BLUERAD LTD

www.bluerad.co.uk

Title: Report on the BLUEPROOF Demonstration at Ollerton Fire Training Center Nottinghamshire

Date: 16th January 2015

Report No. 3/8/MPR/PRE/BR/2

Bluerad Ltd
17, Cavendish Square
London
W1G 0PG

Buys Time, Saves Lives

Prepared by: D.D.Atkinson
Technical Director

Tel: 020 7788 7774

Authorised by: D.D.Atkinson
Technical Director

Table of Contents

1. Background

Bluerad Limited have a product “Blueproof” – an innovative fire suppressant device which attaches to domestic radiators for which there is a worldwide patent.
The device is not intended to extinguish or control a fire but is intended to slow the development of a fire in order to provide additional time for building occupants to make their way to a place of safety.

The Blueproof device is unlike any other conventional fire extinguishing or fire suppression system. It is a fixed system (unlike a portable fire extinguisher) but its location within a room, its mode of operation, and its intended water delivery pattern make it unlike other fixed systems such as sprinklers or water mist.

A live burn demonstration of Blueproof took place at the Ollerton Fire Training Centre on Tuesday the 25th of November 2014 to display the attributes of the device.

A first burn to provide a Bench Mark (Control) took place in the morning. The demonstration with Blueproof took place in the early afternoon.

It is important to note that this was a demonstration and cannot be compared with the controlled laboratory experiments although the results compare favorably.

2. Purpose

The purpose of the demonstration was to display the effects on temperature and conditions throughout a building and display the actual operation and discharge spray pattern of Blueproof.

During experimental work at BRE a single compartment burn chamber had been employed. The effect of temperature changes throughout a building was not studied. This aspect is of particular relevance to stairwells and upper floors. It is of major importance to the Fire and Rescue Services during Emergency Escape and Response operations to recognise the benefits of rapid targeted suppression.

The vent gases in the laboratory were observed to be lukewarm and saturated leaving the burn chamber. Could the same effects be demonstrated in the stairwell and on the upper floor during the Ollerton demonstration?

Would Blueproof suppress the fire in a ventilated room? In the laboratory the burn chamber had been enclosed with minimum ventilation. The connecting door to the stairwell would be fully open during the demonstration.

3. Results.

3.1 Fire Room Ollerton

The door from the fire room to the stairs fully open

Burn Pallets	Temperature C
Control	414*
Demonstration	290
Temperature drop	124

3.2 Laboratory Burn Chamber for comparison purposes only.

The door to the chamber closed

Burn Crib	Temperature C
Control	350
Experiment 1	50
Temperature drop	300

Temperatures recorded on 2 thermocouples set 1.5 m from the floor at each end of the fire burn room set within the wall. in the laboratory the thermocouple was set 1m from the floor.

* During the Control the temperature exceeded the range of the recording system limit of 350 C. For reference, using previously recorded burn data from six pallets the temperature would have peaked in excess of 400 C. Ref: Nottingham Fire authority.

The demonstration results show a temperature fall in excess of 100 C at 1.5m clearly displaying that the fire was under suppression and this is supported by thermal imaging footage taken within the fire room.

3.3 Stair Well

Burn	Temperature C
Reference	108
Demonstration	98
Temperature drop	10

The temperature was recorded on a thermocouple set at 1 m from the floor at the top of the stairs within the wall.

3.4 Upper Room

The door to the upper room was open.

Burn	Temperature C
Reference	105
Demonstration	90
Temperature drop	15

The temperature was recorded on a thermocouple set at 1m from the floor on the wall at the far end of the room. The results compares favorably with reported results. Ref: Governors Island [1]. Where a temperature drop from 107 C to 88 C was recorded in the open upper bedroom during full scale house fire experiments.

In comparison between Ollerton with the door open and the laboratory with the door closed a temperature reduction with the door closed is far greater.

A temperature fall of 10 C can be the difference between life and death to a trapped or incapacitated person in a house fire.

[1]. Fire Behaviour and Tactical Considerations Aug 23rd 2013 IAFTV NIST UL

4. Discussion

Once Blueproof activated the burning pallet surface was sprayed with water delaying the pyrolysis, (decay of the pallet due to high temperature exposure) and this is reflected in graph 2.
The temperature drop proves the suppression of the fire occurred, delaying and reducing the burning. It also proves that Blueproof will effectively delay the growth of the fire in a room even with the door open and fully ventilated reducing the stairwell and the upper room temperatures.

During the full scale experiment with flame impingement at BRE [2] the device activated in all directions off five facets, it targeted the flames. However the sequence and operation had not been demonstrated.

What was proved at Ollerton using thermal imaging is that the jets form in response to the flame movement and temperature rise :-

- the first jet held back the spread.
- as the fire climbed the second jet hit the ceiling penetrating the boundary layer of the smoke and scrubbing commenced.
- the third and fourth jets responded to movement of the fire to the right and left. The device automatically responded to the fires growth and movement.

Blueproof with 5
Jets formed.

Thermal imaging displayed that the discharge from the device directly onto the ceiling had penetrated the boundary layer of the smoke and was scrubbing out the carbon particles. The smoke layer changed colour from black to white.
The temperature fall at the wall was over 100° and the temperature did not exceed 300° throughout the demonstration.

A temperature fall to 50° was achieved in the laboratory with the door closed. The ceiling temperature had also risen to around 400° and dropped by 200°. This proves that if the door is closed then by suppression a higher temperature fall also occurs within the fire area.

The maximum recorded temperature at 1.5 m in the room using six pallets was 414 on the 20th November using a different range setting on the instrumentation. Ref: Nottm Fire Authority. A temperature of 350 C was recorded on the day until the instrumentation went out of range. A peak temperature of between 414 and 450 C is usually observed in the fire room. In the laboratory fire test chamber 330 C had been recorded at 1 m using a single crib.

Although pallets were used in the demonstration the heat release rate and temperature profiles compare favorably with the crib used in the laboratory.

Conclusions and Recommendations

The results of the demonstration compare favorably with the results achieved in the laboratory. However whereas the device failed to activate during experiment 3 in the laboratory it was placed in a similar position during the demonstration. Not only did it activate but it suppressed the fire with the door to the burn area fully open. The thermal currents and temperature profiles were not interrupted during the course of the demonstration. Smoke was scrubbed of particles and temperatures fell throughout the building.

Flash over did not occur when the outer door was opened to display the spray pattern and oxygen allowed to enter. This is shown on graph 2 by the temperature spike.

Further experiments are advised with furniture sourced from the UK market and full scale house burns undertaken to establish a set of data that will provide a reference for researchers.

5. Method.

Temperature measurements were recorded at the control room during the burn.
This was accomplished by capturing the control panel display sequence on video.
The Control panel was filmed throughout.

6. Ignition.

During the reference and demonstration the pallets were ignited at the same position using newspaper as kindling from a gas propane flame.

Ollerton spray patterns

Prior test pattern

7. Water Pressure and supply

The water pressure was 2.5 bar Ref: Seven Trent .
The water supply was via a flexible hose connected to a length of 15 mm copper tube running to the radiator and secured by jubilee clips. The back pressure on the mains supply rising against the non-return valve of the outlet supply.

8.Building Temperature

It is important to note that as the Control burn took place shortly before the demonstration the fabric of the building was at a raised temperature. The outside temperature was 0 C and wind movement was negligible.
The building was forcibly ventilated prior to the demonstration to cool it down to the same temperature used during the control. The walls still retained residual heat so results were actually even better than recorded although the extent cannot be accurately determined.

9. Position of Blueproof

Blueproof was connected to the top of the radiator and placed farthest from the ignition point to allow the fire to spread along the upper surface. This was

also positioned in a similar position to laboratory experiment 3 where human error had led to activation failure. The radiator was placed adjacent to the pallets to allow observation of the spray pattern when the outer door was opened.

The device was placed within the fire room as recommended by ISO Draft Guidance TC 021/SC 05 N634 Dated 14-06-2013 Fire Protection — Automatic Sprinkler Systems — Part 13:
Requirements and test methods for extended coverage sprinklers.

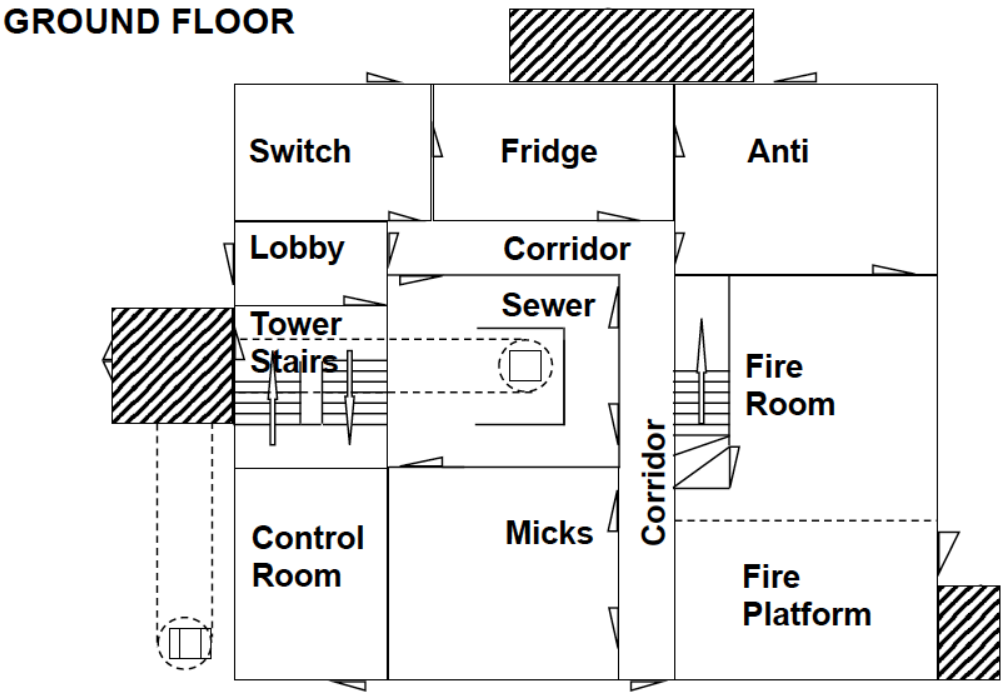
This for a side-wall mounted sprinkler head.
However the heat responsive element was placed at 270 mm above the fuel source whereas the guidance calls for it to be placed at 150 mm.

Blueproof would have activated faster in closer proximity.
The radiator was also positioned adjacent to the pallets to allow observation of the fire scenario on opening of the outer door.

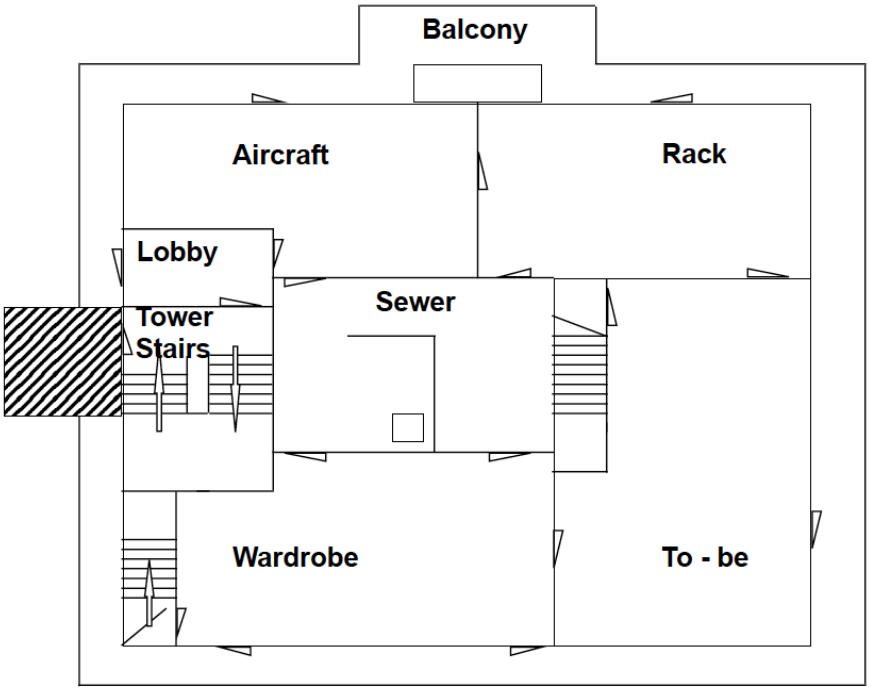
10. Room Layout

The fire room size 6m x 3m x 2.2 m with a volume of 39.6 m^3
The doors were made of steel H60 construction.
Walls, ceiling and floor made from heat-resistant concrete.
(heat-resistant concrete absorbs heat more slowly as it has twice the heat capacity than that of Portland cement concrete)

(Laboratory Burn Chamber size was 3.6 x 3.6 x 2 m with a volume of 26 m^3)



FIRST FLOOR



11. Control Burn.

Six pallets were placed on the fire platform stacked to simulate furniture. The position of the pallets was noted and marked to ensure the same positioning for the second burn.

A record was taken of the time the ignition started.
Temperature measurements during the burn were recorded at the control room on video.
The water pressure, wind speed, moisture content of the air and ambient air temperature were recorded.

12. Second Burn with Blueproof fitted

12.1 Demonstration Procedure

1. A flexible hose was connected to the tap on the wall opposite the Anti Room entrance.
The hose was strung out along the floor through the Anti Room into the Fire room and connected to a copper pipe and secured by Jubilee clips that extended to the inlet of the radiator. (sic Ante Room)

2. Water was transported across the roadway through the Anti Room into the Fire room by the flexible hose at a pressure of 2.5 bar. Typical for water pressure in a domestic environment. (sic Ante Room)

3. The radiator was placed, free standing and leveled, next to the pallets.

4. Blueproof was visibly inspected for leaks and defects.

5. The water was flowed to the radiator until it reached the bottom thread of the radiator vent plug housing. The flow of water was stopped and Blueproof fitted. The water was allowed to flow and pressurise the radiator. Blueproof was tightened and checked for leakage. This leak test was undertaken by observation.

6. Six pallets were stacked to within 270 mm below the Blueproof device. As per ISO TC 021 05 N634 for side-wall mounted sprinkler heads but in excess of the 150 mm required for under ISO. This was due to time limitations to position the equipment on the day.

Temperature measurements were recorded from the thermocouples located at 1.5 m above the floor on the wall at either end of the fire room. At 1m on the top of the stairwell and at 1.5 m at the far end of the upper room.

7. The control panel monitors were video recorded (the time and date displayed on the display panel. This ensured a record of results from the demonstration was maintained)

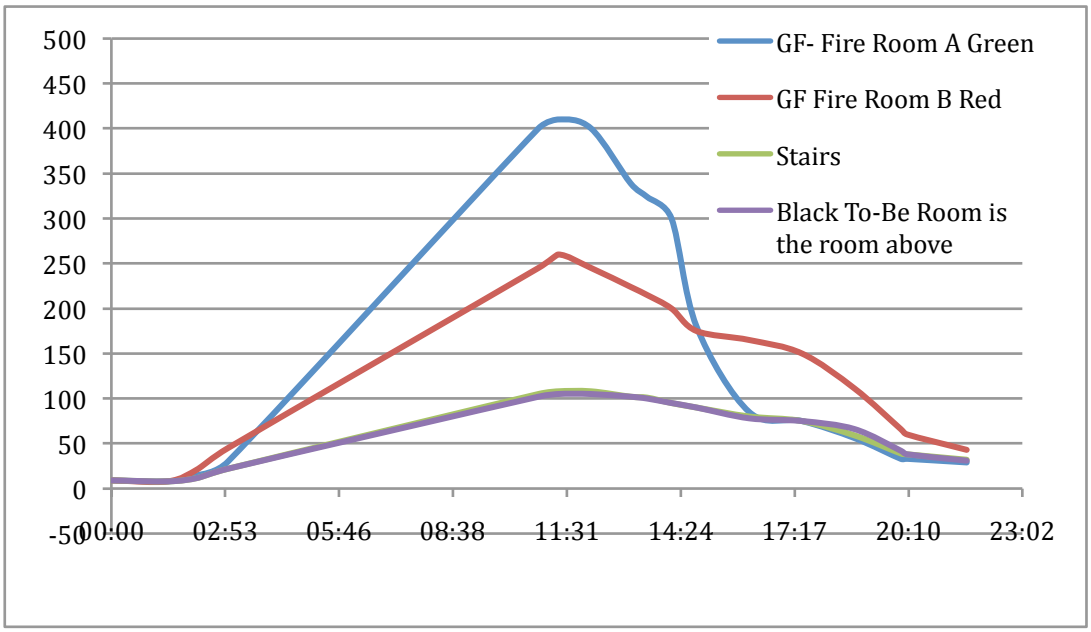
8. The temperature rise was recorded at the control room panel.
The gas concentration levels were also observed.

All instrumentation was checked to ensure it fell within the calibration expiry date.

The position of the wooden pallets was arranged to enable them to be sited in accordance and with respect to the **ISO TC 021 05 N634 Dated 14 06 2013.** Fire Protection — Automatic Sprinkler Systems — Part 13:
Requirements and test methods for extended coverage sprinklers

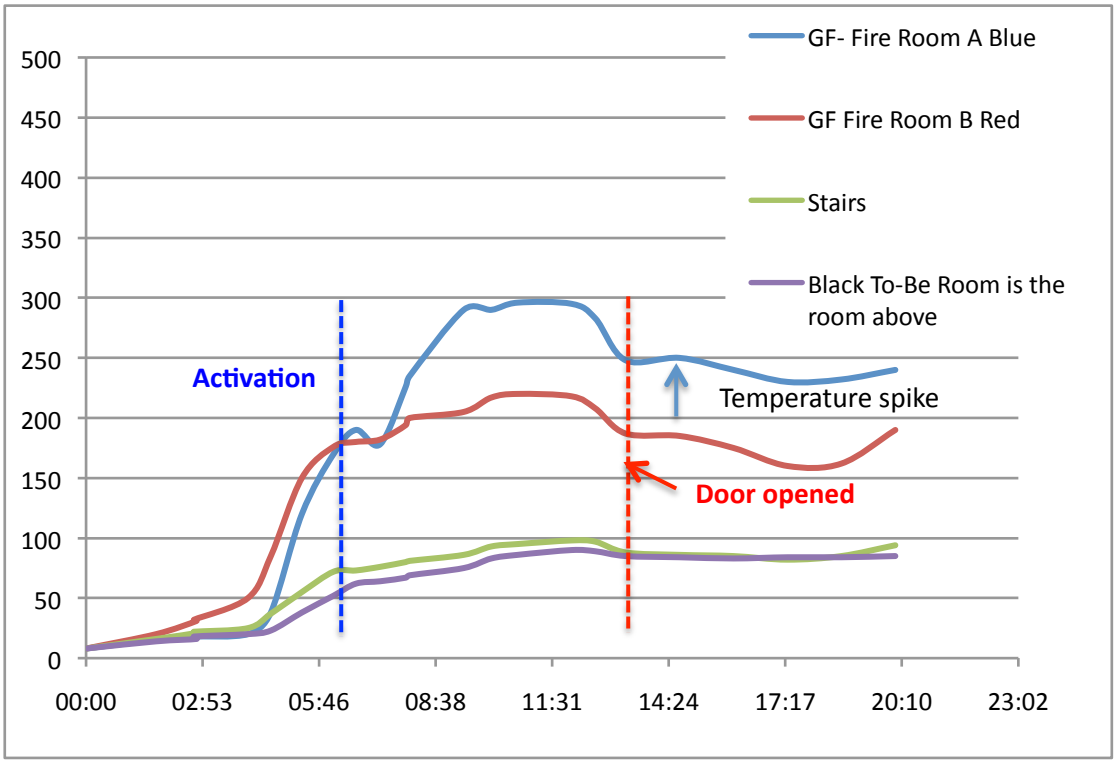
Ref: ISO TC 021 05 N634 Dated 14 06 2013. Section 7.20.4 Water is to be discharged from the open sprinkler at a service pressure of 0,52MPa (5.2 bar) less than the rated pressure. Under this condition, the automatic sprinkler is to be exposed to the heat and flame from a 300 mm x 300 mm pan, 100 mm deep containing 0,47 litre of heptane and 0,47 liter of water, with the top of the pan located **150 mm below the heat responsive element of the automatic sprinkler**. Observations are to be made for operation of the automatic sprinkler.

Graph 1. Temperature Profiles of the Reference burn at 1.5 metres room height 2.2 meters



Nb. Outer door opened and remnants of pallets raked out at 14:24

Graph 2. Results Demonstration Temperature Profiles with Blueproof at 1.5 meters room height 2.2 meters



Nb. Pallets sprayed with water from Blueproof delaying fire spread. Door opened to display temperature increase from influx of oxygen.

Graph 3 Four Pallet Burn NIST for comparison purposes.

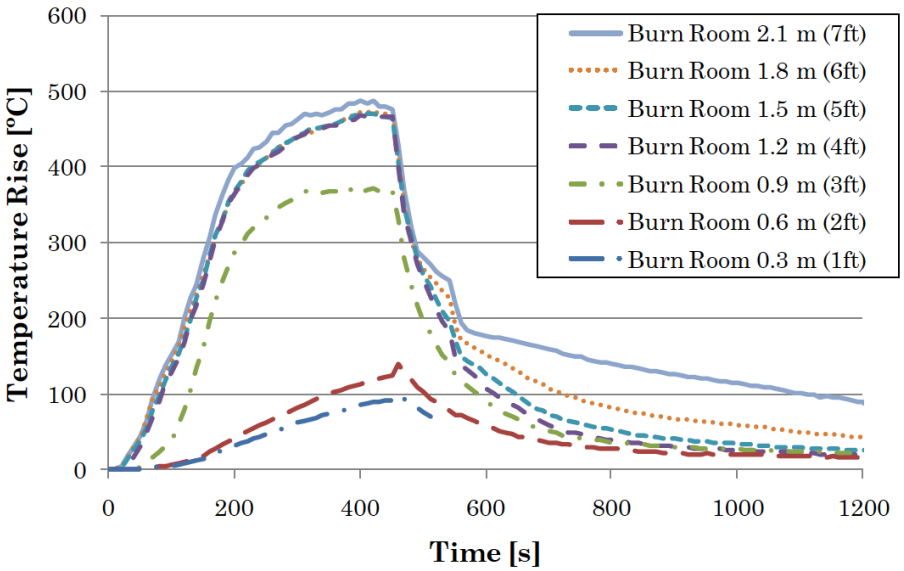


Figure 4-21: Temperature rise measured by 7 TC array in the burn compartment for one test

Ref: Heat and smoke transport in a residential-scale live fire training facility: Experiments and modeling 2010
Adam M. Barowy

Room size 3.6 x 4.8 x 2.4 m with interconnecting door open. Gypsum board cladding on walls and ceiling.

Heat Release Rate for burning pallet

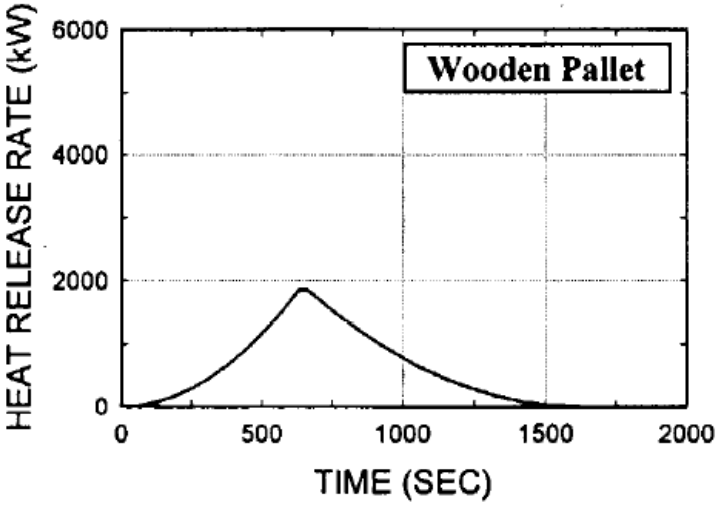


Fig. C8. Wooden Pallet, BFRL in February 1996

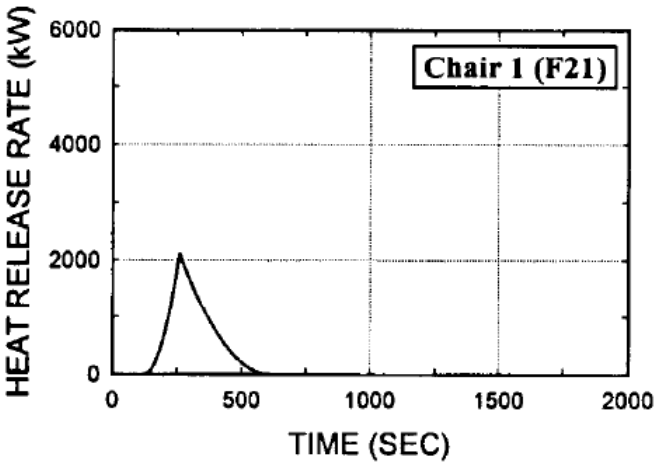


Fig. B3. Upholstered chair, F21, wood frame, pu foam-fr, olefin

Ref: Heat Release Rates of burning items in a fire 2000 American Institute of Aeronautics & Astronautics NIST.

Without Blueproof

The only item remaining after a severe house fire.

TV melted, Settee burnt out but water remained in the radiator.