Fire experiments with Ultra Surefire's UltraGuard water mist system for local application protection

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Protecting People, Property and the Planet

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Contents

1 Introduction

BRE Global was commissioned by Ultra Surefire Ltd (Ultra) to conduct a series of fire experiments with their 'UltraGuard' local application low pressure water mist system. The UltraGuard unit comprises a stand-alone self-contained water mist system and is shown in Figure 1. The UltraGuard was linked to two ceiling mounted detectors which activated the system.

The UltraGuard unit

Ceiling mounted optical detectors

Figure 1 – The UltraGuard unit

Ultra stated that the UltraGuard unit contained a 110 litre capacity water tank and pump (the capacity of the water tank was not verified by BRE Global). The UltraGuard required a connection to a mains 240 Volt electrical supply and the unit also contained a 'battery backup'; the performance of which did not form part of this investigation.

In addition, the system was also connected to the BRE Global pump and water supply for two experimental runs.

2 Description of the project

2.1 Experimental room

The room in which the fire experiments were carried out measured nominally 8 m by 4 m by 2.5 m high. There were two full height doorway openings at each end of the compartment, see Figure 2.

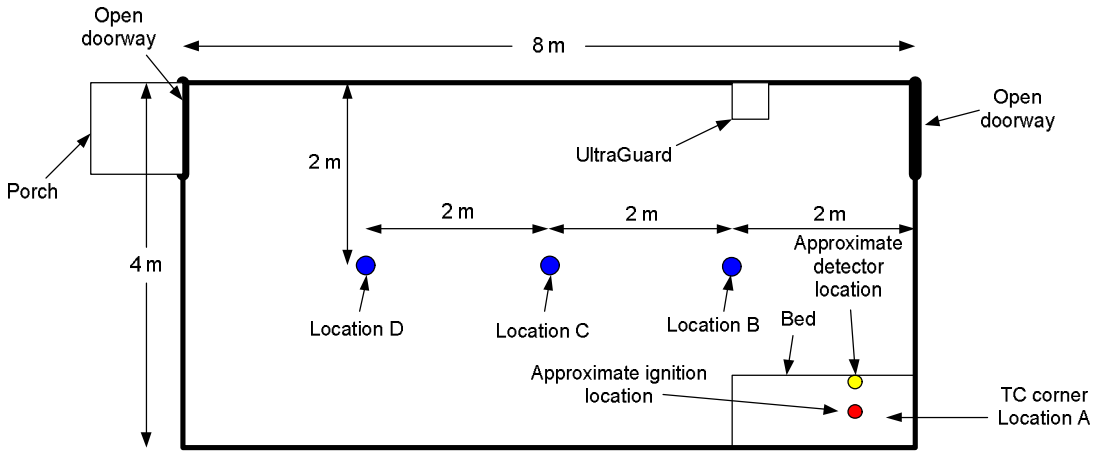


Figure 2 – Schematic plan view of experimental compartment

Instrumentation was added to the room to enable measurement of temperatures at various locations, as shown in Table 1. Stainless steel sheath 1.5 mm k-type thermocouples were used. A Graphtec GL800 data logger was used to record instrumentation data at a sample rate of 1 Hertz. In experiments in which the UltraGuard was connected to the BRE supply a Druck PMP 0 – 100 bar pressure transducer was used.

Location	Instrumentation
Ignition location	K-type thermocouple positioned ~100 mm above the point of ignition.
Location A	K-type thermocouples at 1.6 m and 2.43 m height
Location B	K-type thermocouples at 1.6 m and 2.43 m height
Location C	K-type thermocouples at 1.6 m and 2.43 m height
Location D	K-type thermocouples at 1.6 m and 2.43 m height
Porch	K-type thermocouple at 2.43 m height

Table 1 – Instrumentation positions

2.2 Fire scenario

The fire scenario for all the experiments included a single metal frame bed on which was placed a mattress, sheet, duvet, duvet cover and pillow. A folded newspaper was placed on the bed and ignited using a cigarette lighter flame, see Figure 3. For each experiment the used fuel loading (all items) were removed and replaced with new, dry items.

Bed arrangement

Ignited newspaper on bed

Figure 3 – Fire scenario

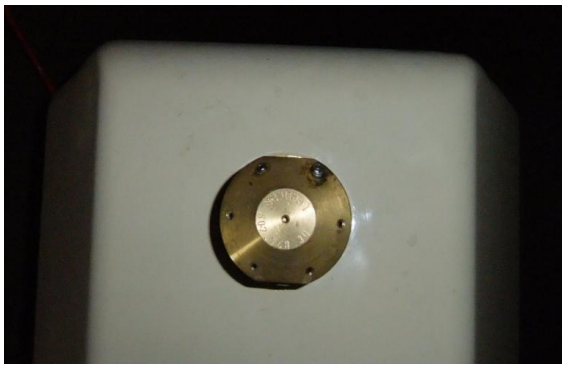
2.3 Water mist system nozzle and detector arrangements

For the experimental programme Ultra supplied two different nozzles for use with the UltraGuard unit. Ultra supplied BRE Global with the following information on the nozzles (this was not verified as part of this study):

- Nozzle A with a K-factor of 2.9
- Nozzle B with a K-factor of 3.9

Two new smoke detectors were supplied and installed by Ultra for each experiment. The smoke detectors were commercially available optical and 'multi-sensor' types. Datasheets provided by Ultra stated that these units were multi-sensor detectors containing an optical and thermal sensing element.

A photograph of the nozzles is included in Figure 4.



Nozzle A

Nozzle B

Figure 4 – UltraGuard nozzles used in the experiments

3 Findings

Four fire experiments were carried out on 17 January 2013 in BRE Global's Burn Hall laboratory. The experiments are described in the sections below.

3.1 Fire experiment 1

Table 2 details the experimental arrangement and findings.

Experiment set-up	**Details**
Fuel arrangement	Newspaper placed on the bed on top of the duvet cover. The newspaper was placed approximately 'inline' with the UltraGuard nozzle.
Ignition	A cigarette lighter flame was applied to the newspaper.
UltraGuard nozzle	Nozzle A.
UltraGuard position	0.95 m from open doorway, 400 mm away from wall and 1.87 m high (see Figure 6). The nozzle was approximately 3.3 m away (horizontally) from the fire location.
Detectors	(1) optical and (2) multi-sensor.
System activation	Multi-sensor detector activation and water mist operation 4 minutes and 14 seconds after ignition.
System discharge	Flow rate and pressure not measured. Discharge duration 12 minutes 17 seconds.
Water supply	Self-contained tank housed in the UltraGuard unit.
Experimental observations	The water mist spray directly impinged the fire location and the small fire was suppressed. At the time of water supply exhaustion the fire had been extinguished.

Table 2 – Fire experiment 1

A photograph showing the mist operation during experiment 1 is shown in Figure 5.

Figure 5 – UltraGuard unit operation during experiment 1

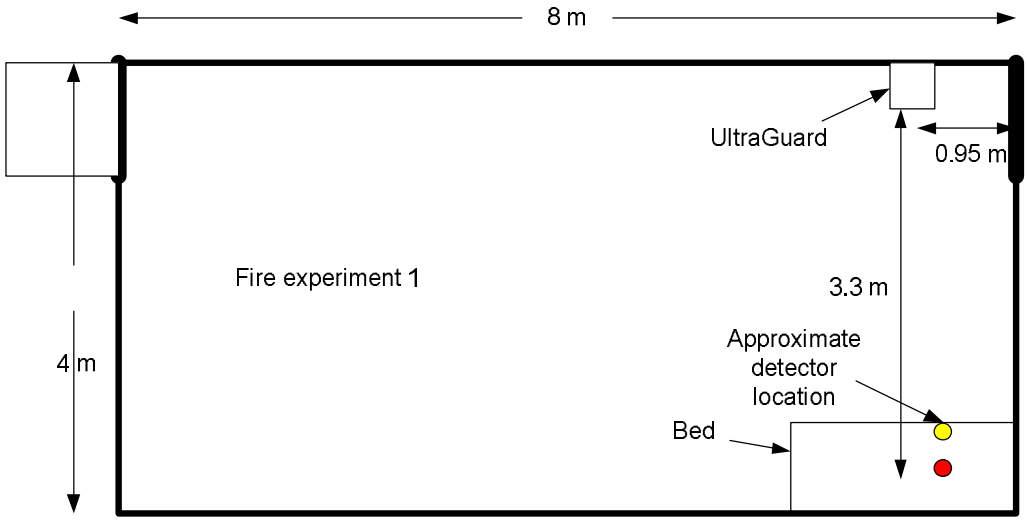


Figure 6 – UltraGuard unit position in relation to the fire location

Temperatures near the ignition location are shown in Figure 7. The temperature measured directly above the ignition location (blue line on the graph) was reduced on activation of the water mist system and remained close to ambient levels for the remainder of the experiment.

Temperatures in the experimental compartment are shown in Figure 8. Temperatures in the room remained close to ambient levels during the small experimental fire and water mist system discharge.

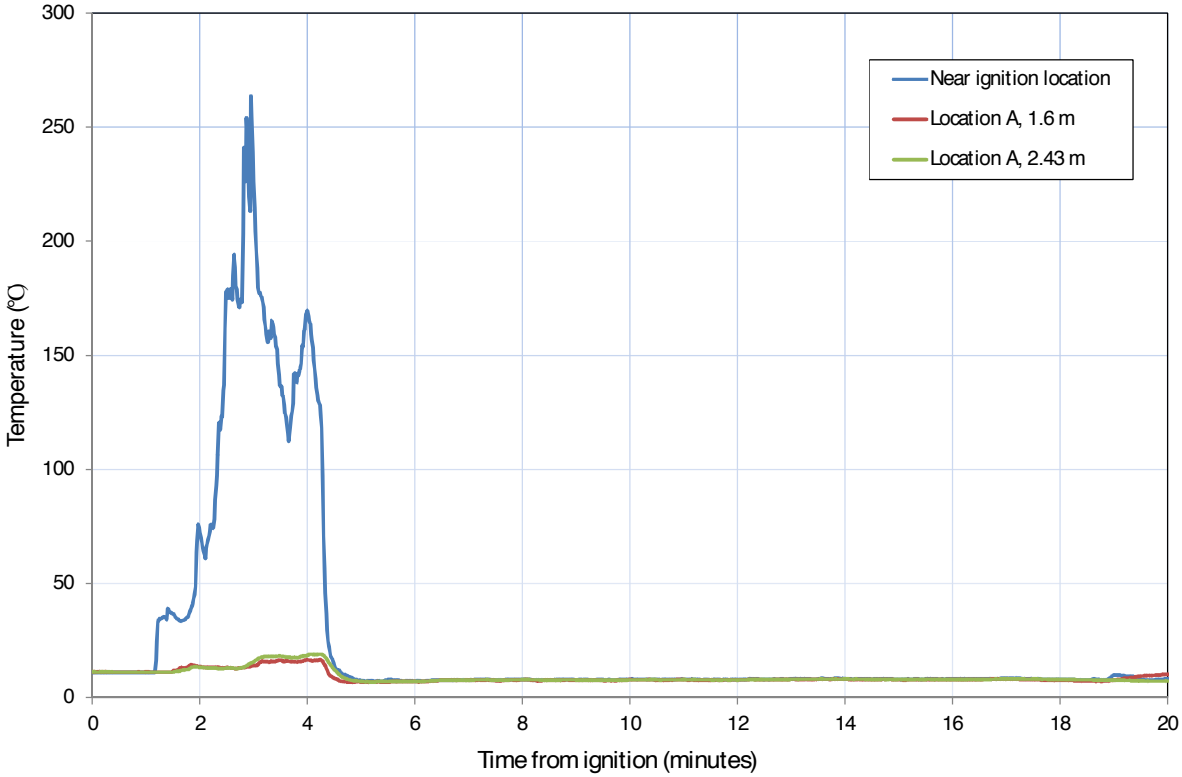


Figure 7 – Temperatures near the ignition location during fire experiment 1

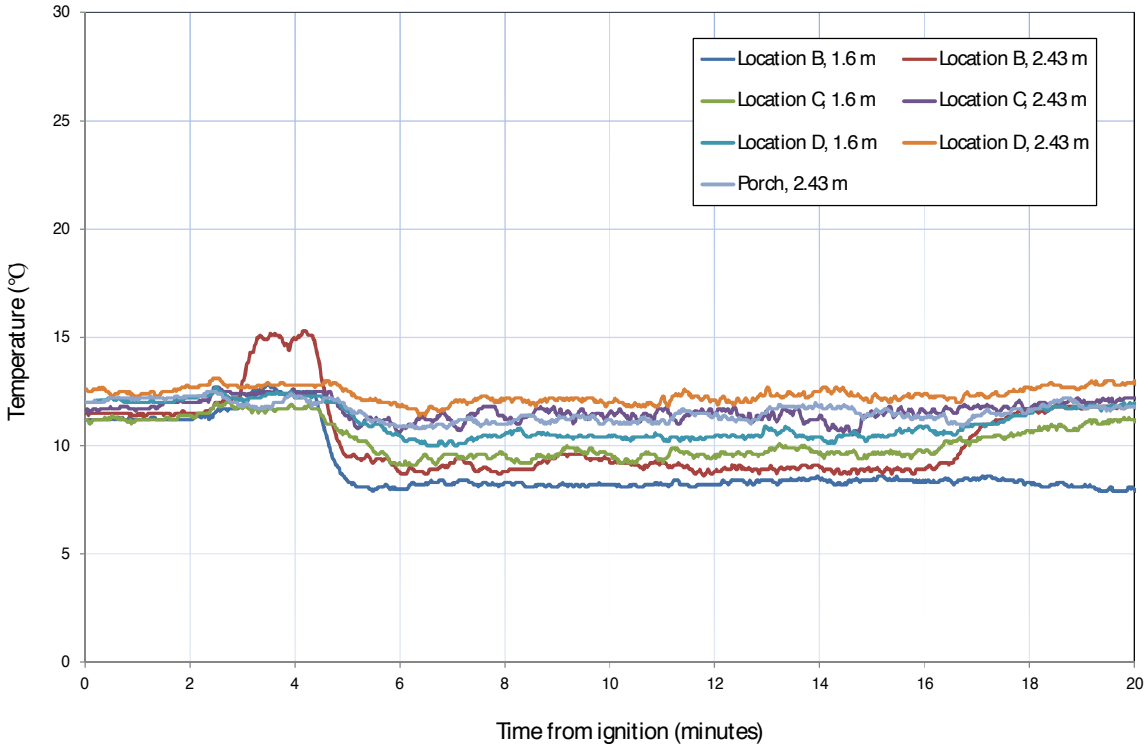


Figure 8 – Temperatures in the compartment during fire experiment 1

The water mist spray effectively suppressed and extinguished the small fire in the newspaper which had also spread to involve the duvet cover and duvet (see Figure 9).

Figure 9 – Fire damage after experiment 1

3.2 Fire experiment 2

Table 3 details the experimental arrangement and findings.

Experiment set-up	Details
Fuel arrangement	Newspaper placed on the bed on top of the duvet cover. The newspaper was placed 'offset' from the UltraGuard unit nozzle by approximately 1.5 m (horizontally).
Ignition	A cigarette lighter flame was applied to the newspaper.
UltraGuard nozzle	Nozzle A.
UltraGuard position	2 m from open doorway, 400 mm away from wall and 1.87 m high (see Figure 10).
Detectors	(1) optical and (2) multi-sensor.
System activation	Multi-sensor detector activation and water mist operation 3 minutes and 15 seconds after ignition.
System discharge	Flow rate and pressure not measured. Discharge duration ~9 minutes (manually terminated).
Water supply	Self-contained tank in the UltraGuard unit.
Experimental observations	The water mist spray did not directly impinge the fire location and flaming continued at the fire location during the mist operation. The fire was manually extinguished after ~11 minutes 40 seconds.

Table 3 – Fire experiment 2

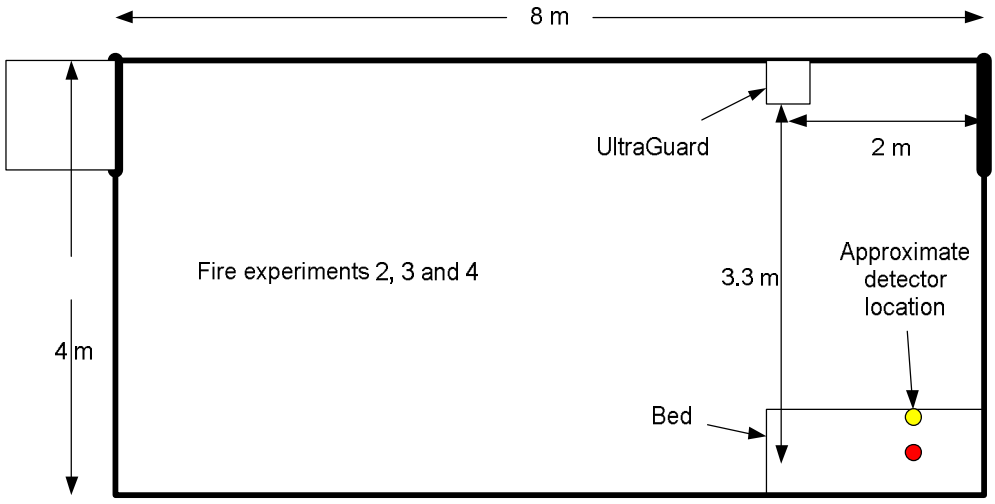


Figure 10 – UltraGuard unit position in relation to the fire location

Temperatures near the ignition location are shown in Figure 11.

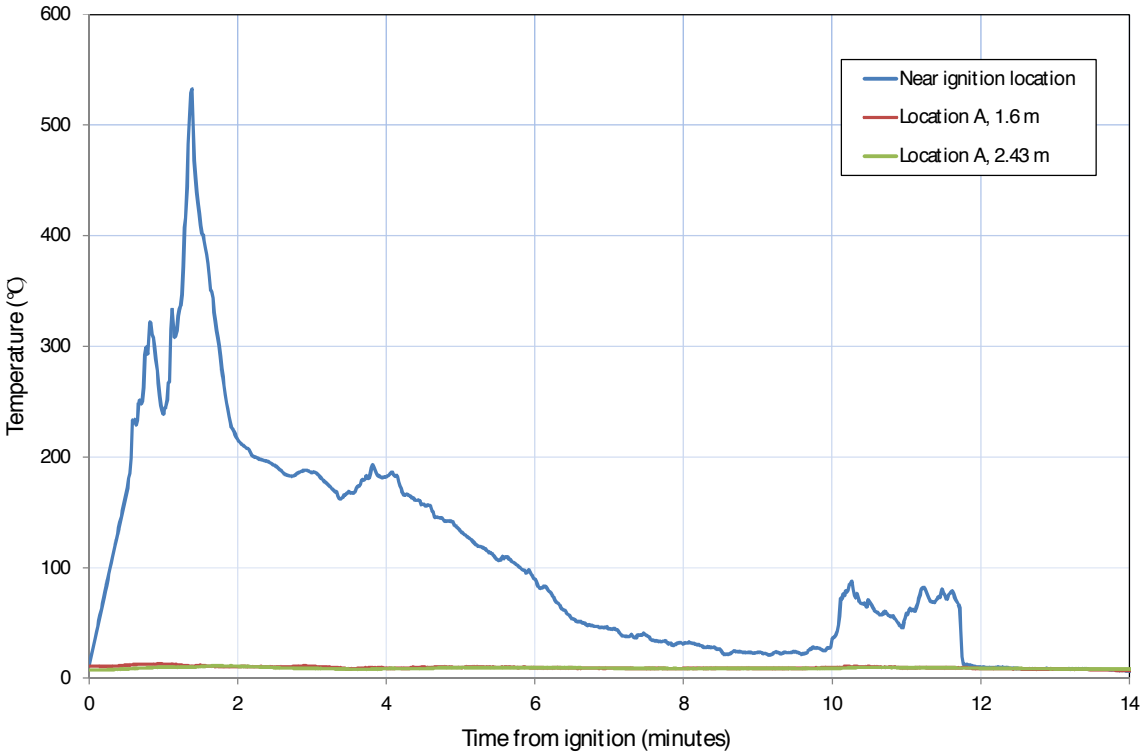


Figure 11 – Temperatures near the ignition location during fire experiment 2

The flaming continued at the fire location during water mist discharge (see Figure 12).

Figure 12 – Fire during experiment 2

3.3 Fire experiment 3

Table 4 details the experimental arrangement and findings.

Experiment set-up	Details
Fuel arrangement	Newspaper placed on the bed on top of the duvet cover. The newspaper was placed 'offset' from the UltraGuard unit nozzle by approximately 1.5 m (horizontally).
Ignition	A cigarette lighter flame was applied to the newspaper.
UltraGuard nozzle	Nozzle B.
UltraGuard position	2 m from open doorway, 400 mm away from wall and 1.87 m high (see Figure 10).
Detectors	(1) optical and (2) multi-sensor.
System activation	Multi-sensor detector activation and water mist operation 2 minutes and 38 seconds after ignition.
System discharge	Discharge duration ~10 minutes.
Water supply	System supply connected to BRE water supply and pump (the pressure in the water supply was measured).
Experimental observations	A low coverage of water mist spray directly impinged the fire location and the small fire was suppressed. At the time of water supply termination the fire had been extinguished.

Table 4 – Fire experiment 3

Temperatures near the ignition location are shown in Figure 14. Pressure in the water supply pipe is shown in Figure 15. Photographs showing the fire damage from experiment 3 are shown in Figure 13.

Fire damage to the newspaper

Showing the duvet with newspaper removed

Figure 13 – Fire damage from experiment 3

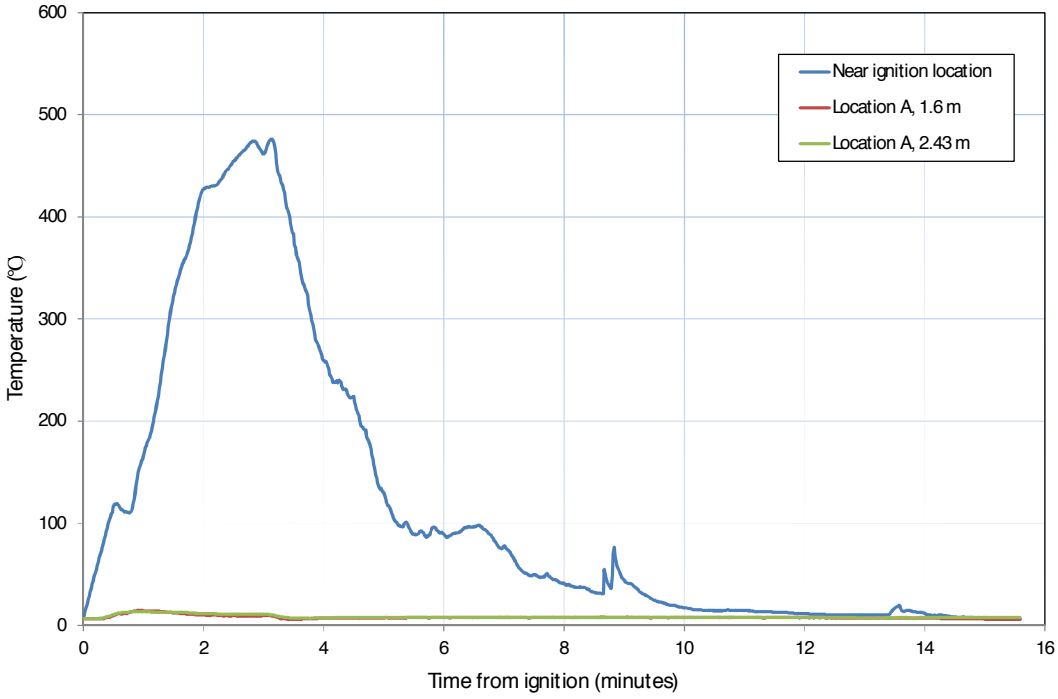


Figure 14 – Temperatures near the ignition location during fire experiment 3

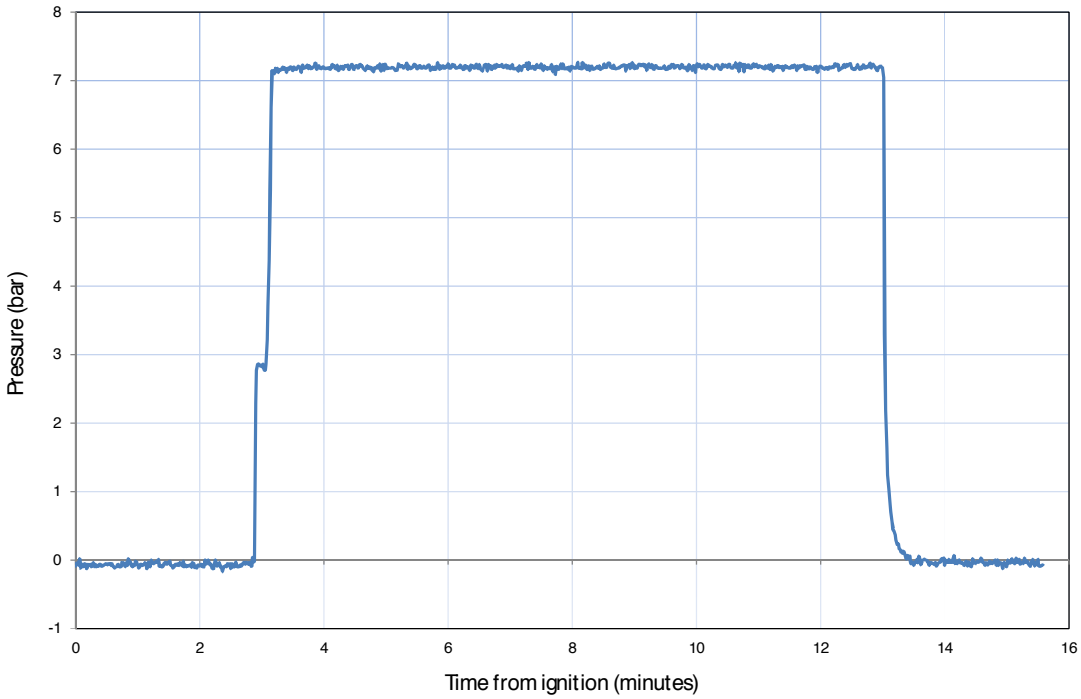
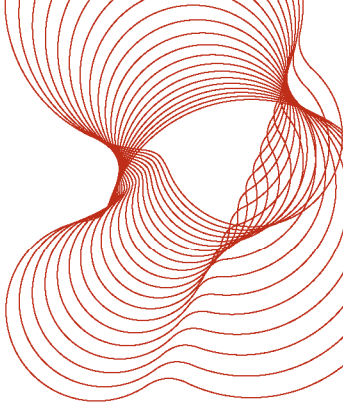


Figure 15 – Pressure in the water supply pipe during fire experiment 3



3.4 Fire experiment 4

Table 5 details the experimental arrangement and findings.

Experiment set-up	Details
Fuel arrangement	Newspaper placed on the bed on top of the duvet cover. At the start of the experiment, the newspaper was placed 'offset' from the UltraGuard unit nozzle by approximately 1.5 m (horizontally).
Ignition	A cigarette lighter flame was applied to the newspaper.
UltraGuard nozzle	Nozzle A.
UltraGuard position	2 m from open doorway, 400 mm away from wall and 1.87 m high (see Figure 10).
Detectors	(1) optical and (2) multi-sensor.
System activation	Multi-sensor detector activation and water mist operation 2 minutes and 28 seconds after ignition.
System discharge	Discharge duration ~6 minutes.
Water supply	System supply connected to BRE water supply (the system pressure was measured).
Experimental observations	Upon operation of the water spray it was observed that mist droplets were not reaching the fire location and flaming continued. Shortly after 4 minutes from ignition the bed (and fire position) was moved into the direct spray from the nozzle and suppression achieved.

Table 5 – Fire experiment 4

Temperatures measured near the ignition location are shown in Figure 16.

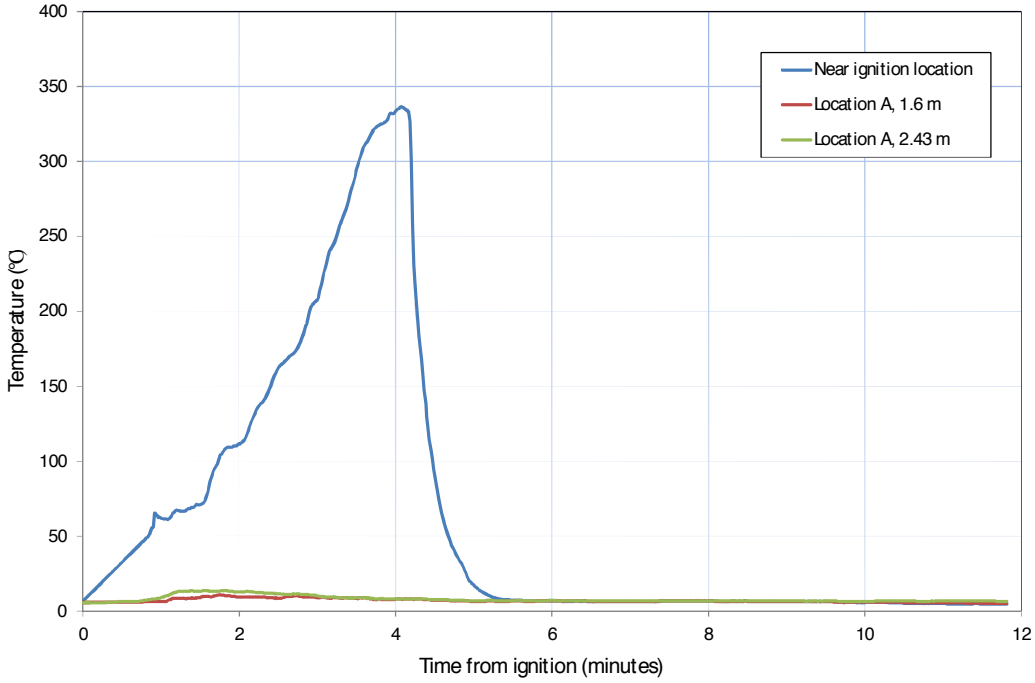


Figure 16 – Temperatures near the ignition location during fire experiment 4

The pressure in the water supply pipe to the nozzle is shown in Figure 17.

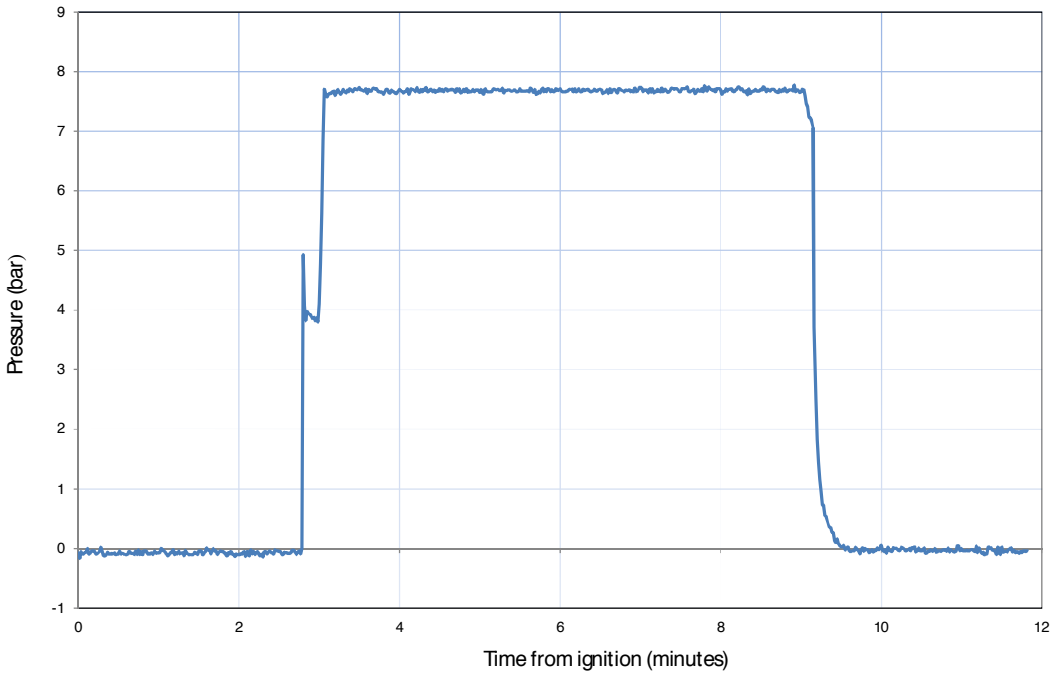
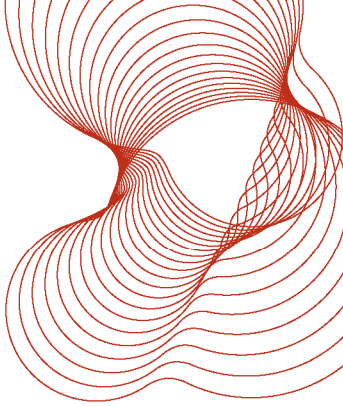


Figure 17 – Pressure in the water supply pipe during fire experiment 4



4 Summary

BRE Global carried out a series of four fire experiments with the UltraGuard low pressure water mist system fitted with a fire detection system to activate the systems, as described in this report.

The experimental programme considered:

- Two nozzle designs;
- Two water delivery systems (one self-contained and the other connected to the BRE Global external pump and water supply system) and;
- Two configurations; direct and indirect fire source locations (i.e. within or beyond the water mist discharge impingement area).

In all cases the fire detection system activated and the water mist system operated.

In the experiments where the water mist nozzles were located in-line with the fire source (or within the area of water mist impingement):

- Experimental Fire 1 – Nozzle A, self contained pump and supply, and;
- Experimental Fire 3 – Nozzle B, external BRE Global pump and water supply;

The experimental fires were extinguished.

Where the fire source was not in-line with the nozzles (or outside the area of water mist impingement):

- Experimental Fire 2 – a repeat of Run 1 but with the fire source offset from the nozzle; intervention was required to extinguish the fire.
- Experimental Fire 4 – Nozzle A and the external BRE Global pump and water supplied. In this case the fire source was moved during the experiment to improve the suppression performance of the system.

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