

REALISTIC FIRE BEHAVIOUR TRAINING

ARE UK FIRE BRIGADES EVALUATING THE RELEVANCE OF FLASHOVER & BACKDRAUGHT TRAINING CORRECTLY AND WITH THE DESIRED DEGREE OF URGENCY?

A

REPORT BY

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Summary

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This report considers the issues of Hot Fires and the relevance of training to Fire Crews, Brigades and members of the public.

Beginning with descriptions of Fire Behaviour, how Fires develop and some of the factors that contribute to their escalation.

It moves on to review training that can be provided and the devices available to support realistic 'Fire Behaviour' training for Brigades intending to move beyond a purely theoretical approach.

A consideration of the drivers for implementing realistic training; include a review of Risk Management, Legislation, Economic factors and benefits to the Brigade and society.

It reflects the generally slow response by Brigades to 'Improvement Notices' across the UK While all Brigades not currently

providing 'Realistic Fire Behaviour' training have plans to introduce it within three to five years. .

The report concludes that sufficient evidence exists to support full implementation of realistic 'Fire Behaviour Training' in all Brigades across the UK, Theoretical preparation alone can not adequately prepare FireFighters for such incidents. 'First Hand' is the best way to gain this experience.

Finally, in recognition of the financial barriers facing all Brigades, the report explores the potential for collaboration and generating additional income.

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1 Introduction

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1.1 Flashover and Backdraught incidents threaten the lives of firefighters. The idea of them provokes anxiety. There is evidence to suggest that whilst firefighters are aware of them as a concept; limited experience exists, particularly at recruit level, and confusion between the two phenomenon is apparent in many experienced firefighters.

1.2 An understanding of the different types of Fire Behaviour will equip firefighters with the skills to anticipate and predict the course a fire may take. Consequently they will be better able to protect themselves, their colleagues, members of the public and reduce fire damage to buildings and the environment.

3. The report is being compiled as part of the requirements of the F.B.T.I. 1/99 course at the fire Service College.
4. Bibliography and references section refer to the numerous books and articles that have provided information on this subject.

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2. Overviews of Fire Behaviour.

"First and most important, we have learnt from talking with firefighters across the country that as a group, firefighters do not understand the real life cycle of fire very well. Most firefighters have read the books and seen the videos, but even those who understand flashover have not been able to observe it" Knapp & Delisio 1996

Further more, Knapp & Delisio say it is not surprising that firefighters fail to understand flashover. Scientists and engineers appear to have equal difficulty defining and describing it. Consequently, firefighters today use numerous definitions.

2.1 Common features include the following

2.1.1 Gas temperatures of 300° to 650°C although temperatures of 500° to 600°C are

More widely used and can be recreated in the training environment.

2.1.2 "The result of radiation feed back from ceilings and upper walls that have been

Heated by a fire in a room" (Dunn 1992)

2.1.3 Ignition of flammable gasses in the smoke, products generated by heating the fuel and the products of combustion, [pyrolysis products]commonly carbon monoxide, carbon dioxide and water vapour, leads to rollover and eventual flashover.

2.1.4 "The classic signs. High temperatures that force you to your knees; thick dark smoke; free-burning fire; and fire rollover (a late warning sign)" (Knapp & Delisio 1996)

2.2 Types of Fire Behaviour - Definitions

2.2.1 Flashover;

"In a compartment fire, there can come a stage where the total thermal radiation from the fire plume, hot gases and hot compartment boundaries causes the radiative ignition of all exposed combustible surfaces within the compartment. This sudden and sustained transition of a growing fire to a fully developed fire is flashover."

2.2.2 Backdraught;

"Limited ventilation can lead to a fire in a compartment producing fire gases containing significant proportions of partial combustion products and un-burnt pyrolysis products. If these accumulate then the admission of air when an opening is made to the compartment can lead to a sudden deflagration. This deflagration moving through the compartment and out of the opening is a backdraught"

The Behaviour of Fire: Compartment Fires. HMSO 1995

2.2.3 Delayed Backdraught

In the event of a smouldering deep seated fire, if the door to the fire room is opened, air entering the oxygen deficient environment, alters the explosive limit from the rich mixture towards the Ideal Mixture, but not immediately causing a Backdraught.

The Delayed Backdraught happens when the carbonised layer of a smouldering fire is disturbed, either by a length of hose or the moving of smouldering furniture to reveal an ignition source.

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2.2.4 Delayed Backdraught at the 'IDEAL MIXTURE'

This type of 'Delayed Flashover', is a major concern to Firefighters. Igniting at the I. M. with maximum force, the involvement of energy rich gases would cause the explosive force to kill any firefighters in the vicinity. It is likely that the building would suffer significant structural damage.

3. Fire Behaviour Training; A Description

3.1 Theoretical/Practical Training

All Brigades can provide this type of training. Set up costs are varied depending on the size of Brigade, but generally it will entail having a number of staff attend an approved specialist course, appropriate demonstrating devices (Cheshire box, dollhouse, bangbox, etc), handouts and case studies, (Blaina, Watt St, etc). The document provided by the Home Office in 1995. 'The Behaviour of Fire; Compartment Fires' can be supplemented by journal articles, video footage, the experience of other countries and that of senior fire fighters combined with Fire development input.

If firefighters are to understand the 'Mechanism of Fire', a theoretical understanding is critical to support practical ability. This knowledge strengthens their capability to predict Fire Behaviour. The instructor's ability to enliven and introduce realism is core to the success of any theoretically based training program and should be supported by video footage.

3.2 Practical Training

3.2.1 Simulators- Metal Box [Cheshire box]

This is a simulator, constructed from steel, measuring approximately 1x1x1 meter's. The advantage of using this type of container is the portability, low cost, installation and maintenance. Fuelled using chipboard heated by a small kindling fire, it produces small quantities of energy rich gases. The instructor can produce one controlled flashover followed by repeated Backdraughts, all be it on a small scale.

3.2.2 Simulators- Traditional Construction

A significantly small number of Brigades have fitted flashover simulators. Overall, these have been added to existing buildings or incorporated into new training facilities or comprise of a steel cargo container. Expensive to produce, and not portable, many were not built to withstand real fires or the internal use of water. Consequently, many Brigades have few options available to them

Those that have opted for this type of building, Liquid Petroleum Gas (LPG) is the preferred fuel, source. The advantages include no air pollution and the capability for use in quick succession. This may be viewed as a distinct economic and

environmental advantage however not producing Realistic Fire development conditions. The chipboard lined, Fire demonstrators allow for natural Fire behaviour and development, with very limited omissions.

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4. Drivers for Implementing Hot Fire Training

4.1 14 Zephiniah Way, Blaina, Gwent and King's Cross-Station, London is but two scenes at which 'Hot Fires' claimed the lives of three firefighters. Kevin Lane and Stephen Griffin died at the 'Backdraught' incident in Gwent on 1 February 1996. While a 'Flashover' occurring at 19:32 on 18 November 1987 was responsible for the loss of Station Officer Colin Townsley. A 'probable' Flashover on 2 July 1993 led to Iain McPhee sustaining over 60% burns, he died from these injuries

4.2 A Health and Safety Executive (H.S.E.) investigation followed. The investigation focused on training of firefighters to appreciate and recognise the situations that they may face. In these circumstances, particular emphasis was placed on flashover and backdraught situations. They also looked at the firefighters ability to employ appropriate techniques that would lower the risks to themselves and their colleagues.

4.3 In the former Gwent, the H.S.E. investigation concluded that inadequate Health & Safety arrangements were in place. Limited knowledge and training around key Health & Safety issues existed amongst the senior officers responsible for this. Lack of access to any expert advice indicated how low the issue was on the training program.

4.4 The training that was given did not adequately prepare firefighters for such incidents. Additionally, poor monitoring of watch based training existed. There were insufficient resources available to support 'quality training'. Few fire fighters in Gwent had received 'fire Behaviour' training.

4.5 Consequently, an Improvement Notice (Appendix 1) was issued to South Wales Fire Authority (Previously Gwent). It required them to establish 'sound' fire training programs. These had to be supported by 'adequate' facilities and resources. The need to explore 'Best Practice' across three brigades was a method aimed at developing a comprehensive program, designed to equip fire-fighters, 'so far as is reasonably practicable' to deal appropriately with the conditions they may face.

4.6 The improvement notice lies within a framework that is enforceable through statute. Section 2(1) and 2(2) (C) of the Health & Safety at Work Act 1974. Section 1(b) of the Fire Services Act requires fire authorities to train members of its fire brigade to become efficient members. Regulation of the Management of the Health & Safety at Work Regulations 1992 has explicit requirements. These include adequate health and safety training for recruits and exposure to new or increased risks. This improvement notice had a marked affect on Fire Behaviour training countrywide.

4.7 Injury or the loss of life has major implications for those involved. No data is available to analyse expenditure on compensation claims and other financial losses. The report published by the Training Strategy Committee (1994) supports this.

5. Cost Benefit Analysis of Fire Behaviour Training.

5.1 Lack of information about expenditure on compensation, litigation uninsured loss and the social cost of loss of life or permanent disability prohibits any detailed analysis of the financial impact. This denies us the opportunity to measure performance across Brigades. This information would drive and maintain development within Brigades.

5.2 Failure to implement realistic Fire behaviour training will mean that death or serious injuries do not reduce. "As buildings become better insulated and sealed for energy efficiency, such hazards to firefighters may become increasingly common" Bukowski (1996) Statistics collected across England and Wales during 1992 categorised approximately 1250 firefighters as "Casualties at Fires", Joint Training Committee,(1994)

5.3 Taylor (1993) argues strongly for the implementation of 'Flashover' training. He believes that this approach adds to existing procedures and more importantly, saves the lives of firefighters and members of the public. Environmental benefits are realised through the firefighters ability to control and contain fires thereby reducing pollution and building damage, Schnell (1996). For the Brigade, the advantages include a reduction of litigation, compensation, sickness and replacement costs.

5.4 Brigades able to release this cash as a result of improving performance and safety will unlock revenue to fund realistic training. Additional benefits include greater opportunity to manage resources, human and material, more effectively and efficiently. This facility is also a potential source of income, Brigades have the potential to sell training to industry and organisations faced with the demands of Health and Safety legislation. However profit from such training should not steer or direct the implementation of such facilities.

5.5 The reputation of Brigades will be enhanced through compliance with Health and Safety recommendations. Additionally, a positive influence on firefighters who feel valued and most importantly, trained, to deal with Fire behaviour situations within compartments that they could possibly face.

5.6 Chitty (1996) suggests that safety considerations can be a major barrier to providing realistic training facilities. Schnell (1996) supports this view, "Flashover education and training can be dangerous if carried out in the wrong way". However, both concede that reinforcing academic fire science, with small scale demonstrations and then full scale fire-fighting exercises

"Would provide a good understanding of the basic scientific principles of fire development and how various fire fighting techniques operate" However this must be progressive.

5.7 All of this adds to the human dimension of Fire Fighting. The firefighters, their families and the community can feel that a greater degree of protection is available.

"After more than 10 years of training and practising the developed technique in real fire-fighting, we can establish that this is the single action in training and technique development that has had the greatest impact on our work and performance"

Schnell (1996)

5.8 The Swedish experience tells us that their firefighters are more knowledgeable, able to predict and influence the life cycle of a fire, assess risk at fires, capable of preventing flashover and spread of fire; protect themselves and other crew members safety.

"Today our fire brigade produce more efficient fire-fighting, which saves lives and great property value by less fire- as well as less water damage"

Schnell (1996)

9. Correct use of visual indicators of fire behaviour, combined with correct branch techniques in the form of gas cooling and direct cooling will be a direct result of this type of training which in turn has to be money well spent.

6. **Conclusion**

6.1 "All operational training should be designed to improve the safety of firefighters at the scene of an incident", Joint Training Committee (1994)

6.2 Those responsible for training have to assess risks, consider how training can minimise them, while addressing to the risks associated with realistic training.

6.3 Various writers comment on the ignorance and lack of awareness generally found amongst firefighters. This can cause them to be less able to predict the course a fire may take and blinds them to how their acts or omissions will influence that fire. Of greater significance, is their lack of ability to protect themselves, their colleagues, members of the public, property and the environment. This I have experienced myself as a Training Officer.

6.4 There is sufficient evidence to support the introduction of Realistic Fire Behaviour training. The Swedish Fire Service describes the numerous benefits to the community and the Brigade. Across the UK, incidents, loss of life, permanent disability, extensive damage to property, litigation and compensation claims, supports the demands for swifter reaction to 'Improvement Notices' and Health and Safety Recommendations which may prevent them from being issued in the first place.

6.5 The introduction of the Health & Safety at Work Act in 1974 removed the self-regulation previously granted to the fire service. This legislation forced the service to recognise the implications of a powerful, independent body, The Health & safety Executive, enforcing statutory requirements. Since that time, these have been extended to coincide with both National and European requirements.

6.6 Despite having the weight of legislation behind them, protagonists for realistic 'Fire Behaviour' training find themselves faced with slow implementation. The Home Office appears to play a limited role in enforcing this and Brigades make slow strategic plans to provide this training.

6.7 The potential for collaboration must be explored. In times of limited and shrinking resources, Brigades have to move beyond traditional boundaries and explore the scope to collaborate. This will enable the provision of expensive, varied and quality training facilities to be put to maximum use to the benefit of all concerned.

6.8 The lack of accurate, meaningful information about injury and loss of life has a particular relevance. It detracts from the weight of the message and denies members of the public, firefighters and the Brigade the opportunity to ask questions about performance and factors, like training, that contributes to that. Times are moving on and the fire service has to change with them moving away from traditional methods of training and practices.

7.Recommendations

7.1 There should be rapid and widespread introduction of realistic 'Fire Behaviour training across all Brigades in the UK.

7.2 The Home Office should survey all Brigades and produce a report about the extent to which this type of training is available, the reasons for non-implementation, action plans and the resources needed to achieve these plans.

7.3 A system should be introduced to monitor the level and quality of realistic training to achieve a uniform standard.

7.4 This should include a Fire development science input, which should be updated when new theories are proved.

7.5 Brigades should be encouraged to collaborate across boundaries, sharing resources and financial pressures.

7.6 Instructors should be supported to develop and maintain the appropriate level of skill and expertise to provide safe, effective realistic 'Fire Behaviour' training.

7.7 Brigade instructors should be given the necessary knowledge from attendance on an approved course.

7.8 Firefighters should be made aware that all Realistic Fire Behaviour training is developed and controlled for simulation only. Outside of the training environment Firefighters should be aware of the variables involved in a realistic condition which involves the signs and symptoms of a Flashover Backdraught situation.

- Compartment size
- Fire loading
- Ventilation
- Time lapsed since ignition

- Ceiling height

7.9 Advanced use of branch techniques is the key factor following recognition of the indicators to achieve rapid fire control and neutralisation of the conditions within the compartment.

8. References

Bukowski, P.E. (1996) **Modelling a Backdraught Incident: the 62 Watts St. New York Fire.**

Fire Engineers Journal, Vol. 56, (No 185) p 14-17

Chitty, R. (1996) **Management Summary of A Survey of
Backdraught FrdG Report No. 5/94**

Fire Engineers Journal, Vol. 56 (No. 185), p.12

Dunn, V. (1992) **Safety and Survival on the Fireground**

Fire Engineering Books 1992

HMSO (1995) **The Behaviour of Fire; Compartment Fires** Manual of Firemanship; a supplement, HMSO

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Joint Training Committee (1994) **Report of The training Strategy Group**

Central Fire Brigades Advisory Council for

England and Wales and for Scotland

Knapp, J & Delisio C, (1996) **Flashover Survival Strategy** Fire Engineering Vol. (56), Page 81 -89, August 1996

Schnell, L.G. (1996) **Flashover Training in Sweden**

Fire Engineers Journal, Vol. 56, (No.185) p.25-28

Taylor, J. (1993) **Flashover Training.**

Fire Engineers Journal, Vol. 53 (No 169) p. 15-22

9. Bibliography

1. Drysdale, D. (1996) **The Flashover Phenomenon** Fire Engineers Journal, Vol. 56 (No 187) p. 18-23

2. "Fire Report", (1996) **Gwent fatalities: fire brigade issues report on incident** Fire, Vol. 89, (No. 1095) p. 7-8

3. Fleischmann, C. M. (1996) **New Zealand Backdraught and Flashover Training.** Fire Engineers Journal, Vol.56,(No. 184),
p.27-28

4. In Attendance 1993, **The West Midlands Fire Service: Bravery Awards For gallant West Midlands Firefighters** Vol. 7. (No. 5) p. 4

5. Jerome, D. (1996) **West Midlands Hot Fire Training** Fire Engineers Journal, Vol. 56 (NO. 187) p. 29-30

6. HMSO **Department of Scientific and Industrial Research** Fire officers Committee 1947

10. APPENDICES

Appendix 1

10.1 An Improvement Notice is issued under the Health & Safety at Work Act, 1974. This is usually the consequence of an investigation conducted by the Health & Safety Executive. Should and employer be in breach of their 'duty of care' under Section 2(1) and 2 (2) of the Act which requires them to ensure "so far as is reasonably practicable, the health, safety and welfare at work of all employees"

10.2 Section 33 (1) (a) of the Act makes provision for failure to comply with the Improvement Notice. Offenders are liable on summary conviction, to imprisonment for a term not exceeding 6 months, or to a fine not exceeding £20,000 or both, or a conviction or indictment, to imprisonment for a term not exceeding 2 years, or a fine, or both.

10.3 The Management of Health & Safety at Work Regulations 1992, places a duty on employers to provide adequate Health & Safety training.

10.4 The Improvement Notice issued to Gwent Fire Brigade identified that the Authority was in contravention of Section 2(1) of the health & Safety at Work Act, August 1994 and Regulations 4 and 11 of the Management of Health and Safety Regulations 1992.