is the most important fire extinguishing agent at fire fighting operations, as it is both cheap and easy to handle. Fire brigade tactics are therefore based on the use of water for extinguishing most fires. There are, however, very few models available to determine the required water flow rate. A question that arises is how the fire brigades are dimensioned in terms of equipment and personnel requirements, which seems to be based more on local traditions and economical or political reasons than on the actual water requirements needed to fight fires. This paper describes the current knowledge on practical dimensioning of water flow rates at fire fighting operations.

### FIRE BRIGADE STUDIES

Statistical studies from fire fighting operations show, although the spread in the material is large, a correlation of roughly  $Q = k \cdot A^{0.5}$  between the water flow rate,  $Q$  (l/min) used by the fire brigades and the horizontal fire area,  $A$  (m<sup>2</sup>), where  $k$  is a constant. Three studies are available on the fire brigade use of water, at building fires. They are presented in figure 1.





Contents lists available at ScienceDirect

Fire Safety Journal

journal homepage: [www.elsevier.com/locate/firesaf](http://www.elsevier.com/locate/firesaf)



# The County/Metro research into fire-fighting suppressive capacity and the impact on building fire damage at > 5000 UK building fires, 2009–2012

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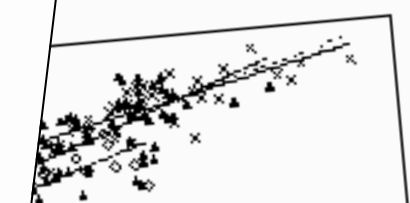
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Fire hazard analysis

## ABSTRACT

This paper describes research by Glasgow Caledonian University into fire-fighting water flow-rates as actually deployed to control and suppress > 5000 building fires that occurred in two fire authority jurisdictions in the UK between 2009 and 2012. One fire service covered a large county suburban risk area with low to medium populated areas, whilst the other covered a large metropolitan region with heavily populated inner city areas included. Using data from the national IRS fire reporting framework (UK Fire & Rescue Service National Incident Recording System), it was demonstrated that there are links between the amounts of water used/required for effective fire fighting and the fire type, the density of the fire load, the estimated fire load density, the estimated fire load, the estimated damage that may impact on the fire load.

the spread in the material is large, a  
Q (l/min) used by the fire brigades and  
studies are available on the fire brigade



× Thomas -59  
▲ Baldw in -72

# FIRE BRIGADE USE OF WATER

Fire Safety Journal 71 (2015) 238–247

Contents lists available at ScienceDirect



Study	Year of publication	Number of fires	Type of fires
Grimwood & Sanderson	2015	4173	UK Metro FRS
Grimwood & Sanderson	2015	1146	UK County FRS
Särdqvist	1998	307	Greater London Non-residential
Baldwin	1972	134	Illinois > 20 m <sup>2</sup>
Thomas	1959	48	UK, > 5 jets, > 200 m <sup>2</sup>

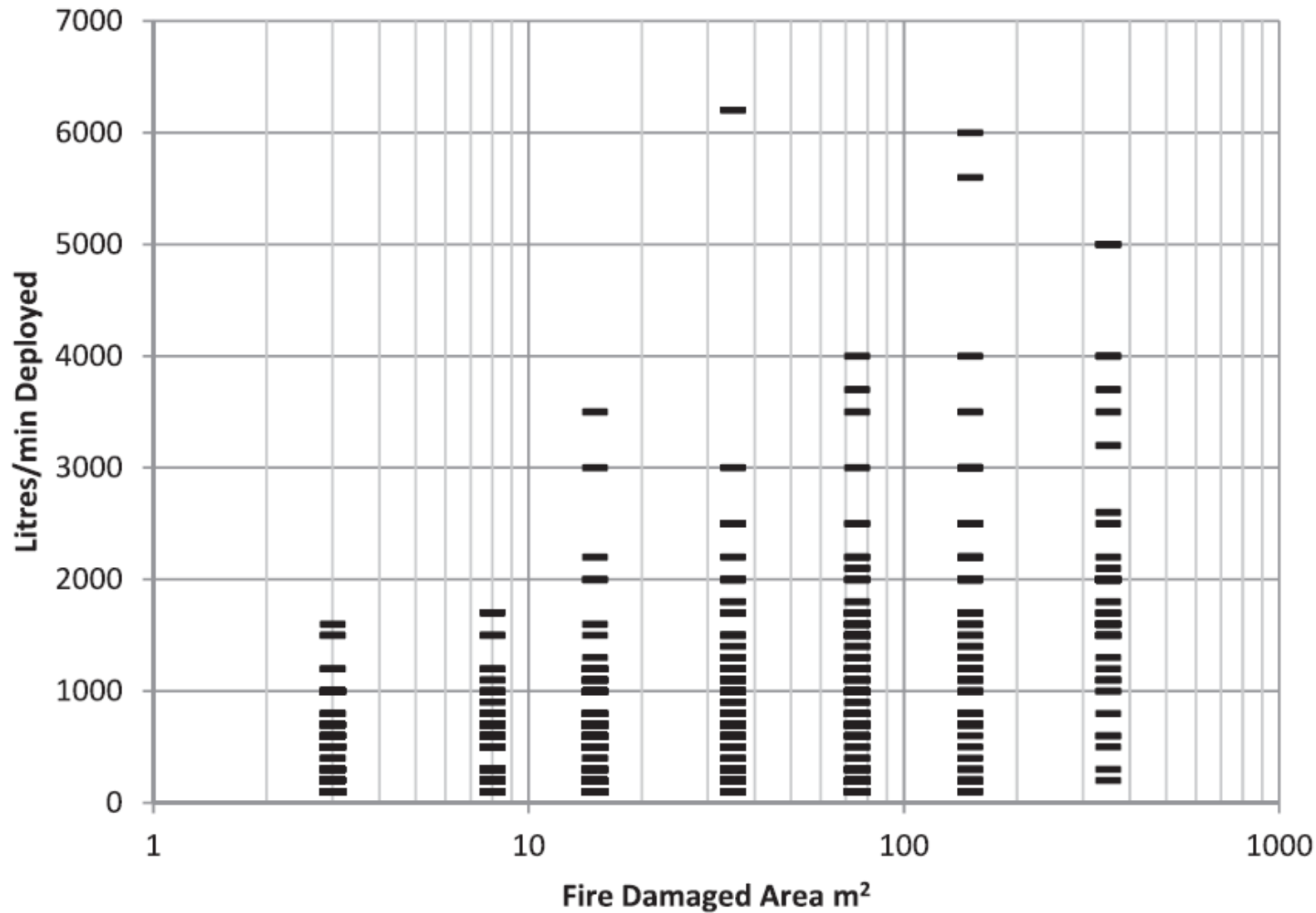
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**Fig. 3.** Metro FRS 4104 building fires 2009–2012: deployed fire-fighting flow-rates in Metro within the targeted zone  $< 500 \text{ m}^2 < 6000 \text{ LPM}$  where the vast majority of working fires in buildings occurred.

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**The County/Metro research into fire-fighting suppressive capacity and the impact on building fire damage at > 5000 UK building fires, 2009–2012**

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<sup>a</sup> Fire and Rescue Service, United Kingdom  
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**ABSTRACT**

This paper describes research by Cheltenham University into fire-fighting water flow-rates actually deployed to control and suppress >5000 building fires that occurred in two fire authority jurisdictions in the UK between 2009 and 2012. One fire service covered a large county suburban risk area with low to medium population density, while the other covered a large metropolitan region with heavily populated inner city areas included. Using data from the national fire reporting framework (UK Fire & Rescue Service National Incident Recording System), it was demonstrated that there are critical links between the amount of water used/required for effective fire-fighting in relation to the occupancy type, the density of the fire load, the minimum heat release from compartment fires and the extent of fire damage that may impact on the building and its contents.

Comparisons are made to similar research undertaken previously in the UK that estimated water carried in the service by fire engines (1800 l) was generally adequate in dealing with building fires on 80% of occasions. Interestingly, some fifty years later the County/Metro research reported in this paper demonstrates that just 14% of fires are currently dealt with using the 1800 l on-board water provision provided by a single fire response vehicle, although the scope of data representation may be different. A deployed flow rate between 5 and 12 LPM/m<sup>2</sup> per 100 m<sup>2</sup> of fire involvement was generally observed in the current study and the variation was mainly related to occupancy type.

An existing design methodology for fire-fighting water provision is then held in comparison to the County/Metro fire-cause data, demonstrating clear correlations with the extensive empirical research. © 2014 Elsevier Ltd. All rights reserved.

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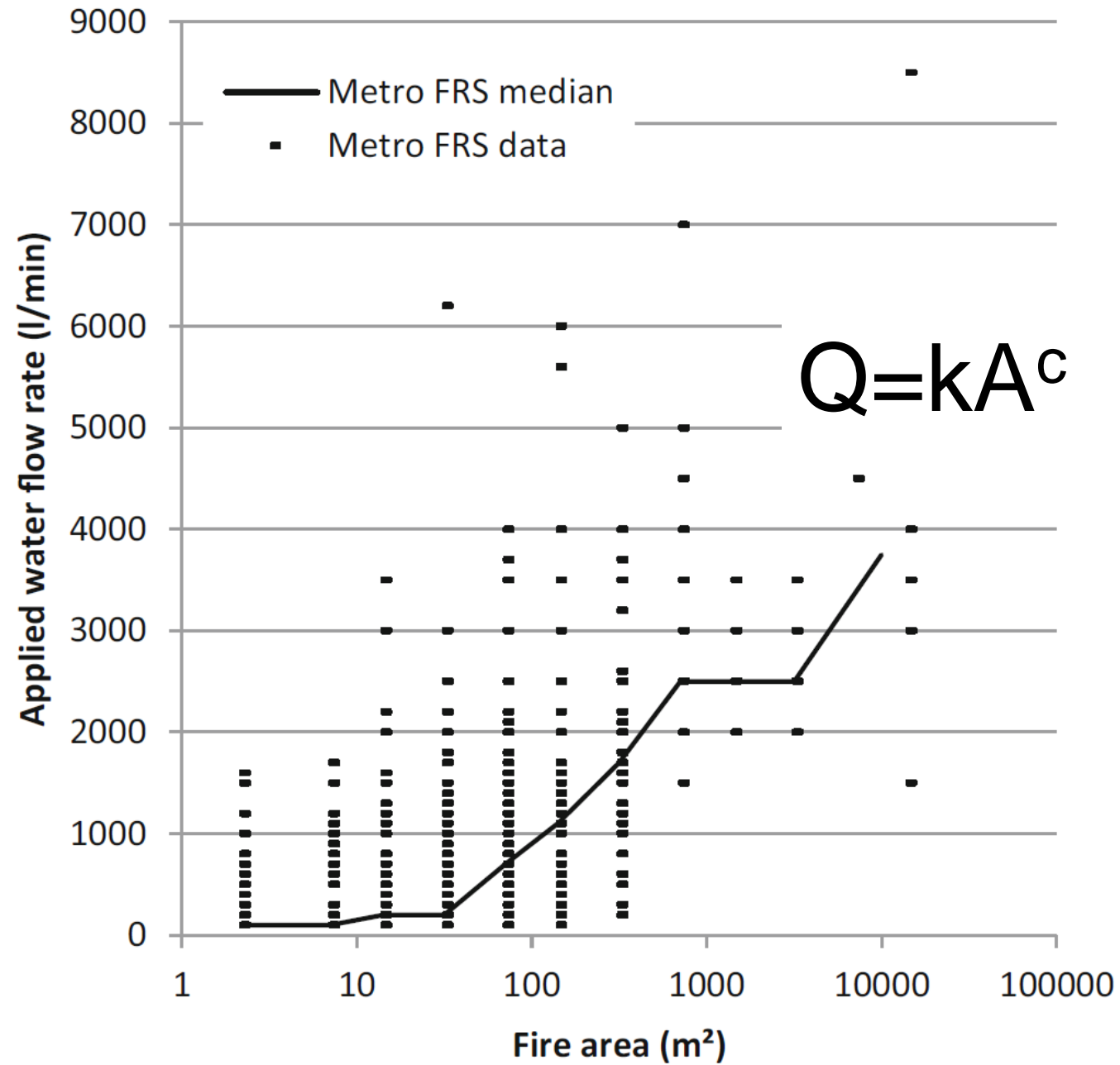
**1. Introduction**

The research compares the fire-fighting suppressive capacity of a County Fire & Rescue Service (FRS) with that of a Metropolitan FRS over a three year period 2009–2012. The data used have been extracted locally from the national Incident Recording System (IRS), a comprehensive national computerised database used by UK fire services to record all types of emergency incidents, including building fires. The research is specific to internal building fires, not including derelicts, exterior roof or chimney fires. The data have been filtered to those fires where an area of internal fire damage was recorded and water was deployed by hose-reel and/or main-line jet/nozzles. The data resulted in over 5000 'working' building fires (> 4000 Metro and > 1000 County). This represents the widest amount of data collated to date in the UK for analysing fire-fighting suppressive capacity. The direct comparison between two UK fire services is also unique.

The large amount of data provided in this research suggests any margin of error is minimised and the final output offers a more accurate representation of similar analytical methods used in previous research of such nature. Previous research in the UK has rarely looked at more than 400 building fires. The overriding objective of this research is aimed at optimisation of the service delivery to building fires from a fire service intervention perspective. In order to achieve this, an effective resource allocation of fire cover relies on a maximum fire-fighting water provision along with adequate firefighter access, both to the exterior and within a building, in line with sufficient fire-fighting facilities and fixed fire protection systems to support a safe and extended fire-fighting operation, for what is considered a 'reasonable' time period.

As an example, a fully involved fire load on an upper level open-plan office floor of 1400 m<sup>2</sup> might be expected to progressively burn for around 90 min. During this period firefighters may occupy the space in order to maintain an on-going fire-fighting

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### Three Different Fire Suppression Approaches Used by Fire and Rescue Services

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**Abstract.** This paper describes the relationship between the water flow rate applied by the Fire and Rescue Services (FRS) and the area of a fire; the limitations of the FRS in terms of water flow rate and the most effective use of firefighting water across a broad range of fire areas. The paper is based on five sets of data gained by the FRS at the fire scene, in total almost 6000 fires. It shows a fundamental difference in fighting a small fire compared to fighting a large one. It also shows that the relationship between applied water flow rate and fire area is not best described by a continuous power function. It distinguishes between three different approaches or modes of firefighting: a standard nozzle approach (fires up to 20–50 m<sup>2</sup>, depending on context), a perimeter approach (fires up to 200–500 m<sup>2</sup>, depending on context) and a maximum flow approach (fires larger than 200–500 m<sup>2</sup>, depending on context). The transition between the approaches varies between the five data sets and can be distinguished using the optimum flow density (5.4–6.0 l/m<sup>2</sup> min) or the water flow density giving the smallest total volume and the critical water flow density (3.5–4.0 l/m<sup>2</sup> min). The two transitions vary with the context; they are not physical constants (the numbers corresponds to the most recent studies of Metro and County FRS). The study validates the strategic considerations that attack is more demanding than containment, that one should ensure containment and then attack; and that the earlier response, the better result.

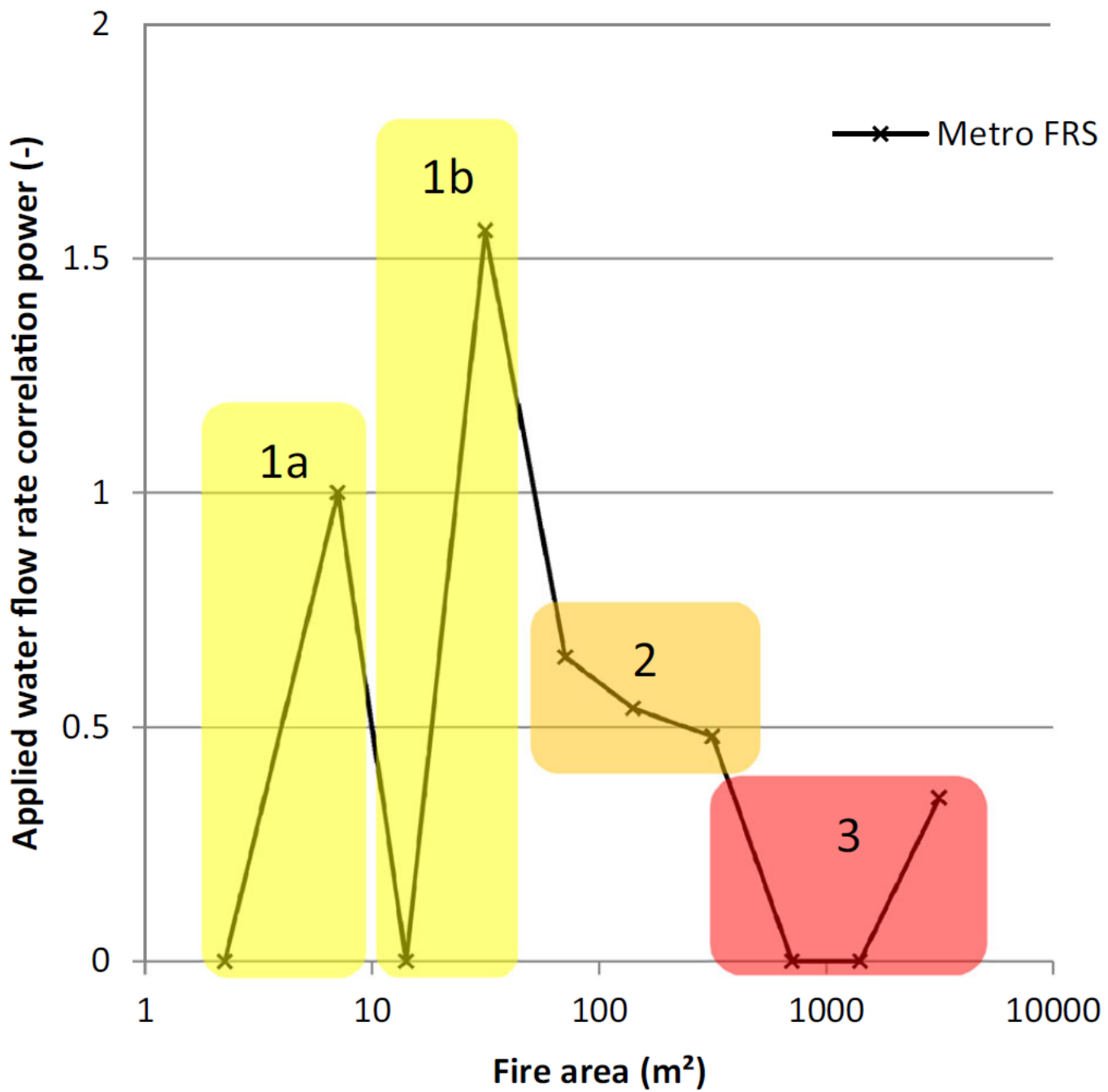
**Keywords:** Fire and Rescue Service, Fire suppression, Firefighting flow rate, Firefighting strategy, Water flow rate

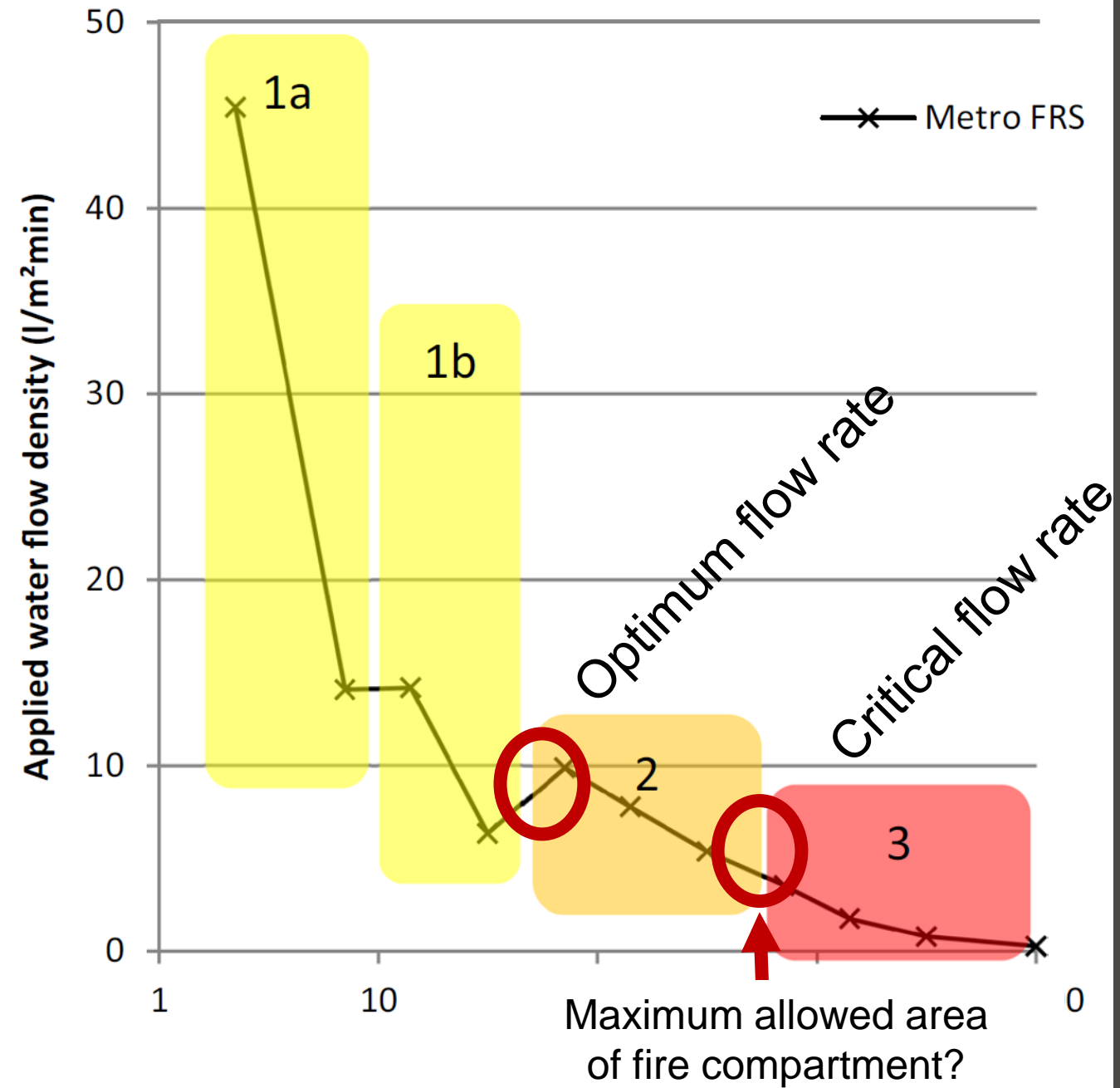
#### 1. Introduction

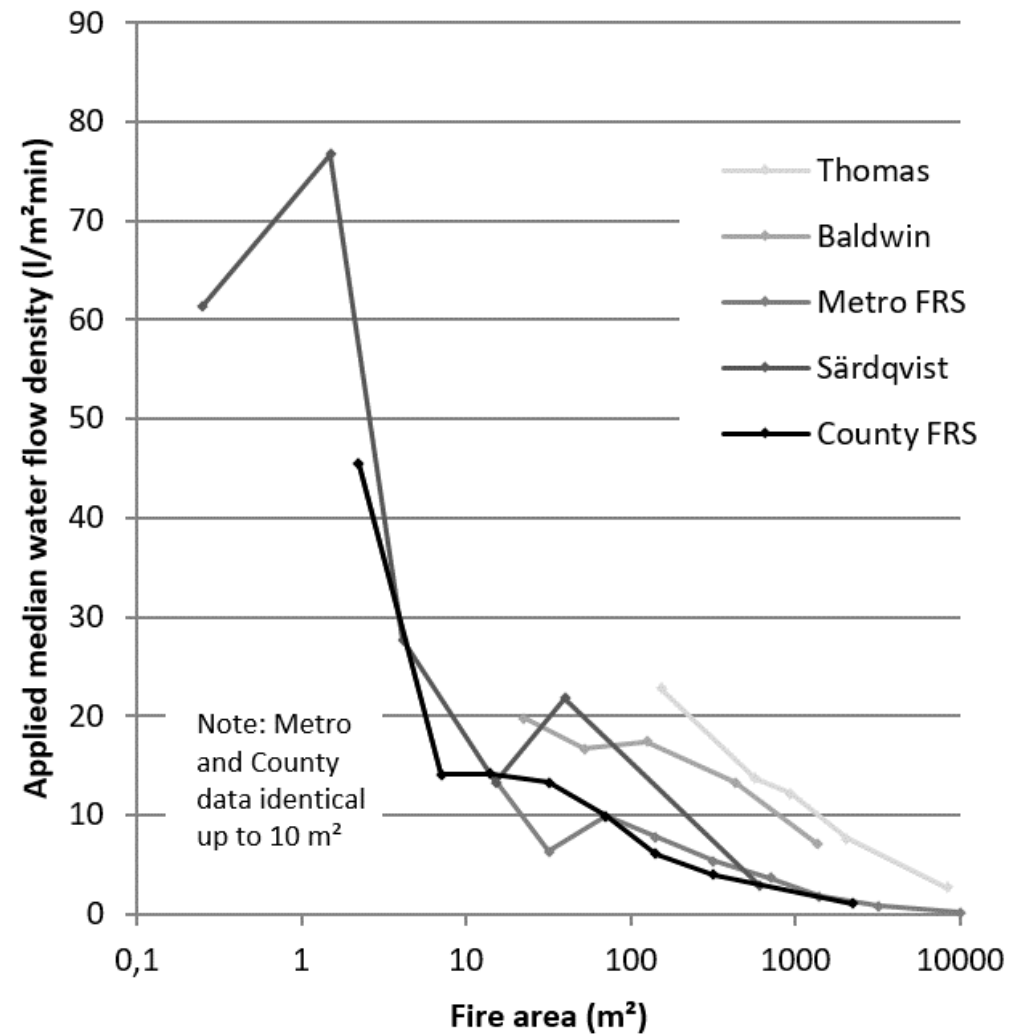
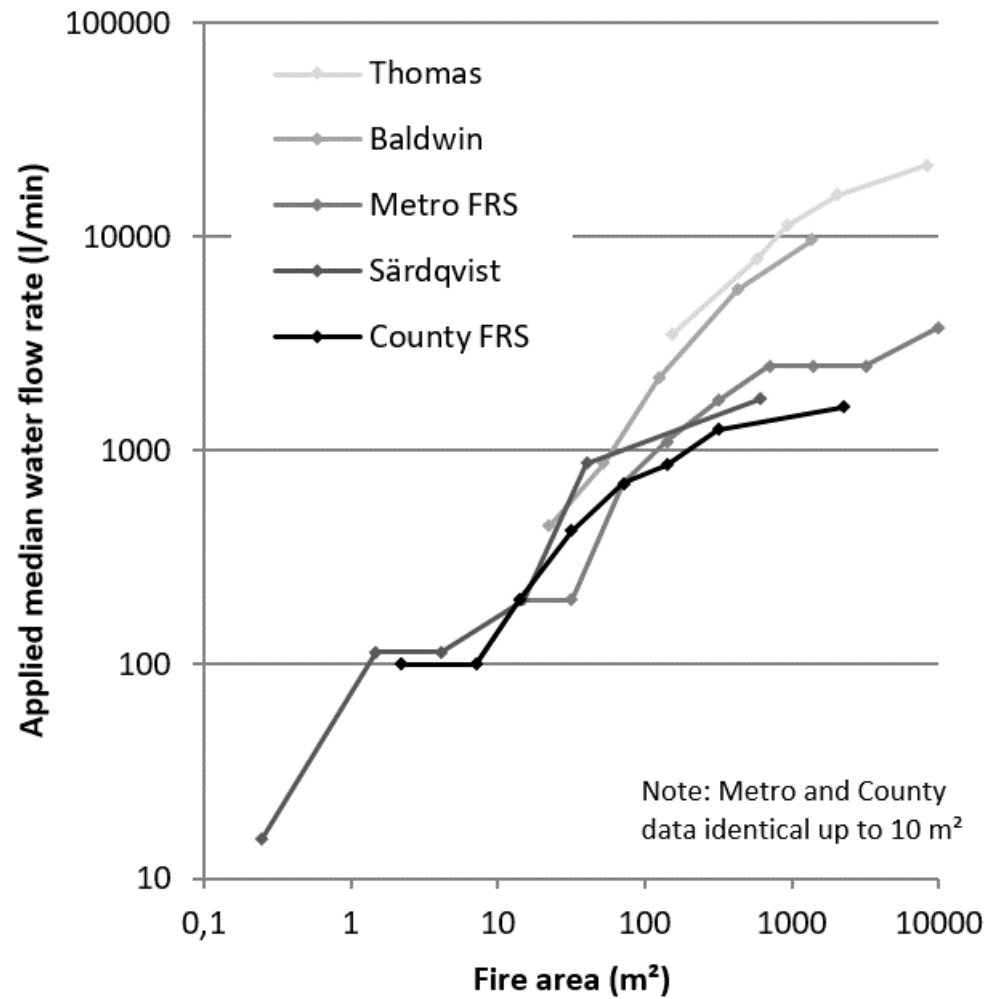
There is empirical knowledge saying that for the FRS attending to fires, exposure control has higher priority than to suppress the fire. At least as long as the fire has a potential to spread, e.g. in many wooden buildings. In most brick and concrete buildings, passive fire prevention measures solve the containment issue. Fredholm [1] formulates four basic rules or strategic considerations of priority: The first is that saving life goes before saving property. Secondly, that attack is more

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# 1: Standard nozzle approach



LP

115 l/min



HP

230 l/min



375 l/min



## 2: Perimeter approach



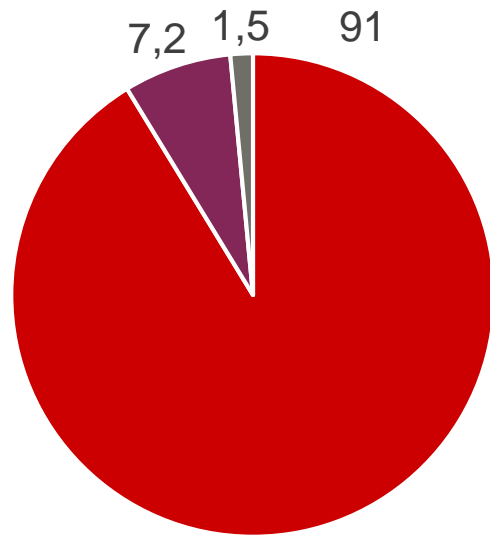


### 3: Maximum flow approach



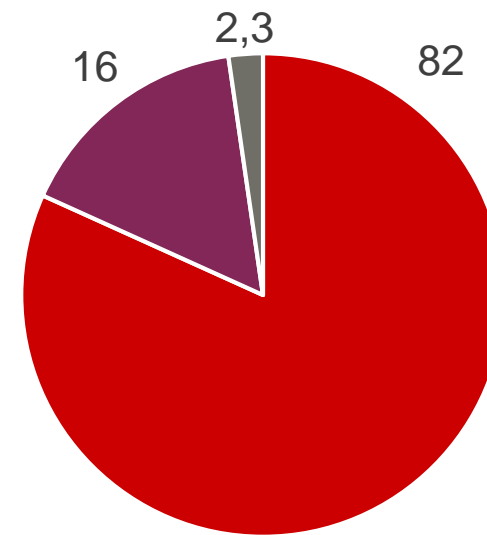
# Percentage of fires with different approach

Metro



■ Standard nozzle ■ Perimeter ■ Maximum flow

County



■ Standard nozzle ■ Perimeter ■ Maximum flow

# Upper limit for the approach

	Standard nozzle (m <sup>2</sup> )	Perimeter (m <sup>2</sup> )
<b>Metro</b>	50	500
<b>County</b>	20	200
<b>Thomas</b>	NA	750
<b>Baldwin</b>	50-100	500
<b>Särdqvist</b>	30	NA

# Three different modes of fire fighting:

Standard nozzle  
approach



Perimeter  
approach



Maximum flow  
approach

