

**Report of Tactical Ventilation trials at
The Fire Service College, Moreton-in-Marsh,
27th - 31st July 1998.**



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Introduction

The main purpose of these trials was to ascertain if using Positive Pressure Ventilation offensively would have an adverse effect on a casualty that was situated between the seat of fire and the exhaust vent.

Other tests were also carried out to look at the suitability of using PPV to assist in Firefighting in Ships and Aircraft, and to compare the output of different size fans.

This report should be read in conjunction with “Home Office report on the relative measurements of Tyne & Wear Metropolitan Fire Brigade’s Positive Pressure Ventilation tests at the Fire Service college” and the report of the tests carried out at Chiltern Fire International on 8th November 1998.

Monday 27th July - Day 1

All tests on this day were carried out in the BA Complex.

Overall objectives for the day

To determine the effects that unvented, natural and positive pressure ventilation has on Fire spread.

To determine the effects that unvented, natural, and positive pressure ventilation has on a casualty located between the seat of the fire and the exhaust vent.

Instrumentation was provided by the Fire Experimental Unit and consisted of thermocouples mounted at one-foot intervals in line, one foot above the floor to simulate the position of an unconscious casualty, and a rig to measure Fire spread. Two radiometers and a video camera were also placed in the compartment.



Test 1

Test 1 Objectives

To determine the effects an unvented fire has on fire spread, and a casualty located between the seat of the fire and the exhaust vent.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 1.5m².

Fire loading: double crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 1.*

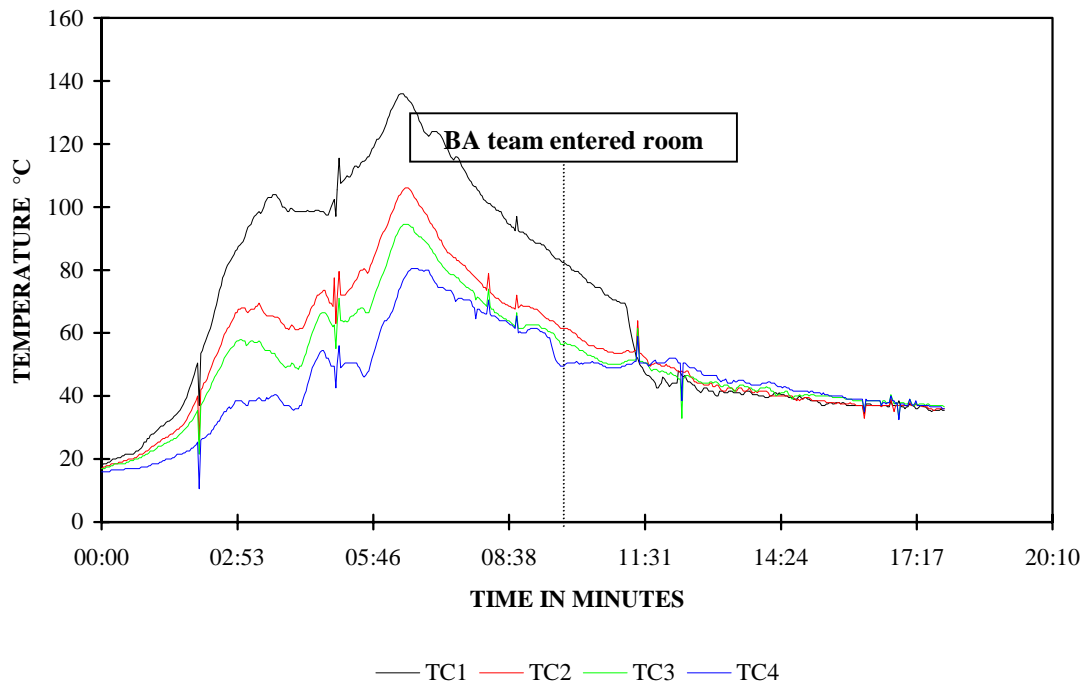
<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open)
5 mins	Windows and doors closed
10 mins	BA crew committed
11 mins	Crew enter compartment, pulsing jet to ceiling, temperature very warm, visibility nil.
13 mins	Visibility nil, water applied to seat of fire.
14 mins	No change in temperature.
15 mins	Fire extinguished using large quantity of water, Visibility 1M.
16 mins	Crew leaving premises, stairs smoke logged.

Conclusions

Without any ventilation visibility was nil throughout the test and temperatures remained high. The BA crews reported that due to poor visibility it was difficult to locate the seat of the Fire, resulting in more water damage and that searching for casualties would have been very time consuming. When leaving the premises the BA crew found that the stairwell was heavily smoke logged with poor visibility.

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TEST 1 : UNVENTED BA COMPLEX



Test 2

After consultation with the Fire Experimental Unit it was decided to reduce the time of the pre burn to 3 minutes and to commit the BA crews after 6 minutes, to try and maintain the high temperatures between close down and commitment of the BA crews.

Test 2 Objectives

To determine the effects a naturally ventilated fire has on fire spread, and a casualty located between the seat of the fire and the exhaust vent.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 1.5m².

Fire loading: double crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 2.*

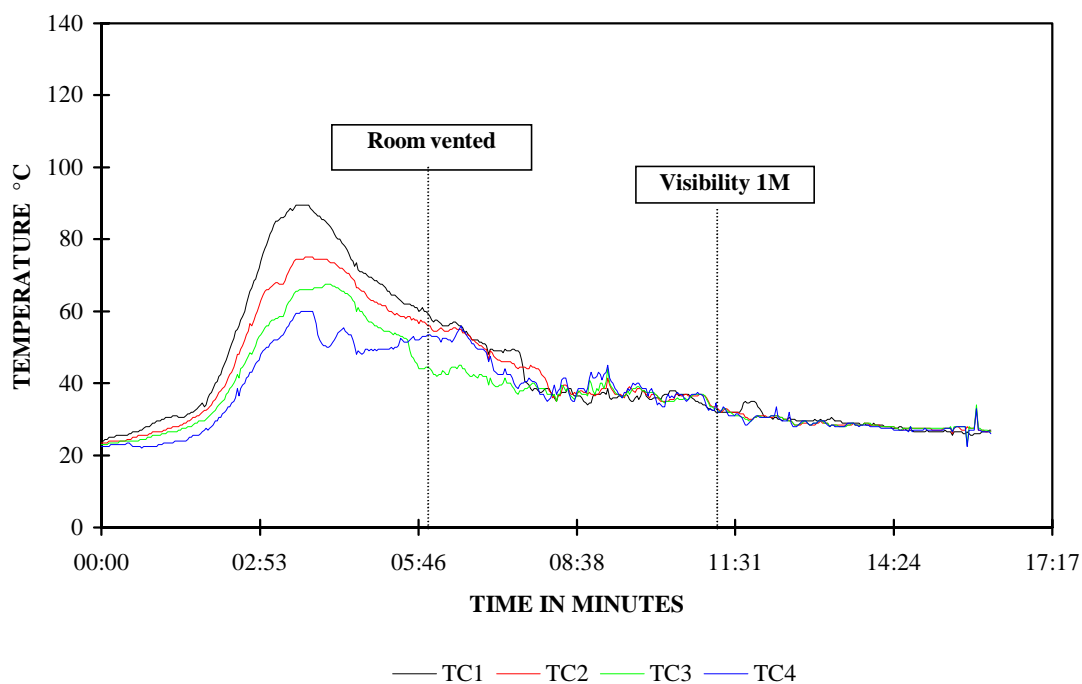
<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open)
3 mins	Windows and doors closed
6 mins	BA crew committed
7 mins	Crew enter compartment, pulsing jet to ceiling, temperature very warm, visibility nil.
8 mins	Crew can't see seat of fire.
9 mins	Flames observed on ceiling, visibility 1M, fire knocked down - visibility now nil.
10 mins	Temperature high, conditions humid
11 mins	Fire extinguished, visibility 1M
12 mins	Humid conditions, temperature reducing, visibility 1M.
13 mins	Crew leaving premises, stairs smoke logged.

Conclusions

When using natural ventilation, visibility was still poor throughout the test with high humidity. The BA crews reported that searching for casualties would have been difficult. 5 minutes after conclusion of test visibility was found to be 3-4M. At the end of the test it was felt that the fire loading was incorrect due to it's rate of burning.

T&W PPV TRIALS

TEST 2 : NATURAL VENTILATION BA COMPLEX



Test 3

Test 3 Objectives

To determine the effects positive pressure ventilation fire has on fire spread, and a casualty located between the seat of the fire and the exhaust vent.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 1.5m².

Fire loading: double crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 3.*

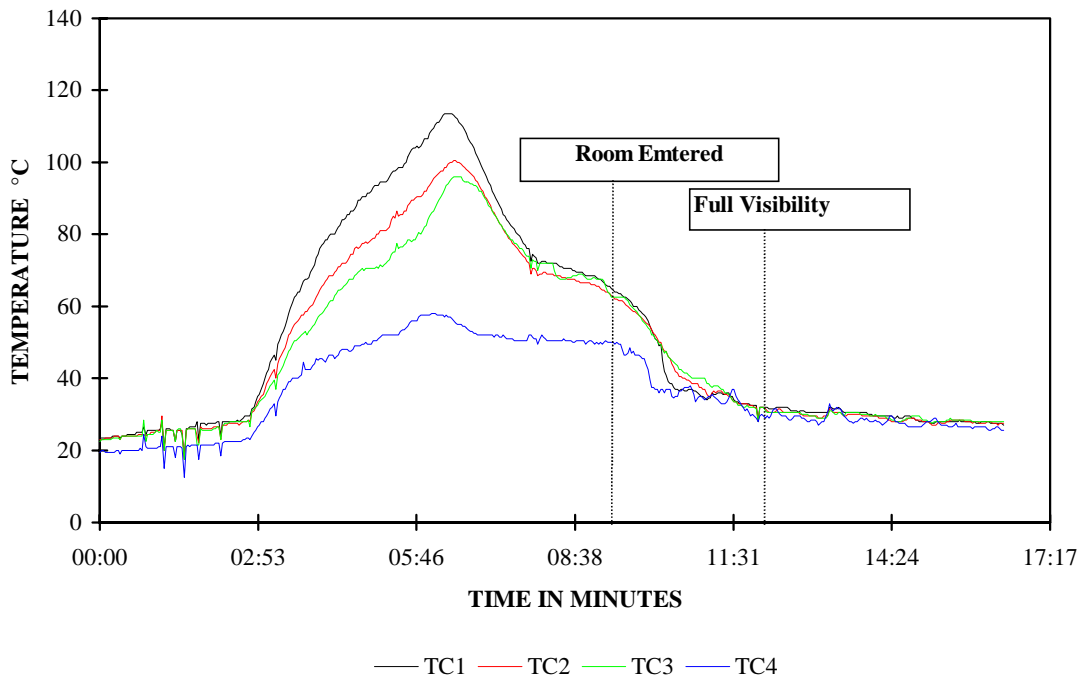
<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open)
3 mins	Windows and doors closed
6 mins	BA crew committed
7 mins	Crew enter compartment, pulsing jet to ceiling, temperature very warm, visibility nil.
8 mins	Crew can't see seat of fire.
9 mins	Flames observed on ceiling, visibility 1M, fire knocked down - visibility now nil.
10 mins	Temperature high, conditions humid
11 mins	Fire extinguished, visibility 1M
12 mins	Humid conditions, temperature reducing, visibility 1M.
13 mins	Crew leaving premises, stairs smoke logged.

Conclusions

When using positive pressure ventilation, visibility was approximately 2-3Metres on entering the compartment allowing the BA crew to immediately locate the seat of the fire. Within 2 minutes of extinguishing the fire there was full visibility in the room and no smoke logging on the stairs.

T&W PPV TRIALS

TEST 3 : PPV BA COMPLEX



Test 4

Test 4 Objectives

This was a repeat of test 2 using natural ventilation as it was felt that the fire loading in test 2 was incorrect.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 1.5m².

Fire loading: double crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 4.*

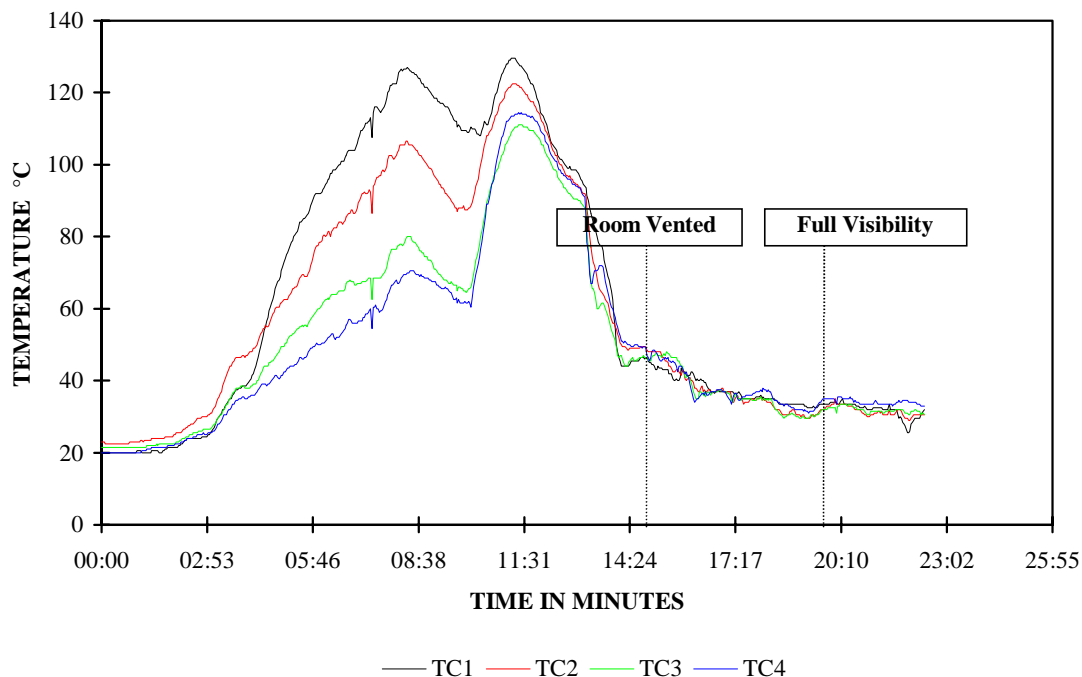
<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
8 mins	Windows and doors closed (an extra 2 minutes was allowed due to a door being left open.).
14 mins	BA crew committed
15 mins	Crew enter compartment, pulsing jet to ceiling, temperature warm, visibility nil.
16 mins	Extremely humid, more steam than smoke, visibility 2 M.
17 mins	Visibility 3M.
19 mins	Fire extinguished, visibility impaired by steam.

Conclusions

This fire was allowed a pre burn of 8 minutes as it was found on entering the room at 6 minutes that a door to the room had been left open. When using natural ventilation, visibility was still poor throughout the test with high humidity. The BA crews reported that searching for casualties would have been difficult. Following advice from the Fire Experimental Unit it was decided to repeat this test the next day.

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TEST 4 : NATURAL VENTILATION BA COMPLEX



Tuesday 28th July - Day 2

The tests on the morning were carried out on the fuselage of the 737 aeroplane no instrumentation was used in the aircraft.

Overall objectives for the day

To compare directly the effects of natural and positive pressure ventilation during firefighting on an aircraft.

The 737 had four exits, two at the front and two at the rear. The fire crib was situated approximately 3/4 of the way down the fuselage towards the front of the aircraft. The fire loading consisted of a single crib containing 8 pallets, 1 bale of straw and a small quantity of diesel.



Test 5

Test 5 Objectives

To determine the effects of natural ventilation when extinguishing an aircraft fire using traditional methods. i.e. all doors open.

Data

Weather conditions: dry.

Size of inlet: 4m²

Size of exhaust: 4m²

Fire loading: Single crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 5.*

<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (Doors open).
3 mins	Doors closed.
6 mins	BA crew committed (all doors opened). Visibility nil, temperature very hot.
8 mins	Crew location 1/2 way down fuselage.
8.5 mins	Water applied to fire, very hot due to steam.
9 mins	Fire extinguished, visibility 1M.
10 mins	Visibility below seat level reasonable, above seat level nil.
11 mins	Crew exit.
16 mins	Visibility above seat level still found to be nil.

Conclusions

The BA crews experienced difficulty in locating the seat of the fire due to poor visibility, an increase in temperature was also felt when water was applied to the fire.

5 minutes after the conclusion of the test PPV has to be used to clear the aircraft as conditions inside the fuselage were found to be very uncomfortable.

Test 6

Test 6 Objectives

To determine the effects of positive pressure when extinguishing an aircraft fire.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 4m².

Fire loading: Single crib containing 8 pallets, paper, kindling and straw.

Times:

<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (Doors open).
3 mins	Doors closed.
6 mins	BA crew committed (all doors opened)
7 mins	Good visibility.
7.5 mins	Water applied to fire, full visibility, steam moving away from BA crew.
8 mins	Fire extinguished, full visibility, can see all seats.
9 mins	Crew able to walk full length of aircraft, approx. 32M

Conclusions

The BA crew were able to see the seat of the fire immediately on entering the aircraft.

Visibility was very good throughout and no increase in temperature was felt as the steam was moved away from the crews by the positive pressure ventilation.

Test 7

Due to the failure of tests 2 and 4, after consultation with the Fire experimental Unit, it was decided to run both the natural and positive pressure tests again to ensure a true comparison.

Test 7 Objectives

To determine the effects positive pressure ventilation fire has on fire spread, and a casualty located between the seat of the fire and the exhaust vent.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 1.5m².

Fire loading: Double crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 7.*

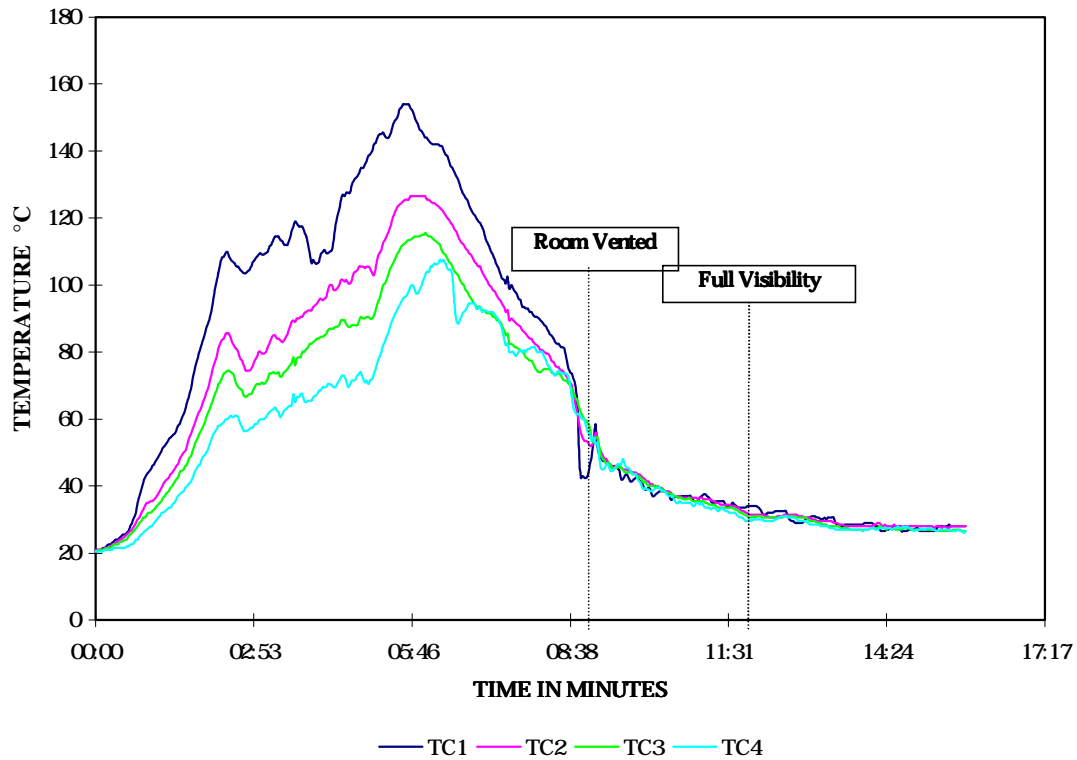
<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
5 mins	Windows and doors closed.
8 mins	BA crew committed
9 mins	Crew enter compartment, standing upright, no discomfort felt, applied water to fire
10 mins	Fire extinguished, visibility 3-4M.
11 mins	Full Visibility.

Conclusions

When using positive pressure ventilation, visibility was approximately 2-3Metres on entering the compartment allowing the BA crew to immediately locate the seat of the fire. Within 1 minute of extinguishing the fire there was full visibility in the room and no smoke logging on the stairs.

T&W PPV TRIALS

TEST 7: PPV BA COMPLEX



Test 8

Test 8 Objectives

To determine the effects a naturally ventilated fire has on fire spread, and a casualty located between the seat of the fire and the exhaust vent.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 1.5m².

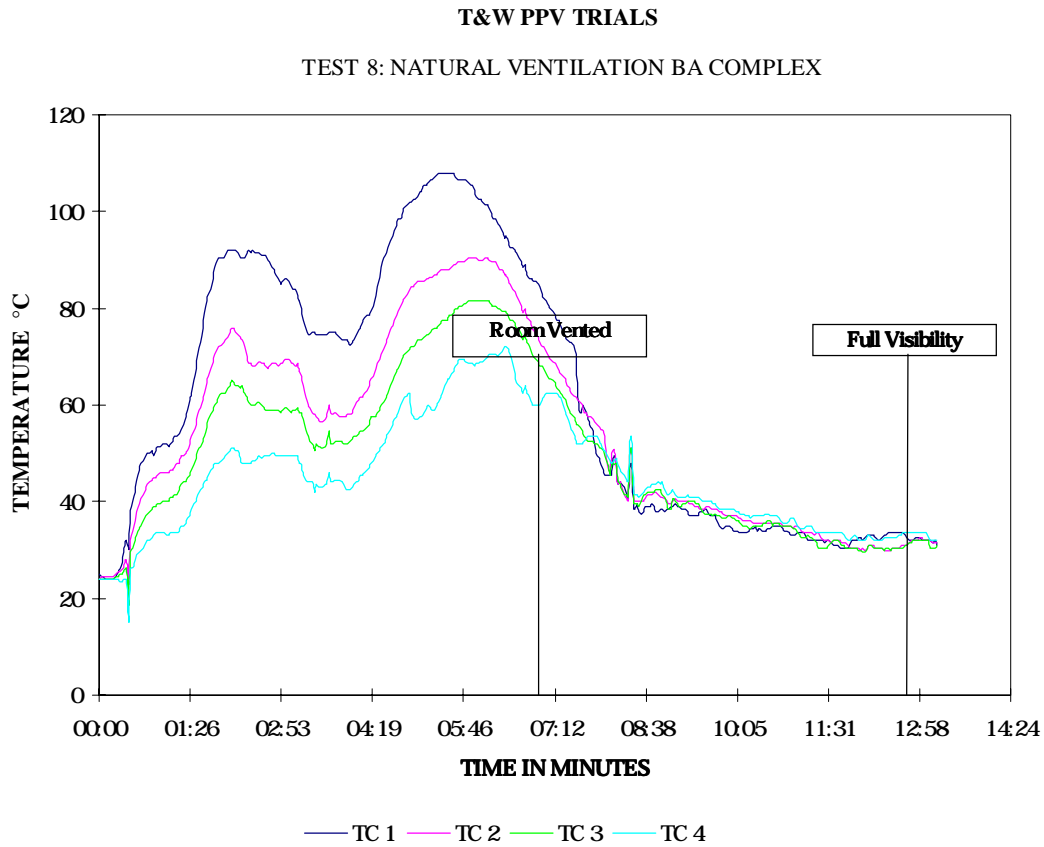
Fire loading: Double crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 8.*

<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
5 mins	Windows and doors closed.
8 mins	BA crew committed
9 mins	Crew enter compartment, standing upright, no discomfort felt, applied water to fire
10 mins	Fire extinguished, visibility 3-4M.
11 mins	Full Visibility.

Conclusions

This test was deemed to be nullified as the door at the head of the stairs had been left open allowing full oxygenation of the fire when the windows were closed, this was noted by the BA crew on entry as visibility was better than in previous tests.



Test 9

Test 9 Objectives

This test was a repeat of test 8 due to the door at the head of the stairs being left open. To determine the effects a naturally ventilated fire has on fire spread, and a casualty located between the seat of the fire and the exhaust vent.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 1.5m².

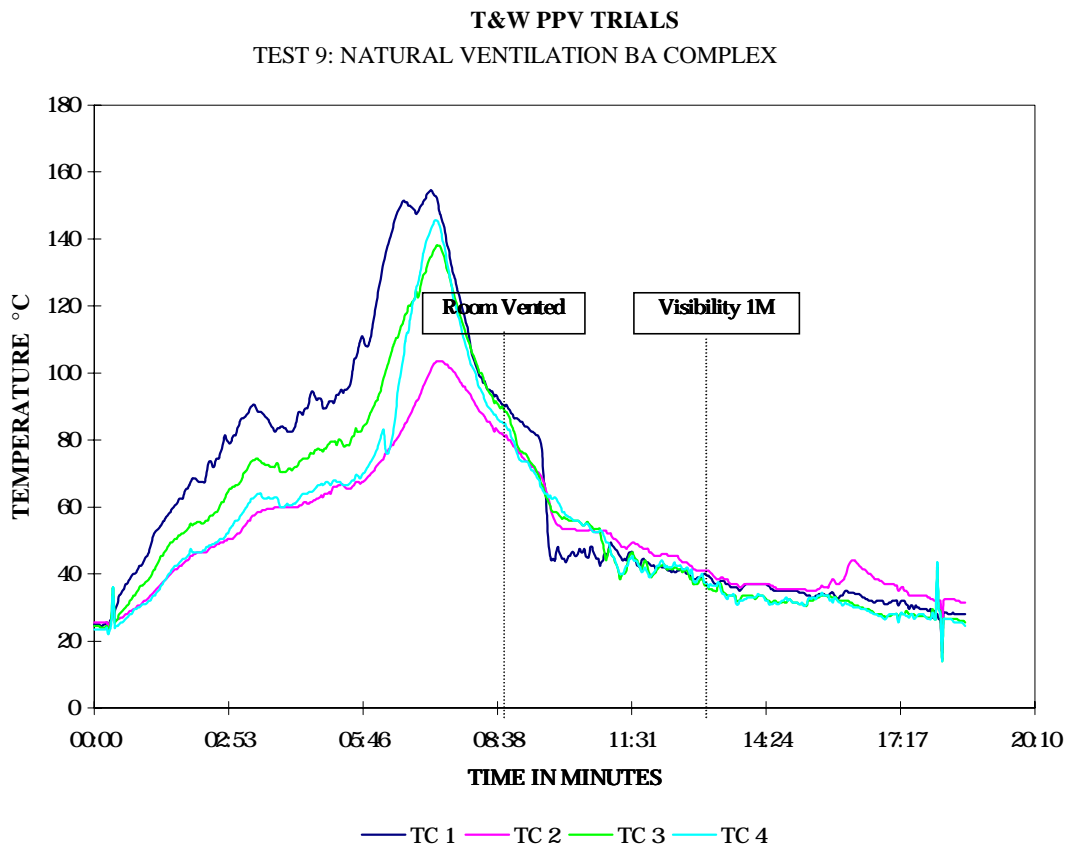
Fire loading: Double crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph - Test 9.*

<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
5 mins	Windows and doors closed.
8 mins	BA crew committed
9 mins	Crew enter compartment, standing upright, no discomfort felt, applied water to fire
10 mins	Fire extinguished, visibility 3-4M.
11 mins	Full Visibility.

Conclusions

When using natural ventilation, visibility was still poor throughout the test with high humidity. The BA crews reported that searching for casualties would have been difficult, 15 minutes after extinguishing the fire the room had still not cleared fully.

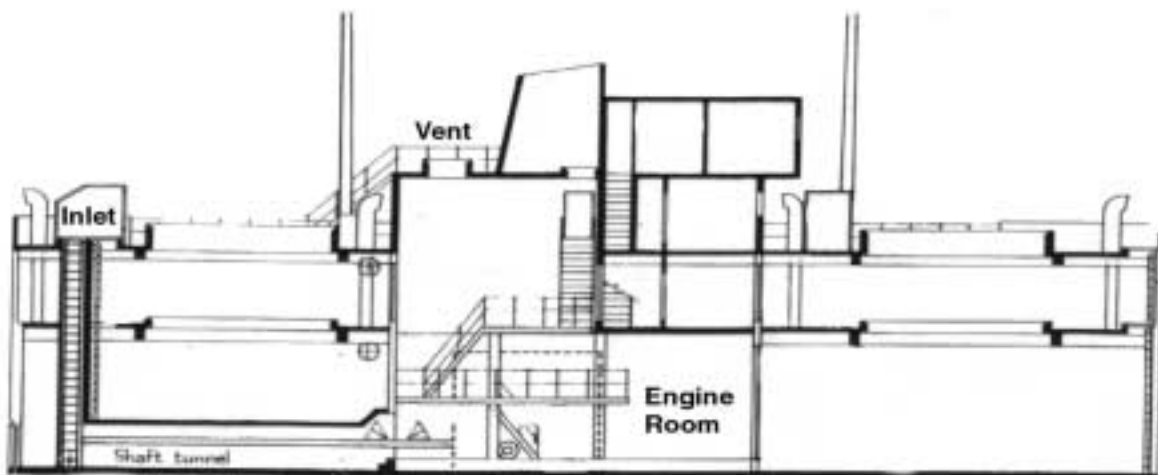


Wednesday 29th July - Day 3

The tests on this day were carried out on the ship the MV Sir Henry. Instrumentation consisted of a portable data logger and thermocouple attached to the outside of one of the BA wearer's tunic. The wearer's temperatures were also recorded at the start and at the end of the test using an electronic thermometer in the ear.

Overall objectives for the day

To compare directly the effects of natural and positive pressure ventilation on fighting a fire in a ships engine room.



Test 10

Access to the engine room was via the rear deck and along the shaft tunnel, the exhaust vent being directly above the engine room. Two fans were used, a 24" fan at the front, the seal being provided by a 21" fan at the rear.

Test 10 Objectives

This test was to use positive pressure ventilation to fight an engine room fire.

Data

Weather conditions: dry.

Size of inlet: 2m²

Size of exhaust: 2m²

Fire loading: Two single crib each containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 10.*

<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
5 mins	Windows and doors closed.
8 mins	BA crew committed
9 mins	Crew enter compartment, standing upright, no discomfort felt, applied water to fire
10 mins	Fire extinguished, visibility 3-4M.
11 mins	Full Visibility.

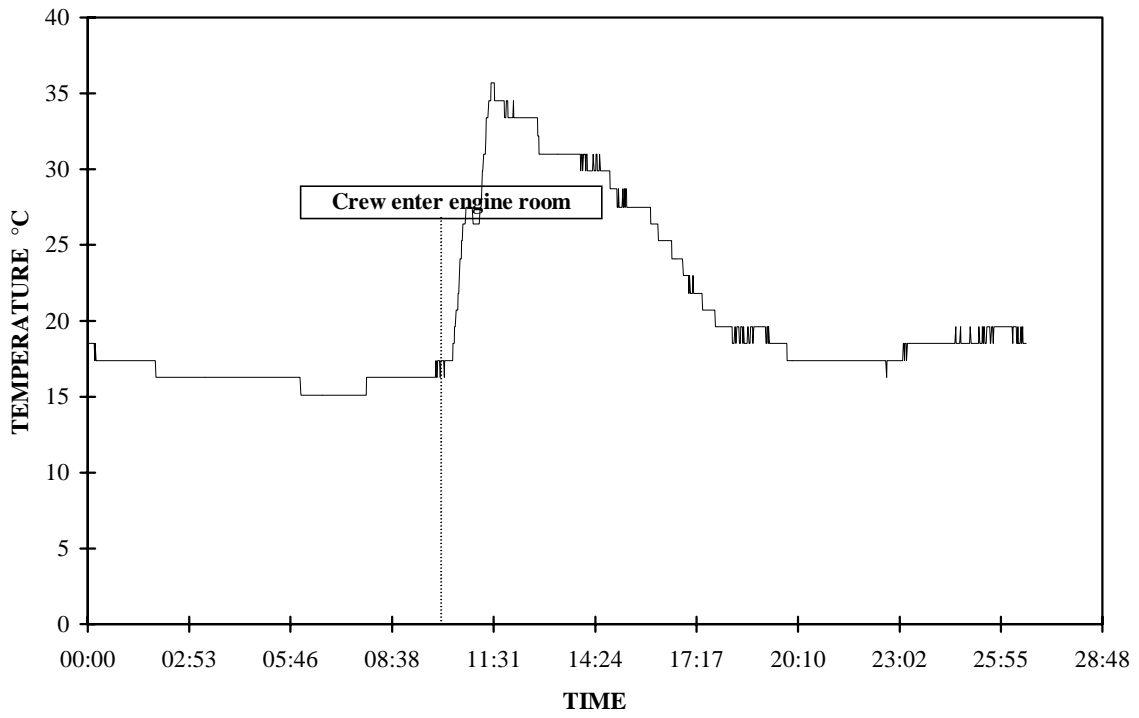
<u>Name</u>	<u>Temperature on entry</u>	<u>Temperature on exit</u>
Stn O Bowser	35 ⁰ c	36.2 ⁰ c
Sub O Sproat	34 ⁰ c	36.1 ⁰ c

Conclusions

The BA crews reported that visibility on entering the engine room from the shaft tunnel was excellent allowing them to locate the two seats of fire immediately. When extinguishing the fire there was no increase in temperature as the steam was being removed vertically out of the exhaust vent. The crew were able to enter the ship, extinguish the fire, search the engine room and return to fresh air within **nine minutes**.

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TEST 10: PPV SHIP



Inlet



Exhaust

Test 11

Test 11 Objectives

This test was to use natural ventilation to fight an engine room fire.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 2m².

Fire loading: Two single crib each containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 11.*

<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
5 mins	Windows and doors closed.
8 mins	BA crew committed
9 mins	Crew enter compartment, standing upright, no discomfort felt, applied water to fire
10 mins	Fire extinguished, visibility 3-4M.
11 mins	Full Visibility.

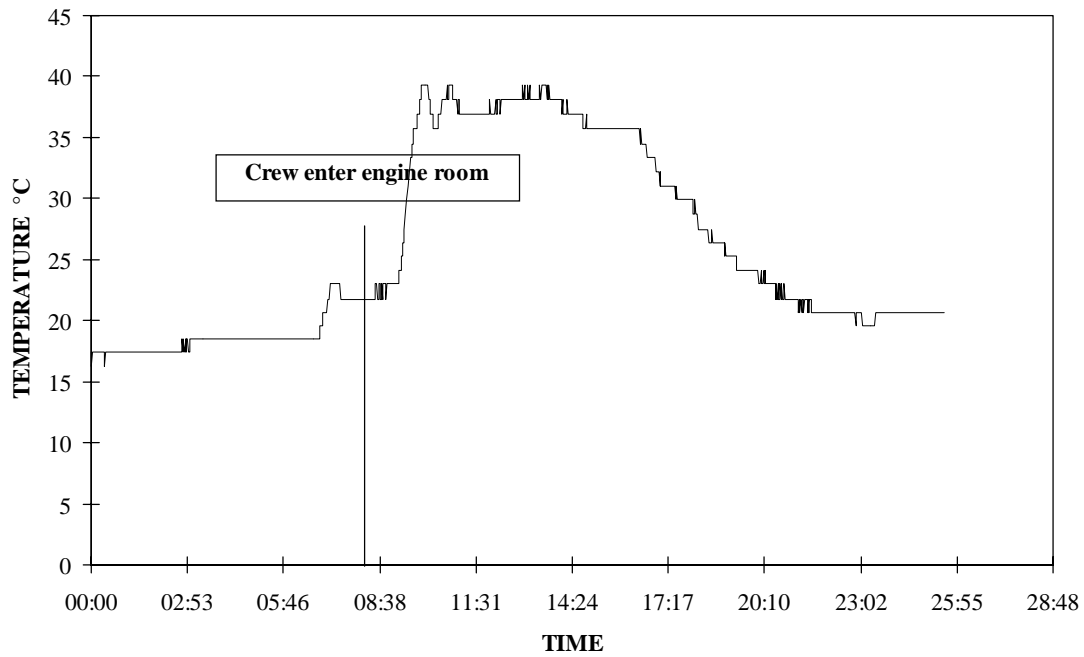
<u>Name</u>	<u>Temperature on entry</u>	<u>Temperature on exit</u>
Stn O Bowser	36.8 ⁰ c	37.7 ⁰ c
Sub O Sproat	34.7 ⁰ c	37.5 ⁰ c

Conclusions

The BA crews reported that visibility on descending the vertical ladder and in the shaft tunnel was not as good as in the previous test. Visibility on entering the engine room was approximately 3M and prior knowledge of the location of the seats of fire assisted greatly.

T&W PPV TRIALS

TEST 11: NATURAL VENTILATION SHIP



Thursday 30th July - Day 4

The tests on this day were carried out in the BA complex. The instrumentation for this day consisted of a vertical rig with thermocouples at 1', 4' and 6' levels.

Overall objectives for the day

The main aims of these tests were to compare fans of different sizes

Test 12

Test 12 Objectives

To monitor the effects of positive pressure ventilation using a 27" fan

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 1.5m².

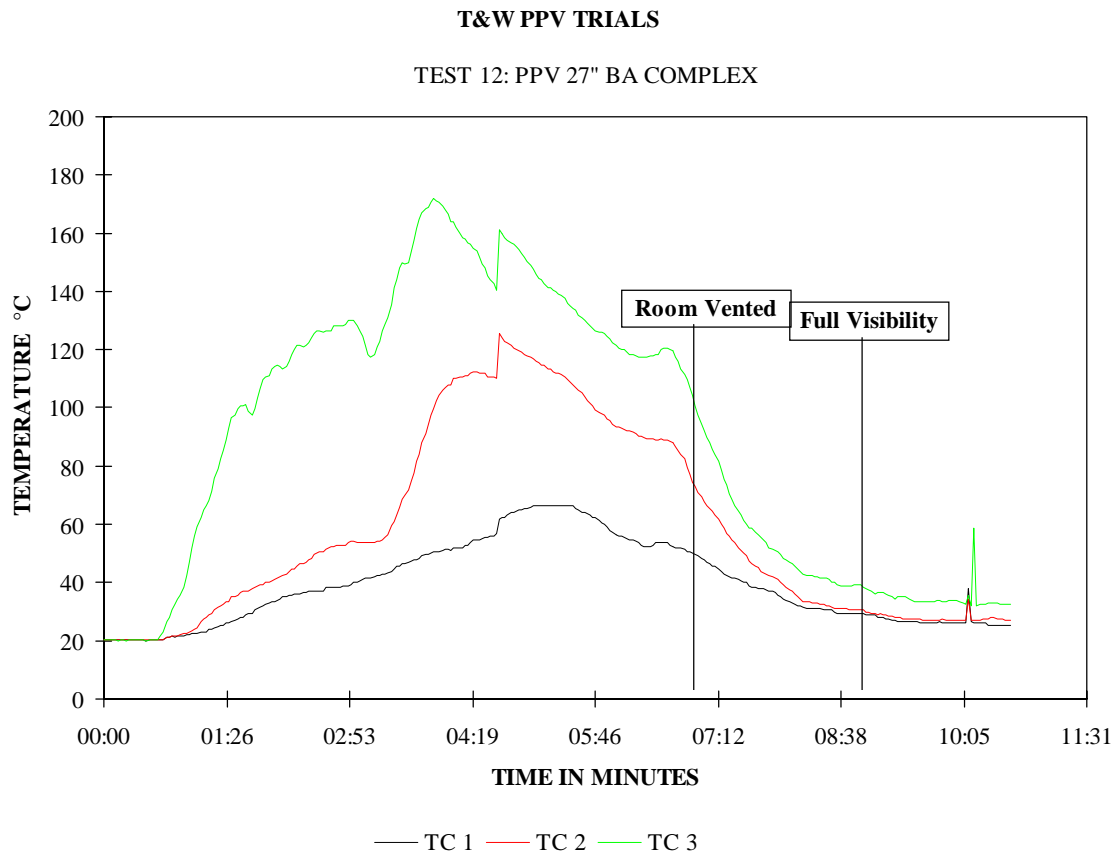
Fire loading: Single crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 12.*

<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
5 mins	Windows and doors closed.
8 mins	BA crew committed
9 mins	Crew enter compartment, standing upright, no discomfort felt, applied water to fire
10 mins	Fire extinguished, visibility 3-4M.
11 mins	Full Visibility.

Conclusions

When using positive pressure ventilation, visibility was approximately 2-3Metres on entering the compartment allowing the BA crew to immediately locate the seat of the fire. Within 2 minutes of extinguishing the fire there was full visibility in the room and no smoke logging on the stairs.



Test 13

Test 13 Objectives

To monitor the effects of positive pressure ventilation using an 18" fan.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 1.5m².

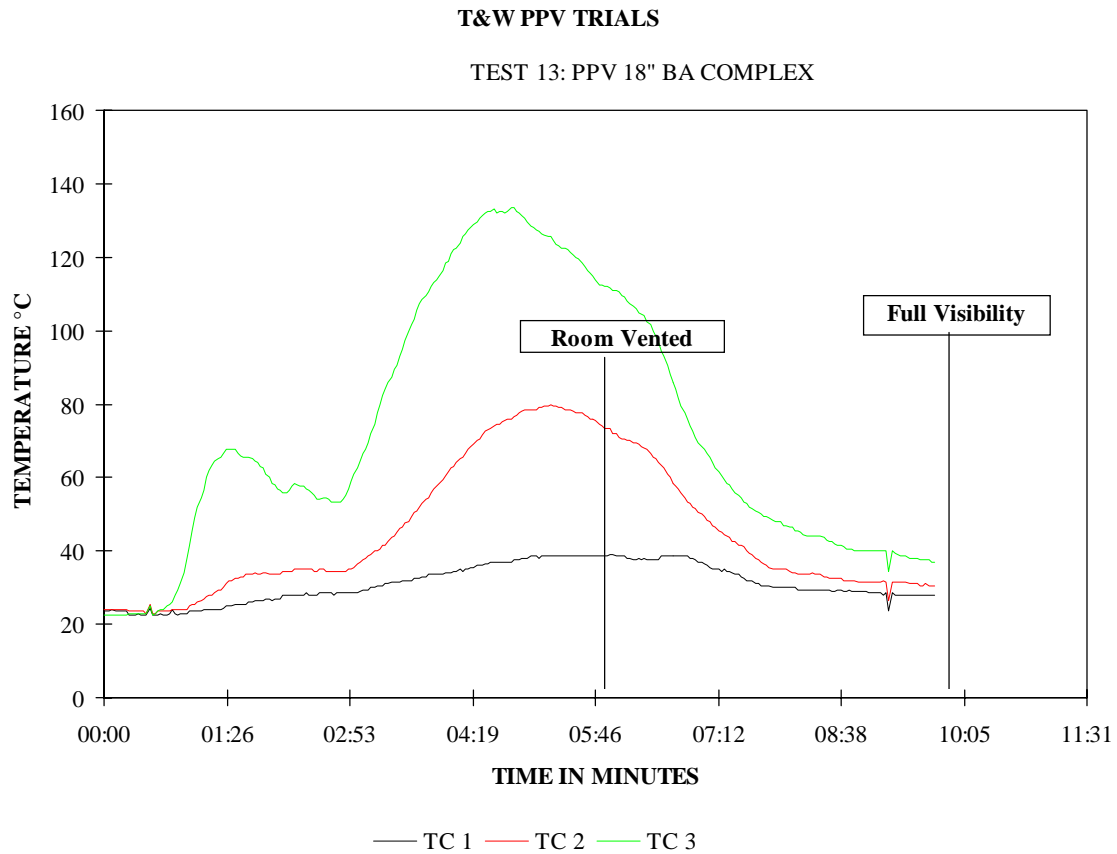
Fire loading: Single crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 13.*

<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
5 mins	Windows and doors closed.
8 mins	BA crew committed
9 mins	Crew enter compartment, standing upright, no discomfort felt, applied water to fire
10 mins	Fire extinguished, visibility 3-4M.
11 mins	Full Visibility.

Conclusions

When using positive pressure ventilation, visibility was approximately 2-3Metres on entering the compartment allowing the BA crew to immediately locate the seat of the fire. Within 3 minutes of extinguishing the fire there was full visibility in the room and no smoke logging on the stairs.



Test 14

Test 14 Objectives

To monitor the effects of positive pressure ventilation using a 27" fan with a larger exhaust vent.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 3m².

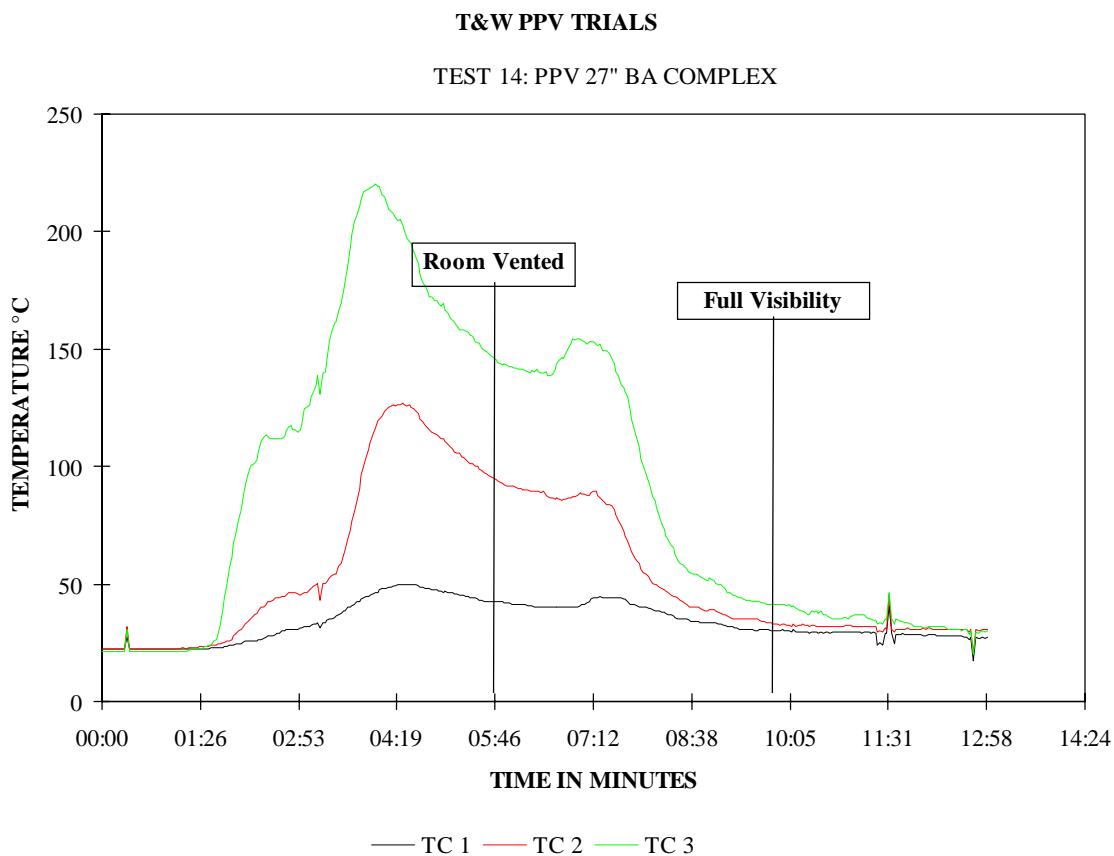
Fire loading: Single crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 14.*

<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
5 mins	Windows and doors closed.
8 mins	BA crew committed
9 mins	Crew enter compartment, standing upright, no discomfort felt, applied water to fire
10 mins	Fire extinguished, visibility 3-4M.
11 mins	Full Visibility.

Conclusions

When using positive pressure ventilation, visibility was approximately 2-3Metres on entering the compartment allowing the BA crew to immediately locate the seat of the fire. Within 1 minutes of extinguishing the fire there was full visibility in the room and no smoke logging on the stairs. The double exhaust was reduced to one exhaust 1 minute after entering the room and the BA crew felt that this was more efficient in clearing the smoke.



Test 15

Test 15 Objectives

To monitor the effects of ventilation using a 16" fan operating on the ram fan principle.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 3m².

Fire loading: Single crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 15.*

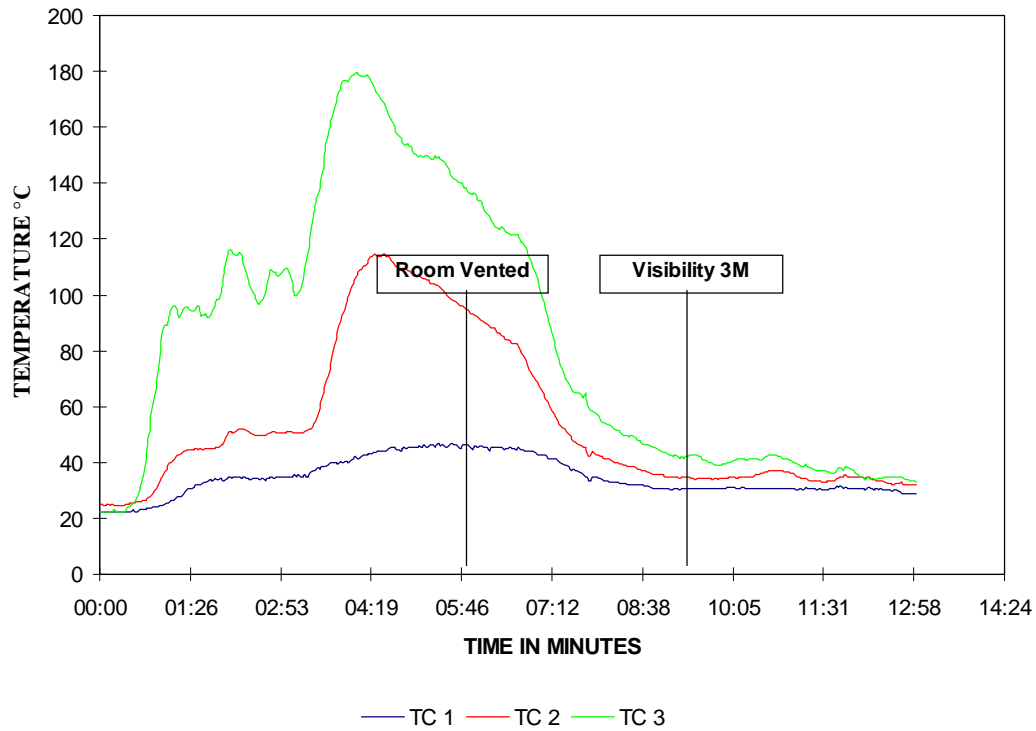
<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
5 mins	Windows and doors closed.
8 mins	BA crew committed
9 mins	Crew enter compartment, standing upright, no discomfort felt, applied water to fire
10 mins	Fire extinguished, visibility 3-4M.
11 mins	Full Visibility

Conclusions

When entering the compartment the BA crew reported that visibility was nil and within 2 minutes it had only cleared to approximately 3M, they also reported that the fan appeared to be causing turbulence within the room. Two minutes after the conclusion of the test it was still smokey and humid within the room, causing discomfort.

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TEST 15: 16" HURICANE BA COMPLEX



Test 16

Test 16 Objectives

To monitor the effects of positive pressure ventilation using a 21" fan

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 1.5m².

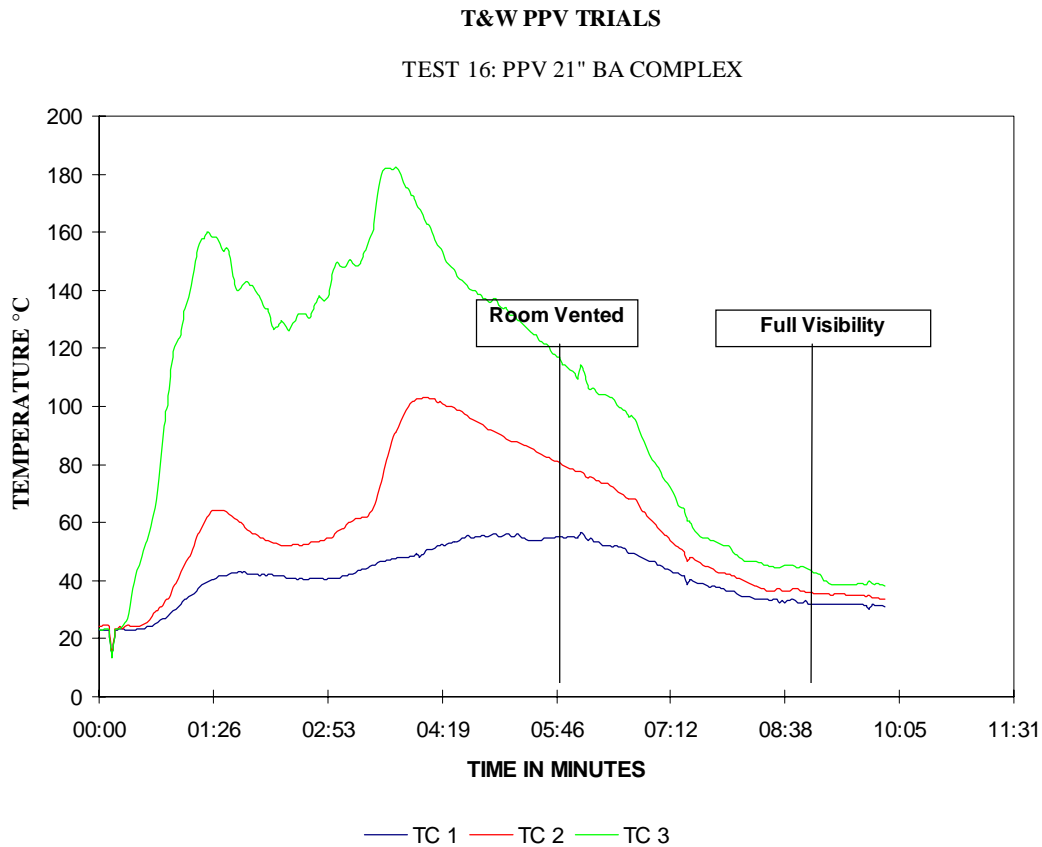
Fire loading: Single crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 16.*

<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
5 mins	Windows and doors closed.
8 mins	BA crew committed
9 mins	Crew enter compartment, standing upright, no discomfort felt, applied water to fire
10 mins	Fire extinguished, visibility 3-4M.
11 mins	Full Visibility.

Conclusions

When using positive pressure ventilation, visibility was approximately 2-3Metres on entering the compartment allowing the BA crew to immediately locate the seat of the fire. Within 1 minute of extinguishing the fire there was full visibility in the room and no smoke logging on the stairs.



Test 17

Test 17 Objectives

This test involved firefighting a multi-seated fire using positive pressure ventilation with 24" and 21" fans inline, the fires being on the ground and second floor. Two BA crews each of two men were used.

Data

Weather conditions: dry.

Size of inlet: 2m².

Size of exhaust: 1.5m².

Fire loading: Single crib containing 8 pallets, paper, kindling and straw.

Times: *to be read in conjunction with graph – Test 17.*

<u>Time</u>	<u>Comments from BA crew</u>
0	Fire ignited (windows open).
5 mins	Windows and doors closed.
8 mins	BA crew committed
9 mins	Crew enter compartment, standing upright, no discomfort felt, applied water to fire
10 mins	Fire extinguished, visibility 3-4M.
11 mins	Full Visibility.

Conclusions

The use of PPV allowed the ground floor to be cleared quickly giving good visibility and the fire was located immediately. This allowed the second BA crew to proceed to the second floor, and using the same procedure the fire was extinguished rapidly.

Overall Conclusions

- I. The detrimental effects on an unconscious casualty placed between the fire and the exhaust vent when using Natural ventilation or PPV were negligible. Any burns or smoke inhalation would already have occurred prior to the commencement of firefighting.
- II. PPV did not seriously intensify or spread the fire, some local flaming was inevitable given the removal of the smothering effect of the smoke and the increase in oxygen in the fire compartment.
- III. PPV always dramatically improved visibility and reduced temperature in a short period of time.
- IV. The tests demonstrated that controlled tactical ventilation allied to effective use of PPV would provide:
 - ◆ Quicker extinguishment of the fire due to greater visibility.
 - ◆ Less heat and water damage.
 - ◆ Enhanced firefighter safety.
 - ◆ Improved working environment.

The reduction in heat and the speed of smoke clearance in the fire compartment is directly linked to the size of output of the fan.

Acknowledgements

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Mr. Guy Roberts
Miss Kirsty Boswell

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Ff Jim Broome - Nottinghamshire
Stn O Malcolm Cooper - West Sussex
Sub O Kim Malcolm - West Sussex
Mr Richard Johnstone - Tyne & Wear
Mr Stephane Bacle - University of Belfast