

DEFENCE FIRE TRAINING AND DEVELOPMENT CENTRE



OPERATIONAL REFRESHER COURSE STUDENT STUDY PACK

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HEALTH & SAFETY AND ENVIRONMENTAL PROTECTION

Hazards to Personnel on the Fireground

1. Firefighters can be subject to all kinds of hazards on the fireground such as:
 - a. Crews arriving at the scene of an incident and being faced with members of the public who may be distressed or in rare cases violent.
 - b. Crews carrying out rescues from lifts and escalators and coming across dangerous machinery, restricted access, shear traps, power supplies, uncontrolled descent of lift cars and manual handling of casualties.
 - c. Crews carrying out rescues from sewers, dealing with traffic, toxic/flammable fumes, fire, explosions, and slip trips and falls. There is a risk of biological infection (eg hepatitis A & B) and possible chemical contamination.
 - d. Crews carrying out rescues from silos and working from height, working in oxygen deficient atmospheres. Unstable surface and fluidity of contents, confined spaces and hidden voids, etc.
2. Other emergency agencies are likely to be present at an incident and it is important for success of firefighting and rescue operations that command and control is in place. It must be emphasised that it is essential to have liaison and agreement with other agencies so control is not lost and dangerous situations occur.
3. Individuals can become victims as a result of being directly involved in an incident (eg in a property that is on fire or a car that is involved in an accident), by being affected by what they have just witnessed at an accident or becoming distressed when a relative or friend is involved. Reassurance can be a great tool in a firefighters arsenal.
4. The general public can also pose a hazard at incidents and the Police should be used to control crowds. When the Police are not available a barrier should be set up, such as by using a long line (rope) to keep crowds at a distance. The Police should deal with any difficult members of the crowd.

Hazards in the Working Area

5. Noise poses a problem to firefighters working on the fireground especially from operational equipment and operating pumps. Vehicle movements can also pose a hazard on the fireground, including Police and Ambulance vehicles responding to the incident.

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6. Working in hot and humid conditions (eg working for long periods in hot weather conditions in full PPE) can be hazardous. To alleviate these problems firefighters should take regular breaks

Hazards to the Environment

7. Firefighting operations can have detrimental effects on the environment, eg water, foam and chemical run off. Firefighters must endeavour to take all reasonable precautions to minimize damage on the environment during firefighting operations, seeking advice if required from the Environmental Agency.

OPERATIONAL RISK ASSESSMENT

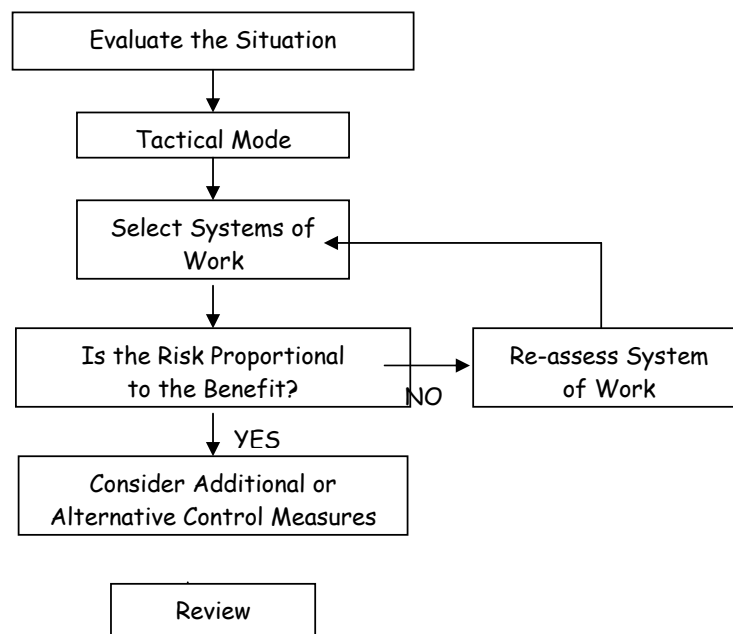
Introduction

1. The Health and Safety at Work Act requires everyone to take reasonable care for the health and safety of themselves and other persons who may be affected by their acts or omissions at work. It also requires everyone to co-operate with the support systems that the organisation has put in place. It is therefore incumbent on everyone to work within the parameters set for safe systems of work.
2. The application of risk assessment in the fire service poses obvious difficulties taking account of wide ranging operational scenarios and the reactive nature of responses. Risk Assessment is part of an overall system for the management of safety. Its purpose is to systematically identify hazards and quantify and control associated risks faced by personnel.

The Process of Risk Assessment

3. Unless hazards are systematically and adequately recognised it is unlikely that control measures will be successful. Dynamic risk assessment must be a continuous process, which means that at different times throughout the incident it will be necessary to revisit that which has already been assessed. It can be useful to look at an incident in 3 separate stages - Initial, Development and Closing.

Initial Attendance Stage of Incident

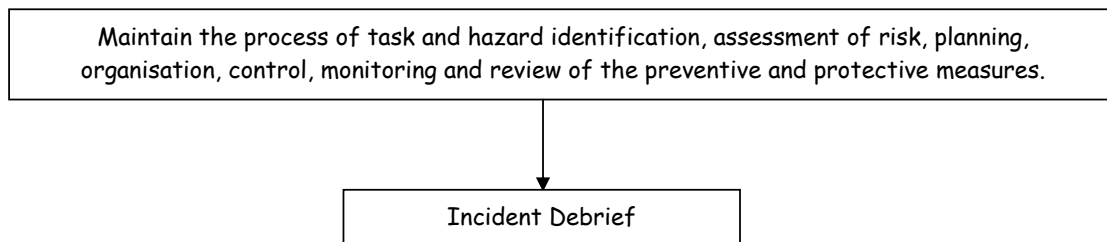


Development Stage of Incident

As the incident develops, re-evaluate the situation, tasks and persons at risk. Apply above model to take account of any new hazards and introduce control measures* as necessary to allow existing or new tasks to proceed.

Halt tasks completely if the risk outweighs the benefit to be gained.

Closing Stage of Incident



* The type of control measures adopted should be considered using the following hierarchy.

1. Elimination of the risk
2. Isolation of the risk by separating persons from it
3. Substitution of the risk by something with less risk
4. Control of the risk by engineering or other means
5. Control by applying safe systems of work
6. Provision of training and information
7. Provision of Personal Protective Equipment

Health & Safety on the Incident Ground

11. The principle consideration of the Incident Commander is the safety of all personnel. This must be established by assessing the hazards that are present and the possible risks to Health & Safety of those at the scene and adopting appropriate, safe systems of work.

12. The following summarises the philosophy of the fire service's approach to risk assessing:

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- a. Firefighters will take some risk to save saveable lives.
- b. Firefighters will take a little risk to save saveable property.
- c. Firefighters will not take any risk at all to try to save lives or property that is already lost.

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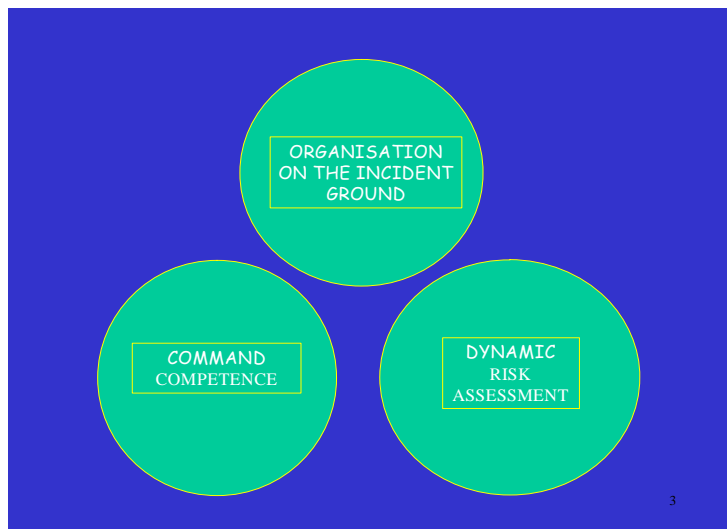
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INCIDENT COMMAND SYSTEM

1. An Incident Command System cannot exist in isolation. The design of systems for incident command and training and assessment of individuals and teams to operate those systems safely and effectively, need other critical factors, which support the incident command function. This needs to be considered in integrating the function within a Brigade's management system.
2. A Brigade should have a clear and coherent policy that sets out the approach to delivering effective incident command.
3. The arrangements by which the Incident Command System is delivered and supported should be defined clearly. This will allow all involved to understand the brigade's approach and objectives in relation to the command function.
4. There should be a planned approach to the development and implementation of the incident command function, the aim of which should be to minimise and mitigate risks. Risk assessment should be used to identify priorities for the development of the Incident Command System and to set objectives to eliminate hazards and reduce or control risk.



Key Elements of Incident Command

The Incident Commander

5. The fire service Incident Commander (IC) at an operational incident has the right to exercise authority over fire and rescue service resources on the incident ground.
6. The IC must ensure that adequate resources are available and arrangements have been made to control them.

Strategy, Tactics & Operations

7. Strategy is the planning and directing of an Organisation in order to meet its overall objectives. For fire and rescue service operations such objectives would be likely to include:

- a. Saving and protecting those in danger.
- b. Ensuring the safety of ops personnel.
- c. Protecting property.
- d. Protecting the environment.

8. Tactics can be summarised as the development of personnel and equipment on the incident ground to achieve the strategic aims of the Incident Commander. These will almost invariably be based on approved operational procedures.

9. Operations can best be described as tasks that are carried out on the incident ground, using prescribed techniques and procedures in accordance with the tactical plan. At small incidents all three levels of command decision-making will be the responsibility of one individual, likely to be the first arriving Crew Commander.

Resources & Control

10. The IC is responsible for securing and controlling resources on the incident ground. The assessment of resources will include:

- a. Appliances, Personnel, Equipment, Firefighting media and Consumables (eg Fuel and BA cylinders)
- b. The degree of control an Incident Commander will need to maintain will depend, in part, on the size and demands of the incident. At large incidents specific areas of resource control may be delegated to appointed officers. Such areas may include Firefighting, Command support, Logistics, Decontamination, Water, Foam and BA. These may be designated as "sectors" for control and identification purposes.

Briefing & Information

11. Effective communication is of critical importance at all incidents. Information has to be relayed accurately from the IC to crews carrying out the work and vice-versa so that crews are aware of the tactics being employed, and the IC is aware of what is happening on the incident ground.

Crew Management

12. Once crews have been briefed they must follow the brief and work safely. This will include wearing full PPE and ensuring that access and egress is properly secured. The IC will need to maintain a position where, so far as is practicable, he can observe proceedings.

Liaison

13. The Incident Commander must secure and maintain effective liaison with other agencies, which can contribute to resolving an incident. This will include liaison with other emergency services to co-ordinate activities effectively.

Post Incident Considerations

14. The majority of fire service activities and interests centre around the emergency phase of an incident. However, there are issues which involve the fire service well beyond the emergency phase, such as Fire Investigation, Financial costs to the brigade, Criminal Investigation and Incident Debriefing and Evaluation.

Communications

15. The Incident Commander must establish effective arrangements for communications, including:

- a. Links with control.
- b. Fireground radio call signs.
- c. Communications with other agencies.

The Incident Command System

16. The Incident Command System (ICS) is based on a framework that ensures manageable "Spans of Control". Other elements are built onto that framework. This provides the IC with the means to find a way through the complexity of the emergency situation and assists with the development of an effective and appropriate incident ground structure. The concept of the Span of Control is important to this basic structure. At a large incident the IC has to deal effectively with many people and a large amount of information. Therefore, the commander's span of control has to be limited. Sectorisation is central to the application of the principle of limiting spans of control.

Span of Control

17. The system requires that the direct lines of communication and areas of involvement of any officer be limited to enable the individual to deal effectively with those areas. No individual should be responsible for so many aspects of the incident that it is difficult or impossible to give sufficient attention to each.

18. The span of control for tactical roles should be limited to 5 lines of direct communications, to ensure that commanders do not become overburdened.

19. At small incidents where the area of operations is easily manageable and there are no sectors, the Incident Commander may oversee all aspects of the incident directly.

Incident Command System Roles

20. There are 3 basic roles in the ICS - Incident Commander, Sector Commander and Operations Commander.

a. Incident Commander. The Incident Commander will normally be the senior officer present at the incident according to each Brigade's policy determining ranks and responsibilities at incidents. The IC is responsible for the overall management of the incident and will focus on command and control, deployment of resources, tactical planning, and the health and safety of crews. Following an assessment of the incident the IC will allocate areas of responsibility to officers as necessary. These officers may be Sector Commanders.

b. Sector Commanders. To reduce the risk of confusion and to allow the proper assignment of tasks it is necessary for boundaries of responsibility at an incident to be clearly defined. This is best achieved by Sectorisation, with a Sector Commander appointed for each sector. The Sector Commander will normally report to the Incident Commander.

c. Operations Commanders. The role of Operations Commander exists as a means of maintaining workable spans of control. It allows some of the workload at large incidents with a number of sectors, to be taken away from the IC and provides an interface through which Sector Commanders can report.

Sectorisation of Incidents

21. Sectorisation should be considered when the demands of an incident make it imperative that responsibility and authority is delegated in order to ensure appropriate command and safety monitoring of all activities. Sector identification can vary provided the method used is consistent and clearly understood by all personnel.

22. The creation of a sector will only be done on the instructions of the IC who will choose a Sectorisation method appropriate to the demands of the incident. Even if it is possible for the IC to oversee all operations, the need to sectorise will arise if there is so much going on that the IC risks being distracted and unable to give sufficient attention to each task. This would indicate that the IC's span of control is greater than about 5 lines of direct communication at a working incident.

23. Sectors can be of various sizes depending upon the situation - high rise buildings may be sectorised on different floors, whereas large single storey buildings may be sectorised on each side. Similarly at a small RTA there will be no need to sectorise, unless a large distance separates the vehicles where it may be necessary to adopt Sectorisation.

The Tactical Mode

24. There are three Tactical Modes - Offensive, Defensive and Transitional.

Offensive

25. This mode may apply to a sector, or the entire incident. It is usually applied where the operation is being dealt with internally, with the objective of carrying out search and rescue or fighting the fire before it involves the whole building, and threatens its stability. Offensive mode is the normal mode of operation used at, for example, house fires and industrial premises to fight fire, effect rescues and to close down plant.

Defensive

26. This mode may apply to a sector or the whole incident. It is generally employed for external operations and must be applied where committing firefighters internally would constitute an unnecessary risk to life (for example at a fire that has fully involved an evacuated large uncompartmented building, or in a building that is displaying signs of collapse).

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27. In these circumstances the Incident Commander would adopt the Defensive Mode, fighting the fire with external and aerial jets, and protecting exposure risks and adjoining property.

Transitional

28. This mode may only apply to the whole of the incident and not to individual sectors alone. It is used where the Incident Commander intends a change in the mode of operations or where a combination of both Offensive and Defensive modes are in operation within different sectors at the same incident.

29. Examples of when Transitional Mode would be adopted are:

- a. A building fire being fought externally with sectors in Defensive Mode has an annex that can be saved, safely, by using an Offensive Mode (ie by fighting the fire inside the annex).
- b. A Defensive approach is being utilised only as an interim measure, until further resources arrive, which will enable the Offensive Mode to be established and an attack on the fire to commence.
- c. An Offensive approach is in operation but circumstances dictate that an evacuation and withdrawal of equipment is necessary in order that a Defensive Mode can be utilised.

30. The IC must make an assessment of the incident and decide which Tactical Mode will be appropriate; advising the Control Centre which Mode is in operation. Updates of any change should be provided at 20-minute intervals. When a Tactical Mode has been decided, the IC must ensure that everyone on the incident ground is aware of it.

ICS EQUIPMENT

To enable the Incident Commander to achieve his aim, ICS packs have been introduced at DFTDC for training purposes. It is anticipated that these (or similar) packs will be issued to all stations in due course.

ICS PACK CONTENTS

The ICS Pack comprises:



Tabards

Acrylic boards - Incident, Sector Command, Additional Agencies and Radio Allocation

Compass

Whistle

Risk Assessment Folder



Reversible tabards are provided for:

Fire Incident Commander

Command Support

Fire Sector Commander

Safety Officer



Compass
Whistle

ICS Pack showing Acrylic Boards
Compass and Whistle



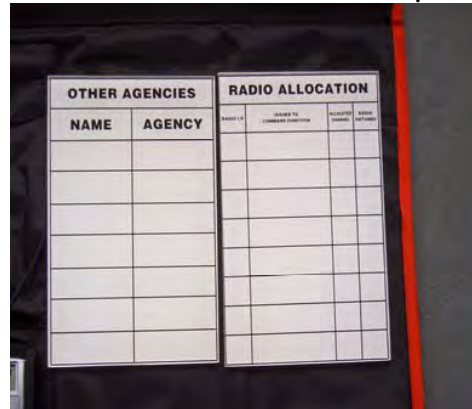
ICS Pack Incident Board
Enables sketch of Incident Area
to be made

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ICS Pack Sector Command Boards

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ICS Pack Other Agencies and Radio Allocation Boards



ICS Pack Risk Assessment Folder

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FIREGROUND SIGNALS

Safety Words of Command

1. There are a number of safety commands that may be used during both fire service drills and operational tasks.
 - a. **Rest**. Rest is used by the instructor when carrying out a drill to point out a mistake. The crew are to remain still until the order 'carry on' is given.
 - b. **Still**. Still is only to be used in an emergency in order to prevent an accident. It can be given by anyone on the fireground and maximum force is to be used. All personnel must remain perfectly still, exactly where they are.
 - c. **Carry On**. The command 'carry on' is used to counter the commands Rest and Still once the mistake or danger has been removed.
 - d. **Stand from Under**. Used when anything is being lowered or dropped from above, or where a building is showing signs of falling masonry or collapse. Personnel should remove themselves from under to a place of safety.

Visual and/or Verbal Fireground Signals

2. A number of signals may be given visually and/or verbally on the fire ground.
 - a. **Water On**. The arm is raised sideways over the head to its fullest extent and lowered smartly to the side. This signal should never be given until a branch is manned and the branch man is ready and prepared.
 - b. **Knock Off**. The right arm is extended horizontally, swung across the chest and back again.
 - c. **Increase Pressure**. As for Water On but repeated several times. Pump operators should increase pressure by 1 bar, unless otherwise instructed.
 - d. **Reduce Pressure**. One arm is extended horizontally from the shoulder and the other arm is raised vertically. The pressure should be reduced by 1 bar, unless otherwise instructed.
 - e. **Knock Off and Make Up**. Both arms are extended outwards and dropped to the sides.

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- f. Report to Me. The right arm is rotated around the head and then the hand is placed flat on the head (or helmet).

- g. Acknowledgement of Signals. All visual signals should be acknowledged by repeating the signal.

MANUAL HANDLING

Introduction

1. The Manual Handling Regulations 1992 came into effect on 1 January 1993 and implemented an EC directive on manual handling.

Purpose

2. Employers must avoid all hazardous manual handling activity where it is reasonably practicable to do so. If it is not practicable to eliminate manual handling, employers must assess the risk in relation to the nature of the task, the load, the working environment and the capabilities of the handler, and take action to reduce the risk to the lowest level possible.

Manual Handling

3. Just over a quarter of the accidents reported each year to the Health and Safety Executive (HSE) are related to the manual handling of loads.

4. Sprains and strains particularly of the back are the most common injuries but there are amputations, fractures, cuts and bruises that occur.

5. Beyond this is a large unquantifiable problem of cumulative injury leading to physical impairment or even permanent disablement.

Note: No type of work is immune

Application of the Regulations in the MOD

6. The regulations apply to all work in the MOD. Heads of establishments are to avoid, so far as is reasonably practicable, the need for any manual handling operations, which involve a risk of injury. Where it is not reasonably practicable they are to appoint competent persons to undertake assessments at work.

Duties of MOD Personnel

7. Every employee is to make full and proper use of systems of work provided by the MOD. Personnel engaged in manual handling are to inform their managers/ supervisors about any physical or medical condition, which might affect their ability to undertake manual handling operations safely.

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8. Personnel who believe that a task that they are expected to perform merits an assessment or a review are to make their line manager aware of the situation so this can be carried out.
9. Personnel are to make proper use of equipment provided for load handling.

Manual Handling of Loads

10. In order to understand the concept on which the correct lifting techniques are based, it is necessary to learn something about the construction of the spine.
11. The spine is a hollow column made up of a series of separate interlocking bones known as vertebrae, which are separated from each other by a small cushion of resilient tissue. This tissue not only provides a cushion against the shock of landing heavily but also allows each vertebrae, at least in young people, to move (slightly) independently of its neighbour.
12. In certain forward and backward movements the cushion will have a tendency to act as a hinge between the vertebrae. If, therefore too much strain is applied with the body in the forward or backward position, the hinge can be damaged resulting in a very painful injury - Slipped Discs.
13. To ensure that such injuries are avoided, safe-lifting techniques must always be practiced.

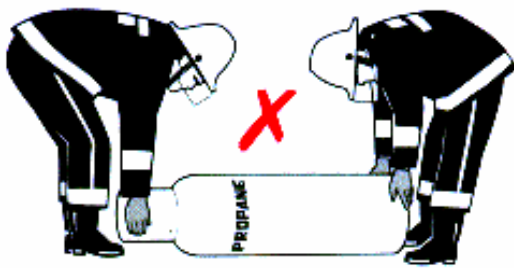
Correct Lifting Techniques

14. Where lifting heavy objects the correct practice is to place the load near the feet, bending the knees and maintaining the spine in a straight posture. When the load is to be raised, the straightening of the legs and maintenance of a straight back places the strain on the powerful leg muscles and not on the back muscles; lifting then requires less effort.

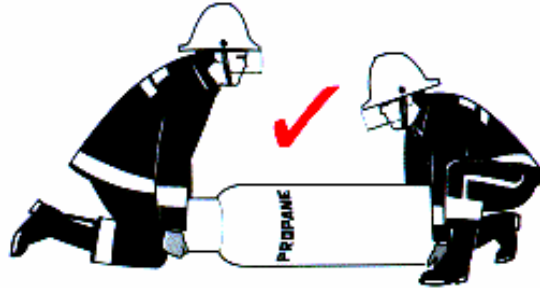


Two Person Lifting Techniques

15. When lifting a heavy or sizeable load requiring 2 firefighters, both should lift together with the knees bent, back straight and facing squarely to the load.

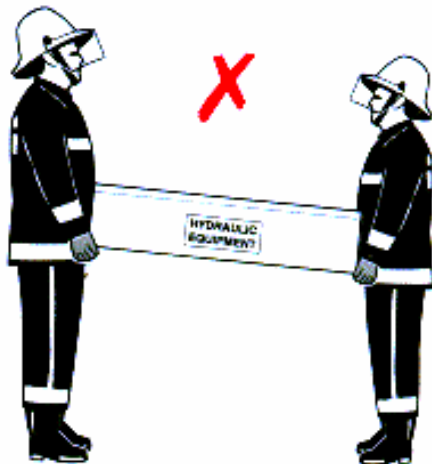


The wrong method with legs straight and backs bent

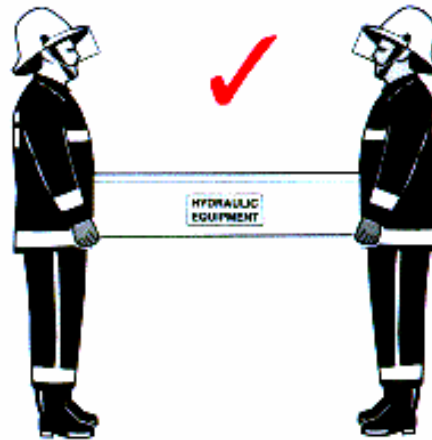


The right method with legs bent and backs straight

16. It is important when 2 firefighters are lifting a heavy load together that the load is evenly balanced between them. The ideal is for both to be of a similar height and physique to avoid undue strain on the smaller firefighter.



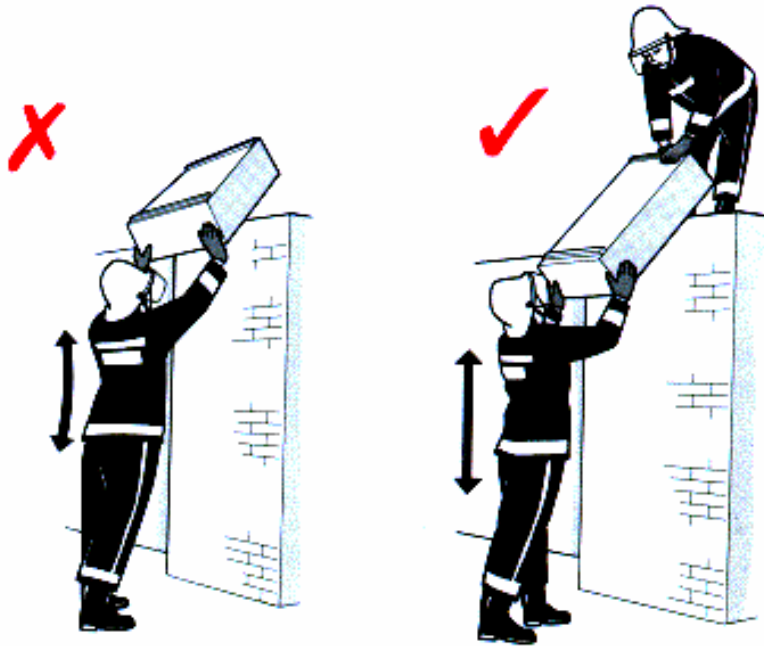
The wrong method with the excess strain on the smaller firefighter



The right method with the load equally balanced

Lifting a Load from Height

17. It is important to seek assistance when lifting a load from height or needing to move a load into position for lifting or lowering. Any attempt to move a load single-handedly by jerking can give rise to the danger of causing a serious strain. Additionally, there is the possibility of the load falling and a more serious injury occurring.



The wrong method showing damage to the spine by sudden jerking movements

The right method showing gradual application of the load with assistance

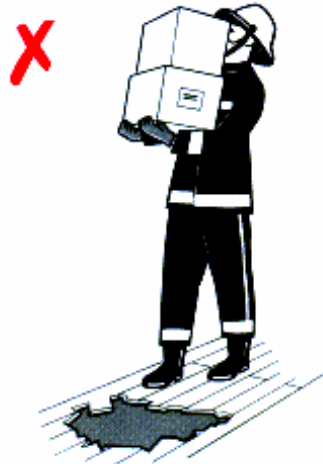
Pushing a Load

18. The full weight of the body should be placed squarely behind a load whenever it is necessary to push it along. The hands should be placed firmly on the load so that the weight of the body will be transmitted, via the arms, to the load to be moved.



Carrying a Load

19. A load should never be carried blindly. The person carrying should be able to see the way and any possible obstructions.



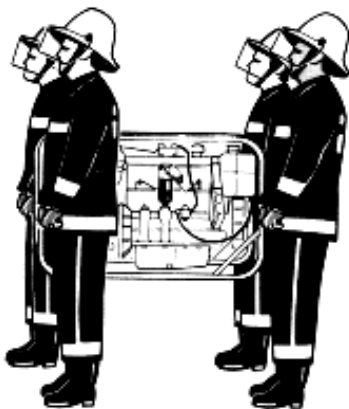
The wrong method of carrying a load and being unable to see the hazards ahead



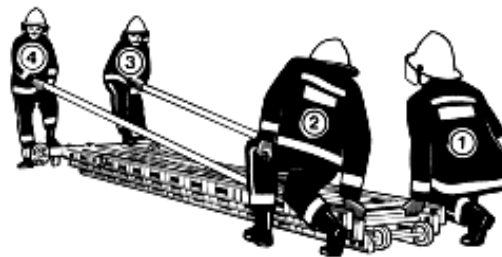
The right method allowing the carrier to see any obstructions

Multi Person Carrying

20. When a number of persons are carrying a load together it is important that they work as a team and that no undue strain is placed on any individual. There must be sufficient persons to carry the load and the orders 'lift' and 'raise' should be given to ensure a concerted effort



The correct method of carrying a load with sufficient personnel to share the burden



The correct method of multi person lifting by the application of forces at different points to move or raise a heavy object

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DANGEROUS SUBSTANCES

SN 20

1. INTRODUCTION

This study note relates to the identification of dangerous substances being conveyed by road and describes how firefighters can use action codes to deal with incidents involving them.

2. THE NATURE OF THE PROBLEM

The number of dangerous substances that may face firefighters at an incident is immense.

For firefighters to cope safely and efficiently with such an incident they must be able to quickly, and without difficulty, discover the nature of the danger and how they should respond.

Sometimes the substances will be at fixed sites, such as factories and laboratories. Here it is essential that firefighters take active steps in advance to familiarise themselves with the dangers and how to cope with them.

While many incidents involve goods being kept in one place, a greater problem could arise with goods in transit, particularly those in bulk tankers. Clearly it would be difficult for firefighters to know in advance the details of all the dangerous substances being transported within their areas. They must therefore be able to obtain the information they require at the time and to rely on it. This is generally achieved by regulations requiring vehicles carrying hazardous substances to be marked with appropriate warning signs.

3. TYPES OF DANGEROUS SUBSTANCES

The United Nations classifies nine types of hazard relating to the transport of dangerous goods. These are as follows:

- (a) Class 1 : Explosives
- (b) Class 2.1 : Flammable gases
- (c) Class 2.2 : Non-flammable, non-toxic gases
- (d) Class 2.3 : Toxic gases
- (e) Class 3 : Flammable liquids
- (f) Class 4.1 : Flammable solids, self-reactive substances and solid desensitised explosives
- (g) Class 4.2 : Substances liable to spontaneous combustion
- (h) Class 4.3 : Substances which in contact with water emit flammable gases
- (i) Class 5.1 : Oxidising substances
- (j) Class 5.2 : Organic peroxides
- (k) Class 6.1 : Toxic substances
- (l) Class 6.2 : Infectious substances
- (m) Class 7 : Radioactive material
- (n) Class 8 : Corrosive substances
- (o) Class 9 : Miscellaneous dangerous substances and articles

Note: In this column the number following a decimal point always indicates a sub-division of a class.

4. THE LABELLING OF DANGEROUS SUBSTANCE CONTAINERS

The number of dangerous substances covered by the nine classes is very great and their physical characteristics - colour, smell, etc, even if apparent, are not necessarily such as to distinguish clearly one from another. This is particularly so for non-experts.

When goods are in transit, information regarding the substances being transported may be available from:

- (a) The driver of the vehicle.
- (b) The consigner's documents.
- (c) The vehicle may carry special instructions on the action necessary in the event of an incident.

In some accidents, however, firefighters would not be able to consult these. In such circumstances, unless they have obtained information in advance, they must rely on the labelling of the vehicle, the tank, the tank compartment or the container.

5. HAZARD WARNING PANELS

The Carriage of Dangerous Goods by Road Regulations 1996 relates to the identification of dangerous substances being conveyed by road or any other substance offering a comparable risk.

The Regulations require that each vehicle should display composite Hazard-Warning Panels. The panel has an orange background with black lettering, except for one of the sections, which shows a variously coloured hazard warning diamond symbol on a white background.

Hazard Warning Panels shall be so mounted as to be clearly visible and will generally be sited:

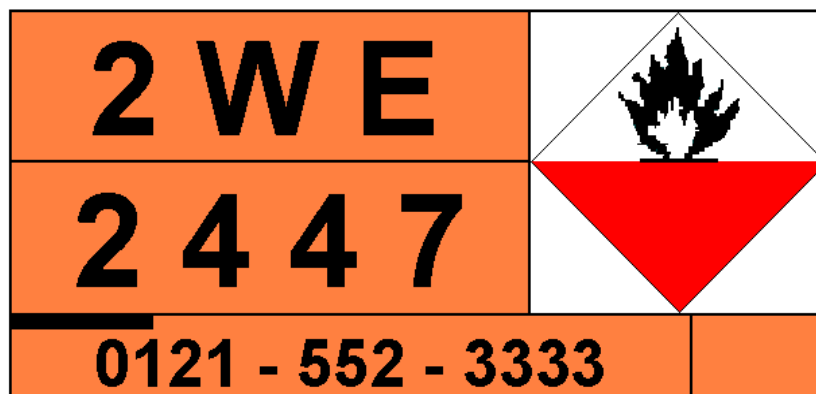
- (a) At the vehicles rear.
- (b) On both sides towards the front.

6. THE HAZARD WARNING PANEL IS DIVIDED INTO FIVE SECTIONS AS SHOWN BELOW.

EMERGENCY ACTION CODE (d)	HAZARD WARNING DIAMOND (a)
SUBSTANCE IDENTIFICATION NUMBER (b)	
SPECIALIST ADVICE TELEPHONE NUMBER (c)	MANUFACTURERS NAME/LOGO (c)

Example of a Hazard Warning Panel

The Regulations also make provision for the simultaneous conveyance, in separate compartments of the same tanker, substances of the same class, namely multi-loads.



The Hazard Warning Panel under these circumstances will vary from the one above in that the Substance Identification Number will be replaced with the words 'MULTI-LOAD'.

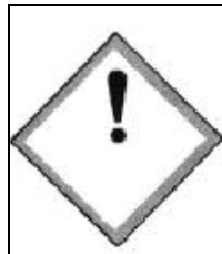
(a) **Hazard Warning Diamond.** As can be seen from the above example, the right hand section of the Hazard Warning Panel contains a symbol in the shape of a diamond. This indicates that the contents of the vehicle are dangerous and shows the broad nature of the principal hazard they present. The symbols are internationally agreed and relate to the classes listed in the 'Types of Dangerous Substances' in Section 3.

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Where multi loads are in different classes the Hazard Warning Diamond will register an exclamation mark! as shown below.



In these circumstances each compartment will also be labelled with the Substance Identification Number to identify the hazard presented by the separate load. (see 6 (b)).

(b) **Substance Identification Number.** The middle section of the Hazard Warning Panel contains a Substance Identification Number produced by The United Nations. This is an international list of the most commonly transported dangerous substances that The United Nations has assigned a separate number to, commonly known as the UN number. Member states of the UN have agreed to use these numbers on their transport vehicles so that the contents can be identified by reference to an index.

Sometimes the name of the chemical appears under the number.

Firefighters should be aware that the number does not necessarily give a precise identification: it may indicate only a general class. As mentioned earlier, where a tanker is conveying a multi-load the word 'multi-load' should appear instead of a number. Each



compartment will, however, also be separately labelled and this label will carry the Substance Identification Number

(c) **Specialist Advice Telephone Number.** In the bottom two sections of the Hazard Warning Panel, there will be a telephone number on the left hand side and, possibly, on the right hand side (which otherwise remains blank) a manufacturer's name or symbol.

Contact with the telephone number brings into operation the Chemsafe scheme organised by the Chemical Industries Association (see Section 10).

(d) **Emergency Action Code (EAC).** The top left of the panel contains the Emergency Action Code, commonly known as the Hazchem code.

The codes are designed to be used in conjunction with the Emergency Action Scale Cards, which should be carried by emergency service personnel. The cards indicate the action that may be necessary (except additional personal protection (APP)) DURING THE FIRST FEW MINUTES of an incident.

The codes allocated apply to the transport in bulk (i.e. 3,000 litres or more) of a substance by road or rail. These codes will not necessarily apply for non-transport incidents although they may be used to provide some indication of the action that may be necessary.

Substances in Class 7, i.e. radioactive material, although included in the list, have not been allocated emergency action codes.

7. INTERPRETATION OF EMERGENCY ACTION CODE

The code consists of a number from 1 to 4 and one of the letters P, R, S, T, W, X, Y, Z, sometimes followed by letter E.

The code does not identify the contents of a vehicle. Its purpose is to indicate the basic method of dealing with an incident.

Set out below is the detail found on an Emergency Action Scale Card followed by a description of the meaning of the different numbers and letters.

Emergency Action Code Card 2004

Emergency Action Code Card 2004
FOR FIRE OR SPILLAGE

EAC
LIN No.

1 **COARSE SPRAY**
2 **FINE SPRAY**
3 **FOAM**
4 **DRY AGENT**

P	V	LTS	DILUTE
R			
S	V	BA & FIRE KIT	
T			CONTAIN
W	V	LTS	
X			
Y	V	BA & FIRE KIT	
Z			

E PUBLIC SAFETY HAZARD

Additional Information

Dry Agent
Water must not be allowed to come into contact with the substance at risk.

V
Substance can be violently or even explosively reactive, including combustion.

LTS
Liquid-Tight chemical protective Suit with BA.

Dilute
May be washed to drain with large quantities of water.

Contain
Prevent, by any means available, spillage from entering drains or water course.

E
People should be warned to stay indoors with all doors and windows closed but evacuation may need to be considered. Consult Control, Police, and product expert.

8. EXTINGUISHING MEDIA

The firefighting extinguishing media is determined by reference to the first character of the Emergency Action Code as follows:

1 denotes *COARSE SPRAY*.

2 denotes *FINE SPRAY*.

3 denotes *NORMAL FOAM* i.e. protein type foam that is not alcohol resistant.

4 denotes *DRY AGENT* - water **MUST NOT** be allowed to come into contact with the substance.

NOTE: ANY HIGHER NUMBER THAN THE ONE SHOWN CAN BE USED BUT A LOWER NUMBER MUST NOT BE USED.

9. **PERSONAL PROTECTION**

Where the second character of the Emergency Action Code is S, T, Y or Z, self contained open circuit positive pressure compressed-air breathing apparatus should be worn in combination with fire kit consisting of tunic, over trousers and firefighters' gloves. The fire kit shall conform to the appropriate British Standard.

Where the second character of an Emergency Action Code is P, R, W or X, liquid tight Chemical Protective Clothing (CPC) conforming to the appropriate British Standard in combination with the breathing apparatus as specified above should be used.

10. **VIOLENT REACTION**

Where the second character of the Emergency Action Code is a P, S, W or Y, there is a danger that the substance can be violently or explosively reactive. This danger exists for all flammable gases and flammable liquids with a flash point below 61°C as well as for many other reactive substances.

11. **CONTAIN**

Where the second character of an Emergency Action Code is W, X, Y or Z, spillages should be prevented from entering drains and watercourses.

12. **DILUTE**

Where the second character of the code is P, R, S or T, spillages may be washed to drains with large quantities of water. Due care must, however, still be exercised to avoid unnecessary pollution of watercourses.

NOTE: In order to mitigate the effects of environmental pollution by fire service operations and to improve liaison between the fire service and the Environment Agency, a consistent set of arrangements and standards for dealing with incidents has been established.

Ideally all contamination and decontamination run-off should be contained. However, the Environment Agency accepts that this will not always be practical for normal fire service operations and that life saving operational procedures must take precedence over other considerations at the scene of an incident. Nevertheless, all steps that are reasonably practicable should be taken to contain contaminants and the fire service should always inform the Environment Agency as soon as possible so that appropriate advice can be given.

13. **'E' - PUBLIC SAFETY HAZARD**

An 'E' following the first two characters of an Emergency Action Code indicates that there may be a public safety hazard and that the following actions should be taken:

(a) People should be warned to stay indoors with all doors and windows closed, preferably in rooms upstairs and facing away from the incident. Ignition sources should be eliminated and any ventilation stopped.

(b) Effects may spread beyond the immediate vicinity. All non-essential personnel should be instructed to move at least 250 metres away from the incident.

(c) Police and fire service incident commanders should consult with each other and also with a product expert, or with a source of product expertise.

(d) The possible need for subsequent evacuation should be considered, but it should be remembered that in most cases it would be safer to remain in a building than to evacuate.

14. **ADDITIONAL PERSONAL PROTECTION (APP)**

As mentioned above, the Emergency Action Codes are only intended to provide advice during the initial stages of an incident. In all cases, further information on the hazards likely to be encountered from the substance or substances and the additional protection required of firefighters should be obtained from fire control as a matter of urgency.

This particularly applies to protective clothing requirements as some substances can be dealt with using Liquid-tight Chemical Protective Clothing (CPC) but in other circumstances Gas-tight Chemical Protective Clothing should be worn.

15. **INTERNATIONAL OPERATIONS - ADR HAZARDOUS IDENTIFICATION NUMBER (HIN)**

The transport of dangerous goods between most European countries is governed by an agreement commonly known as ADR.

The purpose of the agreement is to ensure that dangerous goods transported by road across European frontiers comply with certain conditions, amongst them being the marking of vehicles carrying such loads.

These vehicles must display two forms of hazard identification:

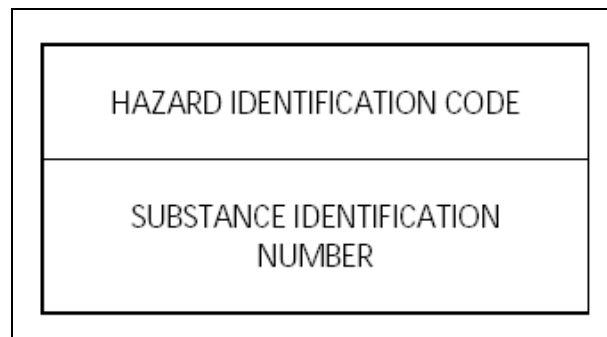
- (a) The Hazard Warning Diamond of the type described in Section 5(a); and
- (b) An ADR Warning Panel.

The ADR Warning Panel is an orange coloured plate (40cm wide by 30 cm high) with black lettering.

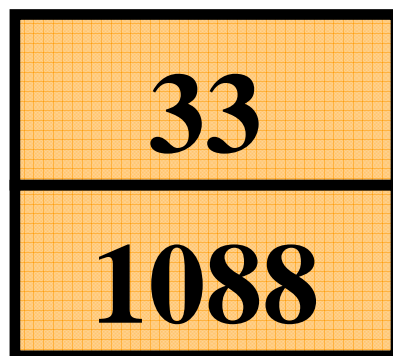
The panels shall be so mounted as to be clearly visible and will generally be sited:

- (a) At the vehicles front.
- (b) Its rear.

The plate shall contain the following information:



16. EXAMPLE OF ADR WARNING PANEL



The Hazard Identification Code consists of two or three figures and in general, the figures indicate the following hazards:

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1 = Not used.

2 = Emissions of gas due to pressure or to chemical reaction.

3 = Flammability of liquids (vapours) and gases or self-heating liquids.

4 = Flammability of solids or self-heating solids.

5 = Oxidizing (fire-intensifying) effect.

6 = Toxicity (or risk of infection).

7 = Radioactivity.

8 = Corrosive.

9 = Risk of spontaneous, violent reaction.

Doubling of a figure (e.g. '33') indicates an intensification of that particular hazard.

Where the hazard associated with a substance can be adequately indicated by a single figure, it is followed by a zero. (E.g. '30').

If the letter 'X' prefixes a hazard identification number, this indicates that the substance will react dangerously with water. For these substances, water may only be used with the approval of experts.

As in the Regulations for the UK, the ADR code also makes provision for the marking of vehicles simultaneously by conveying in separate compartments of the same tanker, substances of the same class or of different classes, namely multi-loads. Under this circumstance the Orange ADR Warning Panel at the front and rear of the vehicle will be left blank and individual Compartment Labels, together with Hazard Warning Diamonds to identify the hazard presented by the separate loads in each compartment, are required.

17. OBTAINING FURTHER INFORMATION

Some of the information available at an incident, for example from the Tremcards or by the Emergency Action Code, will enable firefighters to know at once the basic action they should take. If, however, this information is missing or more details are required then further enquiries must be made. The officer-in-charge must contact Fire Control who will have further resources available, such as computer based information systems or access to specialist officers.

18. OBTAINING ASSISTANCE IN THE IDENTIFICATION OF HAZARDOUS SUBSTANCES

Chemsafe (Chemical Industries Scheme for Assistance in Freight Emergencies)

The scheme requires that vehicles should carry effective markings plus Tremcards [see section 20] or other written instructions on the action to take in an emergency. More than this, however, it recognises that the emergency services may urgently require more detailed advice or help either by telephone or at the scene. The main aim of the scheme is to ensure that this advice and help are constantly available. The scheme is, by intention, comprehensive amongst members of the Association, to which most firms belong.

19. THE STANDARD PROCEDURE

The Chemical Industries' Association first introduced the Chemsafe scheme in January 1974. A number of its provisions have now been incorporated in legislation. Some of its provisions remain voluntary, however, and firefighters should be prepared for firms to operate the scheme in different ways and to different degrees.

(a) **The standard procedure.** Under the standard procedure, each firm ensures that its vehicles are clearly labelled with an emergency telephone number. By calling this number the fire service should be able to obtain advice and help at any time. Each firm, with assistance from the Association, makes its own arrangements for guaranteeing 24 hour coverage and these may include co-operation with other firms.

(b) **Long-stop procedure.** Contact with the emergency number should be the first course of action. In some circumstances, however, the number may be missing or obscured or the arrangements may break down. In this case, there is a long-stop procedure for obtaining assistance, even though the manufacturer or trader is unknown or unobtainable or the product is unidentified.

National Chemical Emergencies Centre [N.C.E.C.]

The principal element of this long-stop procedure is the National Chemical Emergencies Centre at Harwell. This has a continuously manned telephone through which the public emergency authorities can ask for advice on the chemical hazards of a product involved in an incident. In order to readily identify hazards and the emergency action that should be taken for the numerous different products being marketed, the Centre has established a computerised chemical data bank to which members of the Chemical Industries Association are invited to contribute information on their products. N.C.E.C. duty officers, who are scientifically qualified and experienced in handling hazardous materials, have access to this.

If assistance is needed at the scene the Centre will turn out its own qualified staff or, if it is more convenient, request a particular company to send help. The manufacturer or trading company actually involved should take over as soon as its identity is known. The other assistance provided will, however, remain until no longer required.

The data bank at the Centre is very extensive but firefighters should appreciate that the standard of information it can give will vary. The Centre depends on manufacturers to supply information, which it cannot then alter. Accordingly the data bank does not cover some chemicals at all whilst on others it has different information from different sources.

Where the standard procedure does not apply, a telephone call to N.C.E.C. is the normal course of action. The fire service may contact a local firm directly if this seems likely to provide the required help more quickly. Such a firm may not, however, have detailed knowledge of a chemical it does not handle itself.

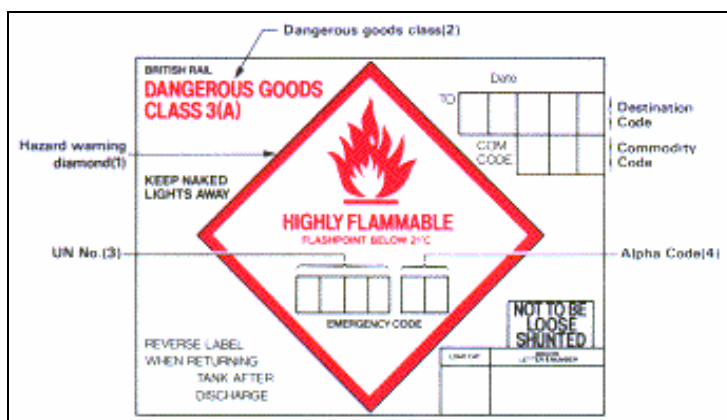
20. TREMCARDS (TRANSPORT EMERGENCY CARDS)

Many companies, in meeting their obligation to provide each vehicle conveying a dangerous chemical with written instruction on the action to take in case of emergency, provide a Tremcard. This is a standard A4 size card in red and black issued for each of a number of common hazardous chemicals. The card gives:

- (a) The chemical name of the substance;
- (b) Its appearance and chemical properties;
- (c) Its hazards and the precautions against them;
- (d) The action necessary in the event of fire or spillage;
- (e) The appropriate first-aid treatment; and
- (f) Possibly, an emergency telephone number.

21. OTHER MEANS OF IDENTIFICATION LABELS

Labels on wagons. Conveyors of dangerous goods sometimes use their own labelling systems in addition to any laid down by law. An example is the British Rail wagon label [see below].



This shows a hazard warning diamond (1), the class of dangerous goods which this indicates (2), the U.N. number (3), and British Rail's own Alpha code (4) which indicates to their staff a source of specialist advice. British Rail can also advise on the contents of any goods train by reference to their records. Firefighters should note that in some cases, e.g. petroleum fuel, the number at (3) may identify the contents more precisely than the substance identification number in the hazard warning panel. Where the contents are mixed the number 8969 will appear here and the hazard warning diamond will show an exclamation mark.

Apart from these labels the tank wagon colour may also help identify the contents. Those carrying liquefied gases have a white barrel with a horizontal orange stripe and those carrying highly flammable liquids are dove grey with signal red sole bars.

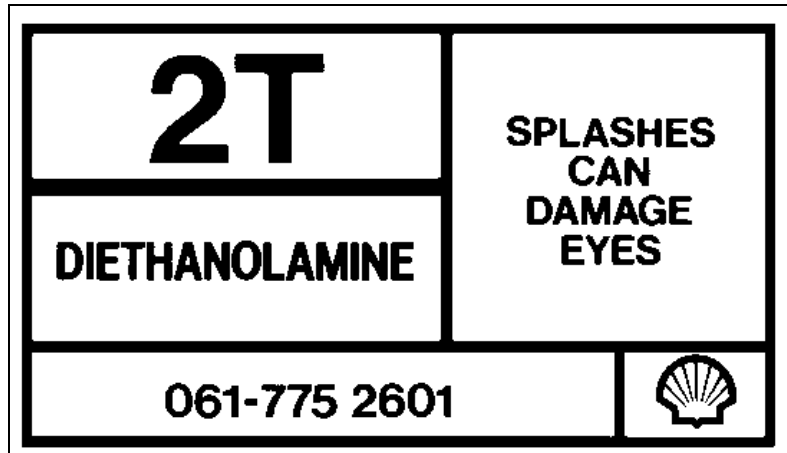
22. SUBSTANCES OF LOW HAZARD

The Chemical Industries Association has introduced a voluntary scheme, known as the black and white marking scheme, for the marking of domestic tanker vehicles carrying substances of low hazard. The substances concerned are those not covered by the DANGEROUS SUBSTANCES [CONVEYANCE BY ROAD IN ROAD TANKERS AND TANK CONTAINERS] REGULATIONS 1981. The scheme states that such tankers should be labelled with panels similar in general appearance to the hazard warning panels described in Section 4 above but using only the colours black and white. The panels convey the same general information as the hazard warning panels. The two principal differences are:

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- (a) There is no hazard warning diamond but words of warning may appear in the same place.
- (b) There is no substance identification number but in the same place there appears some descriptive term: the chemical name, a common name, a trade name or, if appropriate, the expression 'Multi load'.



23. DEALING WITH CHEMICAL INCIDENTS

The first in attendance at an incident may not be aware initially that hazardous chemicals are involved, because of a lack of identification markings on the vehicle, premises or container. Even when firefighters do know or learn this, they may not know the nature of the chemical and how they should deal with it.

The Officer-in-Charge (OIC) can take certain precautions from the start, for example:

- (a) Keep appliances and men upwind, clear of any vapour cloud and out of contact with the chemical.
- (b) Order breathing apparatus to be worn.
- (c) Arrange for an ambulance to be on stand by.

The OIC must, in any case, gather any information, summon further assistance and, if necessary, take any other action that is immediately required, for example, evacuation.

24. **PRECAUTIONS TO BA WEARERS**

(a) **Personnel wearing breathing apparatus.** When a firefighter wearing breathing apparatus is contaminated he should, if possible, leave the incident in time for decontamination to be completed before his cylinder runs out. A minimum reading on the gauge of 150 bars is desirable. All cylinders should be checked before decontamination starts and if any is dangerously low [say, below 100 bar] the decontamination officer should use any means available to ease the situation. He/she could supply the wearer by air-line or, if that is not possible, change the cylinder. When breathing apparatus is removed during decontamination the wearer should, if necessary, be protected by air-line mask, dust mask, or respirator.

(b) **Record keeping.** The decontamination officer should ensure that a record is maintained showing:

- i. The names and stations of firefighters who have been decontaminated.
- ii. The chemical concerned.
- iii. Any other relevant information such as;
 - (1) Their role in the incident.
 - (2) How contamination occurred.
 - (3) The period of contamination.
 - (4) The areas of their bodies contaminated.
 - (5) The decontamination procedure used.

These details should ultimately be recorded at your units Medical Centre. Such information can also helpfully be recorded in respect of members of the public who have to undergo decontamination in case it is needed for medical purposes.

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EXPLOSIVES

Hazard Divisions

1. The UN system of classification of dangerous goods categorises explosives as Class 1. However, to ensure safety during storage, handling and transport explosives are sub-divided into Hazard Divisions (HDs) and Compatibility Groups (CGs). This is essential in order to control the conditions under which these operations are conducted. The Classification of Explosives Regulations (JSP 482) deals with such matters as:
 - a. The type of hazard anticipated if the items are involved in a fire or explosion (eg the probability of mass explosion).
 - b. The possibilities of fighting a fire in which the items are involved.
2. The Hazard Divisions (HD) is categorised according to the hazards presented in the event of initiation. The initial figure in a given HD (1) refers to the Class of Dangerous Goods (ie Class 1); the second figure to the HD (1 - 4 within MOD).
3. Each HD is designated in storage and transportation by the presence of a fire symbol, which may or may not be accompanied by a supplementary fire symbol. These symbols are illustrated in Figures 1 & 2.
4. The main characteristics for each HD are as outlined in the paragraphs that follow.

Hazard Division 1.1

5. The following are characteristic of HD 1.1:
 - a. HD 1.1 comprises substances and articles that have a mass explosion hazard.
 - b. The major hazards are blast, high velocity fragments and other projections of low velocity. An explosion could result in severe structural damage, the severity and range being determined by the amount of explosive involved and the distance from the explosion site. There may be a risk from heavy debris propelled either from the structure in which the explosion occurs, or from the crater.
 - c. HD 1.1 may display hazards associated with other divisions.

Hazard 1.2

6. The following are characteristic of HD 1.2:
 - a. HD 1.2 comprises substances and articles that have a projection hazard but not a mass explosion hazard.
 - b. An explosion results in items burning and exploding progressively, a few at a time. Furthermore, fragments, firebrands and unexploded items may be projected in considerable numbers; some of these may explode on impact and cause fires or explosions. Blast effects are limited to the immediate vicinity.

Hazard Division 1.3

7. The following are characteristic of HD 1.3:
 - a. HD 1.3 comprises substances and articles that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.
 - b. HD 1.3 includes some items that burn with great violence and intense heat, emitting considerable thermal radiation (mass fire hazard), and others which burn sporadically. Items in this division may explode but do not usually form dangerous high velocity fragments. However, firebrands and burning containers may be projected.

Hazard Division 1.4

8. The following are characteristic of HD 1.4:
 - a. HD 1.4 comprises substances and articles that present no significant hazard.
 - b. HD 1.4 includes items that are primarily a moderate fire hazard. They do not contribute excessively to a fire. The effects are largely confined to the package unless the package becomes degraded due to the effects of the fire. No fragments of appreciable size or range are to be expected. An external fire does not cause the simultaneous explosion of the total contents of a package of such items.

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Figure 1 - Hazard Division Symbols



Figure 2 - Supplementary Fire Symbols

Compatibility of Explosives

9. In order to identify those explosives that are compatible and those that may have to be segregated to promote safety in storage and transportation, explosives are assigned to one of 13 Compatibility Groups (CGs) designated A to L, N and S.

Hazard Classification Codes (HCC)

10. The HD and CG for a given store combine to form the HCC, which is a 3 character code consisting of the 2 HD numerals and 1 CG letter (eg 1.1D, 1.2E, 1.3C). Packaging for explosives always displays the HCC on a diamond shaped orange label (known as an HCC Label).



Colour Coding and Marking of Explosive Stores and Packages

11. In addition to their normal supply identity and details of manufacture, MOD explosive stores carry markings, which are used to indicate their primary role and the degree of hazard that their contents present to persons who may handle them. The colour and style of these markings conform to standards set by a NATO coding and colour system. Some colours are significant, others non-significant. The details of these markings and colours are described and illustrated in JSP 482.

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12. The basic overall colour for explosives packaging will normally be one of the following:

- a. Service Brown.
- b. Light Grey (for CS natures only).
- c. IRR NATO Green.

13. Except for Light Grey, these colours are non-significant and do not relate to role or hazard. It should be noted that some packages, notably those for small arms ammunition, are not painted at all, but left with their natural finish, particularly those made of wood or fibreboard.

ACETYLENE

Introduction

1. All pressurized cylinders present a significant hazard when involved in fire. Acetylene, along with other fuel gases, presents particular risks because it is a highly flammable material stored in pressurised containers with the risk of explosive detonation if involved in fires.

2. Acetylene differs from other substances contained in cylinders in that it can decompose to its constituent elements if exposed to extreme heat and/or massive shock. This could result in a catastrophic failure similar to the combustion energy released from other gas cylinders if they burst in a fire. Acetylene is unique amongst the industrial gases in general use - it is a stable gas at ambient temperatures and pressure but can become unstable at elevated temperatures and pressures. To make the gas stable it is dissolved in a solvent (typically acetone) and then stored in a cylinder with a porous mass. The purpose of this is to ensure the acetylene is uniformly dispersed within the cylinder and in this condition it is classed as stable. The porous mass is inert filler and absorbs acetone, which prevents the formation of pockets of acetylene inside the main body of the cylinder. The combination of the solution in the acetone is uniformly dispersed throughout the cylinder and is thus stable.

General Properties of Acetylene

3. The general properties of Acetylene are:
- a. Highly flammable.
 - b. Odour of garlic.
 - c. Slightly lighter than air.
 - d. Soluble in organic liquids (eg acetone).
 - e. Wide flammability range - 2.5% to 80% (93% when mixed with Oxygen).
 - f. Toxic, narcotic and skin irritant

Ignition Energy

4. The ignition energy of acetylene is very low but its burning velocity and flaming temperatures are exceedingly high. Acetylene can be ignited by a wide range of sources including:

- a. Direct flame.
- b. Static discharge.
- c. Sparks (from aluminium rubbing on rusty steel).
- d. Friction.
- e. Shock.

Uses

5. When ignited, oxygen and acetylene together produce high flame temperatures (3,150°C). They are the only combination of gases, which can generate the temperatures required to weld steel. This ability to weld, cut, braze and solder means that acetylene cylinders can be found in many different types of premises

Cylinder Identification

6. Cylinders should be painted maroon in accordance with BS EN 1089-3 (formerly BS 349). Imported cylinders for general use in the UK are also painted maroon. However, there are some exceptions, for example, cylinders used by the USAF on air bases in the UK may be painted yellow and some cylinders on foreign vessels docked at UK ports may not be maroon. It is essential therefore to make a specific note of non-standard cylinders when carrying out familiarisation visits to such premises.

Pressure Relief Devices

7. Cylinders are fitted with pressure relief valves such as fusible pugs or bursting discs. These are designed to release the gas if the temperature or pressure rises excessively.

Note: Regardless of the type and location of the pressure relief device, its operation must not be taken as a signal that the cylinder is in a safe condition.

Causes of Decomposition

8. As long as any cylinder is exposed to direct heat in a fire there is a risk of catastrophic failure. The unique feature of acetylene is its ability to decompose with massive energy release after any fire has been extinguished but whilst the cylinder is still hot. Circumstances that can initiate decomposition include:

- a. Leaks from the cylinder's safety device (where fitted), valve or associated equipment, whether the gas has been ignited or not.
- b. Flashback from a torch into a cylinder or Burn back from hot work residue burning into supply tubes.
- c. Cylinders in the vicinity of a fire and subjected to heat.
- d. Hot cylinders that are dropped or suffer severe mechanical shock.

Signs of Heating

9. Signs, which can be used to detect possible heating include:

- a. Cylinder labels appear burnt.
- b. Plastic rings around the cylinder valve have melted away.
- c. Cylinder paintwork is burnt or blistered.

Wetting Test

10. It is important to try and identify if an acetylene cylinder has undergone internal decomposition due to flashback or excessive heating. The wetting test will give evidence of whether the outer shell is hot and should be used together with other indicators and information when conducting a Risk Assessment.

11. The Wet test involves:

- a. Take up a safe clear view, protected from any potential blast.
- b. Spray sufficient water on to the cylinder to wet the whole surface.
- c. Stop the spray and look for signs of steam rising from the surface of the cylinder.

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- d. If steam is not seen rising, does the wetted cylinder surface dry out quickly?

Note: Under test conditions decomposition inside a cylinder could not always be detected. Use of a Thermal Imaging Camera (TIC) may only provide an indication that the surface of the cylinder is hot.

Incident Command

12. When it is suspected that acetylene cylinders are, or have been, involved in a fire an initial hazard zone of 200m from the cylinders should be considered in liaison with the police. If it is established that cylinders have not been exposed to heating then the hazard zone may be reduced or removed.

Cylinders Affected by Heat

13. Water cooling is currently the most effective method of preventing catastrophic failure of an acetylene cylinder and should be used whenever it can be implemented without compromising the safety of firefighters. Heated acetylene cylinders cannot be considered safe until at least 24 hours after the initial cooling has commenced (whether by water cooling or allowing to cool naturally).

Leaking Cylinders

14. Where leakage of acetylene gas is suspected, the possibility of an explosive atmosphere could exist. The following actions should be considered:

- a. Evacuate the immediate area.
- b. Eliminate or separate ignition sources.
- c. Use water sprays to assist in dispersing the gas.

15. Leakage of acetylene from a cylinder may intensify any decomposition in the cylinder resulting in it becoming hot. Always check to ensure that heating is not occurring by the use of the wetting test.

Closing the Incident

16. Fire Services should maintain a presence at the incident throughout the 24 hour period after any fire has been extinguished or make arrangements to hand over the incident (including the management of the hazard zone) to a competent agency or

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organisation. After the initial 24 hour period, the responsibility for the acetylene cylinder can be transferred to the owner of the cylinder.

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DECONTAMINATION

Introduction

1. The number of hazardous chemical substances, which might face MOD firefighters is considerable and they may be encountered in a variety of different forms and present a variety of hazards.
2. If MOD Fire Services are to cope safely and efficiently with such incidents, they must be able quickly and without difficulty, to discover the nature of the danger and how they should respond. Sometimes the substance will be at fixed sites, such as workshops and stores. It is then essential that personnel take active steps in advance to familiarise themselves with the dangers and how to cope with them.
3. Whilst many incidents involve goods being kept in one place, a greater problem could arise with goods in transit. Clearly it would be difficult for firefighters to know in advance the details of all dangerous substances being transported within their areas of responsibility.
4. The aim of any operational firefighter should be to avoid contamination from such substances as far as they can, but clearly this will not always be possible.

Dealing with Chemical Incidents

5. The first attendance at an incident may not be aware initially that hazardous chemicals are involved because of a lack of identification markings on the vehicle, premises, pallet or container. Even when firefighters do know or learn this, they may not know the nature of the chemical and how they should deal with it.
6. The Incident Commander (IC) can take certain precautions from the start, for example:
 - a. Keep appliances upwind, clear of any vapour cloud and out of contact with the chemical.
 - b. Order Breathing Apparatus to be worn.
 - c. Arrange for an ambulance to be on standby.
7. The OIC must, in any case, gather any information, summon further assistance and, if necessary, take any other action that is immediately required for example evacuation.
8. The primary role of the firefighter (ie saving life) must be a priority and this need may require personnel to enter a hazardous area. The responsibility to commit any

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firefighter into the risk area relies on the IC's Dynamic Risk Assessment (DRA) of the incident. Firefighters must also prevent the incident from spreading and causing further injury to personnel and/or the environment.

9. The manpower and equipment of the MOD Fire Services places restrictions on the ability to deal with such an incident to its conclusion, the Local Authority Fire Service (LAFS) must therefore be informed as soon as possible.

Initial Actions

10. Following the Dynamic Risk Assessment the MOD Fire Services should, assuming the RA allows, carry out the following:

a. **Life Risk.** Where there is a life risk, commit a Breathing Apparatus team, wearing Chemical Protection Suits (CPS) if required, according to the advice obtained from Hazchem plates, Chemdata sheets etc.

Note: CPS are to be worn either when protection is required from the chemical, according to the above, or the substance involved and/or its effects are unknown.

b. **No Life Risk.** Where there is no life risk, do not commit personnel but control, contain and assess the incident until arrival of LAFS with sufficient resources to deal with the incident.

Chemical Decontamination

11. Firefighters wearing chemical protection suits are those most likely to be contaminated, as they will have been committed to the affected area. The procedure to decontaminate personnel must however, also be able to cope with firefighters in normal fire kit and other personnel who might have become involved.

12. The procedures should enable successful decontamination to be carried out at the incident. However, on occasions the nature and extent of the contamination will be beyond its scope to be dealt with thoroughly and specialist treatment will be necessary. This, and the possible need for medical examination, should always be borne in mind. The firefighter must be ready to summon and take specialist advice.

MOD Fire Services Decontamination Policy

13. The operations and decontamination of personnel at an incident involving hazardous substance is a complex procedure, which requires discipline and control throughout the process. It is a manpower and equipment intensive operation that must be carried out in a thorough manner in order to ensure the safety of all personnel involved.

14. In order that the MOD Fire Services discharge their "duty of care" during these operations, sufficient manpower and equipment must be available to the IC in order to carry out the operational decontamination procedures in a safe and efficient manner.

Decontamination Procedures - General

15. The MOD Fire Services primarily adopts the "wet" method of decontamination of personnel, by making full use of high pressure water spray shower units, incorporating a "wash to waste" procedure (non containment of the water used for decontamination).

16. The high-pressure shower method has been thoroughly researched and many tests have been carried out on a national scale. Tests have been conducted using various chemicals such as Benzene, Nitro-Benzene, Toluene and Nitro-Toluene, which are all miscible with water. The efficiency of the showers/water spray showed that personnel could safely be decontaminated without requiring a medical check up. This method of decontamination makes it possible for a person to adequately self decontaminate in approximately two minutes.

17. The Home Office provided the Department of Mechanical and Fluid Engineering with a list of chemicals that fire services were likely to encounter at incidents. The Department of Mechanical and Fluid Engineering provided evidence that provided the dilution ratio was approximately 2000 to 1, any chemical could be washed off with water and have no adverse effects on personnel. Furthermore, at this dilution ratio the problem of pollution in watercourses is virtually non-existent as the amount of contaminant would be insignificant compared with the initial spillage.

Purpose of Decontamination Procedures

18. Fire and rescue service personnel are contaminated at almost every incident they attend but the contaminant is normally in the form of smoke, soot, dusts etc. Any danger to firefighters health in these circumstances can be dealt with on their return to station.

19. There are however, many substances which present extreme danger to the health of firefighters and may have adverse effects on the environment. These substances are defined as harmful and should contamination occur, great care must be taken to ensure that:

- a. The firefighter is exposed to the least contamination possible.
 - b. The environment is involved or exposed as little as possible.
20. Therefore, the purpose of a decontamination procedure is to deal effectively with harmful contaminants whenever personnel and/or their equipment have been involved.

Types of Contaminants

21. The main types of harmful or hazardous substances which may subject personnel, clothing and equipment to contamination are:
- a. Chemical.
 - b. Biological.
22. The above types of contaminants may be in the form of:
- a. Powders and liquids, which are soluble in water.
 - b. Powders and liquids, which are insoluble in water.
 - c. Powders and liquids, that react violently with water.

Decontamination Types

23. There are two methods of decontamination that are defined as "Wet" and "Dry", either of which may be determined as the appropriate method according to the hazards and/or nature of the contaminants.
- a. Wet Decontamination. Wet decontamination includes the use of water, neutralising solutions and/or detergents.
 - b. Dry Decontamination. Dry decontamination may be achieved by the use of dry agents, vacuum cleaners and/or brushes.
24. The LAFS Decontamination Officer (Dec O) or the MOD FS IC will decide the method of decontamination. This depends on the information received and by taking all relevant factors into consideration.
25. The decontamination facilities within the MOD FS are limited and, due to the diversities of roles, individual unit equipment for decontamination differs considerably.

Details of the recommended pack to be carried or made available to first line appliances is included in MOD FS Operational Directive 7/98 (Annex A).

Objectives of Decontamination Procedures

26. The objectives of decontamination procedures, regardless of the type in operation are:

- a. To ensure that the necessary decontamination of personnel can be carried out at an incident.
- b. To ensure the health and safety of personnel by assisting them to remove contaminated clothing without the contamination endangering them by inhalation, ingestion or skin contact.
- c. To prevent the danger of contamination extending beyond the Decontamination Zone.

27. The decontamination procedures implemented by the MOD FS are designed to allow the necessary decontamination to be successfully executed at an incident. However, equipment used during the incident may require further decontamination at designated decontamination centres nominated by local arrangements at units.

Types of Decontamination Procedures

28. To determine the type and method of decontamination, the following factors are to be considered:

- a. Whether the clothing provided adequate protection.
- b. The resources and manpower available.
- c. The extent of the contamination.
- d. The nature of the contaminant.
- e. The incident conditions.

29. There are three levels of decontamination procedure - Emergency Decontamination, Initial Decontamination and Full Decontamination.

Emergency Decontamination

30. Emergency Decontamination, as its name implies, is a procedure to be used in the event of an accident or emergency where rapid decontamination is required. The severity of the emergency may vary considerably and a specific course of action is not possible to suit every circumstance.

31. Emergency Decontamination is not to be used as a standard method of decontamination. Its use is to be restricted to those times where rapid cleansing is required to prevent life threatening situations and minimise further injury. The IC may resort to Emergency Decontamination when:

- a. On arrival at an incident where non-fire service personnel are contaminated.
- b. Fire personnel have become contaminated whilst wearing normal fire gear.
- c. Where CPS wearers have been committed to a risk area to carry out life saving snatch rescue and require immediate decontamination.
- d. Where CPS has become torn or damaged.
- e. Where CPS is being worn, but is decomposing or being penetrated.
- f. Where CPS wearers have become ill or injured.
- g. Where BA equipment has become defective or cylinder contents is exhausted.

Note: Emergency Decontamination facilities are to be provided from the moment the wearers enter the risk area until either the completion of operations or the setting up of a higher level of decontamination.

32. Where Emergency Decontamination has taken place, once the outer garments of the casualty have been thoroughly washed off, further actions may be required:

- a. Where no protective clothing is worn, the protective clothing has become damaged, torn or penetrated, BA has become defective or the cylinder contents are exhausted, immediate disrobing should take place with, if necessary, clothing being cut off in order to minimise contamination of the skin.
- b. Where injury or illness has occurred, determine whether the risk presented by premature disrobing is worse than delaying treatment by completing the decontamination thoroughly.

33. When disrobing has been completed, particular care should be taken to cleanse the body to ensure no contamination remains. The decontaminated person should be dried and re-clothed or blanketed before being removed immediately for medical treatment.

Initial Decontamination

33. Initial Decontamination is the normal minimum level of decontamination available to personnel at an incident. It should be able to be implemented by all first attendance appliances using equipment that may either be carried or made available.

34. Initial Decontamination should be implemented at incidents where hazardous chemicals are known or suspected to be involved and where small numbers of personnel are committed to the incident and the degree of contamination is slight, or where decontamination has to take place before the arrival of equipment for Full Decontamination by the LAFS.

35. The following circumstances may dictate that Initial Decontamination becomes necessary at an incident:

- a. Where a BA team in CPS have entered a risk area and are likely to become contaminated.
- b. In preparation where it is intended to commit CPS wearers into a Restricted Zone.

36. An Initial Decontamination team will be made up from the crew members of the first attendance appliance(s) and will consist of:

- a. Decontamination Officer (may be IC at small incidents).
- b. Pump operator.
- c. BA Entry Control Officer (BAECO).
- d. Two Decontamination Zone operators.
- e. An "Airpak" decontamination airline operator - if equipment is available.

Full Decontamination

37. Full Decontamination procedures will be instituted where a large number of operators require extensive cleansing or as a progression from Initial Decontamination procedures which, due to an expansion in the scale of operation of an incident have become inadequate. This procedure should be implemented whenever:

- a. Extensive contamination is known to exist.
- b. Extensive contamination is likely to exist.

38. Full Decontamination Procedures can only be achieved by the LAFS due to the equipment and manpower required for such a procedure. Cognisance should be taken of the fact that MOD FS crews may work in conjunction with the LAFS at an incident and therefore all personnel should be aware of all the decontamination procedures.

Note: This document does not cover Full Decontamination procedures. Details are available in MOD FS Operational Directive 7/98 (Annex B).

Incident Commander Actions

39. The IC will not necessarily be aware that contamination of personnel and/or equipment has taken place until after the event. The priority in all situations is to save life, and in these circumstances the IC must consider the information at hand and act accordingly. Where life is not endangered, all available information must be gathered and collated. The IC will then decide whether or not to subject personnel to possible contamination.

40. If personnel are to be committed, then the number used must be the minimum necessary to carry out essential tasks only. The numbers are to be increased only as facilities to decontaminate them become available (ie the arrival of LAFS specialist appliances).

41. On becoming aware of contamination, the IC should implement procedures to minimise and limit the exposure and introduce measures to achieve control over the situation for the remainder of the duration of the incident. The IC's action is to comprise of the following:

- a. Establish whether any persons have already been contaminated.
- b. Establish the extent of the existing contamination.
- c. Designate a Restricted Zone.

- d. Ensure unprotected firefighters or other personnel do not enter the Restricted Zone.
- e. Establish the nature of the contaminant.
- f. Establish the level of protection required.
- g. Instigate decontamination procedures.

42. Contamination of personnel not protected by CPS is to be dealt with by Wet Decontamination (unless special circumstances dictate otherwise). The rate of cooling and dilution of 2000 to 1, achieved during decontamination, will result in most water reactive substances being diluted to a level, which will effectively reduce their hazardous effects to a safe level for the purposes of decontamination.

43. When requesting assistance from the LAFS, the initial message should be prefixed with the words "Hazardous Materials Involved". The message is also to contain the name and/or UN identification number of the substance involved (if known), the circumstances of the incident, any other relevant information and the assistance required.

Restricted Zones

44. A Restricted Zone will vary according to the size and nature of the incident. It may simply be the immediate vicinity of the incident - roadway or building, or if the contaminant is airborne or being carried by running water may extend to a large area which may necessitate the evacuation of surrounding properties and areas. Whatever the size, the IC must ensure that no unprotected personnel enter the zone and may have to request police assistance to ensure that the integrity of the zone is maintained.

Instigating Decontamination Procedures

45. In order to instigate decontamination procedures, the IC of the incident is to:
- a. Make an assessment of the degree of contamination that has occurred or is likely to occur.
 - b. Establish whether contaminated personnel have been adequately protected against contaminants.
 - c. Instigate Initial Decontamination procedures.
 - d. Arrange for any necessary assistance.
 - e. Set up a Decontamination Zone.

Setting up a Wet Decontamination Zone

46. The Decontamination Zone must be clearly defined and the IC is to consider the following points when choosing a suitable site:
- a. The size of the Decontamination Zone is to be kept as small as possible.
 - b. The zone is to be downwind of the inspection area and appliances.
 - c. The zone is to be sited so that water run-off from the shower or water spray will not run towards the inspection area and appliances.
 - d. The zone is to be selected so that, as far as possible, drain openings (preferably to foul water sewers) are adjacent and downhill of the decontamination area.
 - e. The Decontamination Zone is to be, as far as possible, on hard standing to prevent water logging grass or earth areas.
 - f. The zone is to be sited in a quiet area of the fireground but as near as possible to the scene of operations.
 - g. The site is to be chosen where good vehicular access can be maintained.
 - h. It is essential that the zone be sited where good water supplies are available.

Decontamination Zone Marking

47. The zone or area selected for decontamination must be clearly marked by means of high visibility tape, as should the dirty area leading from the exit point of the incident to the washing off area HP shower, hose lines etc. All equipment that may be contaminated should be kept within this area until washed off. All decontamination must take place in this established zone. Any equipment that is still considered to be dirty after washing off is to be wrapped in polythene sheets and removed from the fire ground for more thorough cleaning elsewhere. If necessary, specialist advice should be obtained.

Note: the success of decontamination depends on the strict observance of a disciplined procedure within the defined zone.

BA Control During Decontamination

48. To enable identification of wearers undergoing decontamination, the BAECO is to record the number of the wearer's suit alongside their name on the BA Tally before the wearer is committed to the incident. The BAECO is also to make an appropriate entry in the "Remarks" column on the BA Entry Control Board as to the location of the wearer.

49. Upon withdrawing from the Restricted Zone, the wearer is to be directed to the waiting area of the Decontamination Zone. The IC will ensure that the BAECO is informed of the suit numbers of personnel undergoing decontamination. The BAECO will indicate those wearers under his control who are subject to decontamination procedures by placing a diagonal line across the appropriate tally.

General Considerations

50. Decontamination procedures are manpower and equipment intensive. MOD Fire Service crews attending incidents vary greatly in manpower and equipment levels and therefore, it is not possible to specify a course of action to suit every incident. However, the safety of personnel at an incident is of the highest priority and therefore, the minimum level of decontamination - Initial Decontamination - is to be instigated at any incident likely to involve hazardous substances.

This document has been withdrawn as the information contained in it is no longer relevant. The course it refers to is now obsolete and no longer offered
<https://www.gov.uk/government/collections/defence-fire-training-and-development-centre>

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MAN MADE MINERAL FIBRES

Introduction

1. Man Made Mineral Fibres (MMMF) also known as Composite Advanced Aerospace Materials (CAAM) form lightweight, high tensile fibres which are increasingly being used in the construction of modern aircraft (e.g. to strengthen parts of the fuselage and rotor blades). They are particularly common in modern rotary wing aircraft and gliders, such as the Lynx Mk 8 and EH 101 Merlin. A number of different matrixes (resins) are used in the manufacture of MMMF. The commonest type of matrix is epoxy resin based, the usual resin being Diglycidyl Ether of Bisphenol A (DGEBA), which is a skin and eye irritant. Polyurethane and urea or phenol/formaldehyde matrixes are also used. These contain toluene di-isocyanate, which is an irritant. MMMF are a popular manufacturing process due to a number of factors:

- a. They possess an excellent strength to weight ratio
- b. They do not fatigue like metals
- c. They are lightweight
- d. They can be moulded into a variety of shapes

Hazards

2. Whilst intact, MMMF are deemed to be inert and non-hazardous; the main risk to firefighters arises from the decomposition of the matrix following a fire. A significant risk to firefighting personnel arises from the thermal decomposition of the bonding agents (resins) following a post crash fire. These agents are flammable and release highly toxic vapours at very low temperatures. When exposed to fire MMMF will be left in a friable format and easily liberated when touched. These fibres when in solid form could cause needle stick injuries and traumatic dermatitis due to the MMMF being capable of absorbing the products of a post crash fire.

3. MMMF particles of breathable size can be released into the atmosphere following impact damage, when being cut and drilled or during a fire when the bonding agent breaks down. There is also a possibility that the materials, in dust or vapour form, may plume following an aircraft crash and be carried a considerable distance downwind.

4. At incidents involving MMMF, care must be taken to ensure that dust concentrations are kept to a minimum. Cutting or drilling is to be avoided, as it will give rise to dust. Where such work is absolutely essential for the purpose of completing the task being undertaken the dust must be dampened down.

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5. Contamination from MMMF can be reduced by the use of hand tools and by wetting or thorough dampening the material before commencing operations. Once dust particles become airborne it is not possible to control the concentration of fibres by the use of water sprays, although this does help to reduce the amount of airborne fibres.
6. The hazards associated with MMMF are quite distinct and vary from the damage sustained. Hazards are grouped under three headings:
 - a. Exposure hazard following impact damage but no fire
 - b. Exposure hazard during a fire
 - c. Exposure hazard to fire debris in the aftermath of the fire

Operational Procedures

7. The Incident Commander must ensure that cordons are established at all MMMF incidents:
 - a. Inner cordon - 30m - which will be an exclusion zone into which only the absolute minimum number of personnel are committed
 - b. Outer cordon - 100m - to prevent unprotected personnel from entering the risk area.
8. Firefighting crews attending incidents involving MMMF fall into two categories:
 - a. Those committed to firefighting and within the inner cordon (30 meters); and those outside the zone but subject to the effects of any smoke plume.
 - b. Those not directly involved in firefighting or rescue operations, nor subject to the effect of any smoke plume.
9. Full use of vehicle monitors should be made to limit the requirement for sideline use. However, vehicles (and equipment) should not be deployed in the smoke plume or 'fall out' area unless absolutely operationally essential.
10. All downwind areas are to be evacuated and equipment is to be treated as contaminated. The actual size of the evacuation zone will be dependent on weather conditions.
11. After initial firefighting operations, it will be necessary to apply foam/water to the debris, at low pressure, to act as a 'fixant'. This will help to prevent particles of

MMMF from becoming airborne. This is to continue until a proprietary fixing agent can be applied to the debris. All work in the inner cordon should be kept to a minimum until a fixing agent is applied.

Levels of Protection

12. All firefighters responding to incidents involving MMMF must wear full Personal Protective Equipment¹ (PPE). Personnel involved in firefighting or inner cordon tasks are to wear full PPE and BA until all fires have been extinguished and the area cooled to a temperature near or below ambient temperature. Personnel who are not firefighting or are outside of the inner cordon are to keep well upwind and outside any areas that are likely to be contaminated.

13. Firefighting clothing will be contaminated when coming into contact with MMMF and will require decontamination and specialist cleaning.

Note: All personnel are to avoid eating, drinking or smoking near an incident involving MMMF.

Command and Control

14. Command of the incident must be kept strictly under control with the following points being observed throughout:

- a. The IC must make an early Dynamic Risk Assessment (DRA), which recognises the involvement of MMMF.
- b. An early "MMMF involved" message should be sent to the Local Authority Fire & Rescue Service (LAF&RS) control who will be required to provide support.
- c. The number of personnel exposed to MMMF must be kept to a minimum.
- d. Work methods should be planned which do not create unnecessary dust.
- e. The use of power tools should be avoided.
- f. Unnecessary breaking and disturbance of MMMF must be avoided.
- g. MMMF must be kept wet whenever practicable.
- h. Smoking, drinking and eating must not be allowed until simple washing facilities are provided and used.

¹ Full PPE means helmet, tunic, leggings, boots, gloves and flash hoods.

- i. All personnel are to be made aware of the hazard.

15. Re-committing BA wearers must be carried out under strict supervision, with all contaminated personnel being kept separate from uncontaminated personnel. If the BA facemask needs to be removed, the wearer should wipe around the head and seal of the facemask with a wet sponge, break the seal carefully and exchange the BA set with a serviced BA set without disturbing the contaminated protective clothing.

Decontamination

16. Where clothing and equipment have been subjected to contamination at an incident, a suitable area, upwind on the cordon edge is to be identified to carryout decontamination procedures.

17. All personnel who are required to work in the inner cordon must undergo decontamination. Personnel requiring decontamination must proceed directly to the decontamination zone and, where possible, arrangements must be made to maintain respiratory protection whilst awaiting decontamination.

18. The concepts of operations when carrying out decontamination of firefighters at incidents involving MMMF depends on the type of protective clothing worn:

Decontamination Procedures - PBI GOLD

19. Any personnel wearing PBI Gold that have been in the inner cordon are to undergo the following decontamination procedures:

- a. Hand brushes (with nylon bristles) are to be used by the BA teams, to ensure a comprehensive brushing down of their PPE. Particular attention must be paid to the gloves, helmet and facemask. The wearers should assist each other to brush down their BA sets and the rear of their helmets, jackets etc. Upon completion of the brushing down the wearers can enter the Decontamination zone where the designated undresser is to utilise the pressure sprayer to provide a fine water spray over the BA wearer to prevent residual particles from being blown around.

- b. Upon completion of the above the BA wearer with the assistance of an undresser is to remove helmet and place in the bin provided.

- c. Leaving the facemask on, the BA set is to be removed (the set may be supported by a tripod or Teklite mast).

- d. The flash hood is to be carefully removed over the facemask and down the BA hose.

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- e. Peel or roll off the jacket (with gloves) and place in a suitably marked container.
- f. Roll down the trousers over the top of the boots and place in a suitably marked container.
- g. Hold breath, close eyes and remove BA facemask.
- h. Undresser is to pass the BA wearer a suitable respirator (currently Sabre Mask & A1P3 Filter). The BA wearer blows out 3 times to clear the filter. Once this action is complete the BA wearer dresses in new protective clothing (disposable coveralls etc).

Note: All items of PPE & equipment removed from a BA wearer, once decontaminated, should be bagged prior to its removal for further cleaning. Helmets, boots, BA sets and respirators are to be bagged separately from firefighting trousers, jackets and flash hoods. Respirator canisters are to be removed from the respirator and bagged separately. All bags containing jackets, trousers and flash hoods are to be labelled 'CARBON FIBRE CONTAMINATED' and either sent for specialist cleaning or disposal.

Decontamination Procedures - Chemical Protection Suits (CPS)

- 20. If CPS are worn decontamination centers around the decontamination system supplied with the vehicle.
- 21. Having decontaminated the CPS, the wearer is called forward to the undresser, who will assist in unzipping and removing the suit. The wearer is to step out of the suit and cross directly into the clean area fully dressed in their PPE.

Health Surveillance

- 22. The COSHH Approved Code of Practice (ACOP) states that the collection and maintenance of health records is required for all personnel exposed to MMMF. After returning from an incident involving MMMF, the Watch Manager is to ensure that:
 - a. Firefighters report to the medical centre for examination and to have their medical files annotated.
 - b. Individual personal records (held on the fire station) are annotated appropriately.

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- c. MOD FS civilian firefighters inform their Civilian Personnel Manager ensuring that their personal records are annotated accordingly.

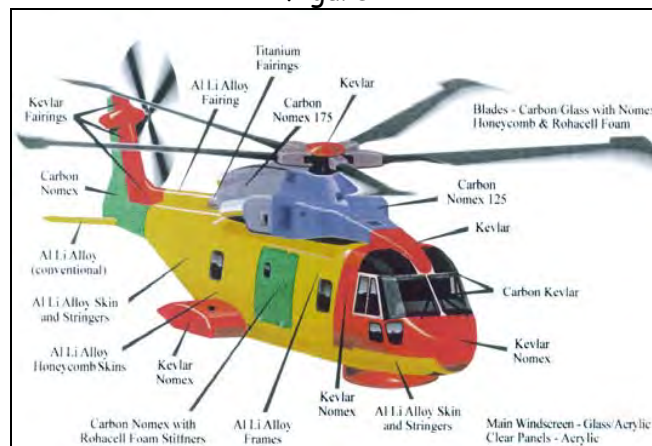
Note: Additional information and policy guidance on dealing with MMMF incidents can be found within DF&RS Operational Directive 01/2004.

HELICOPTERS

Introduction

1. The construction of the helicopter airframe is similar to the fuselage framework of fixed wing aircraft, the only difference being that it is considerably lighter. One of the main reasons is that the airframe is not stressed to carry a wing, the cabin area will not be pressurised for high altitudes and the undercarriage assemblies are small in comparison to fixed wing aircraft. Any sheet metal used is very thin and light alloys such as Alclad and Duralumin are used.
2. With the widespread introduction of Composite Advanced Aerospace Materials (CAAM) into aircraft construction, many modern helicopters have a large CAAM content. Composite materials are corrosion resistant, very strong and light. Figure 1 shows areas where CAAM is used on a modern helicopter.

Figure 1



Features of Helicopter Crashes

3. The most significant difference between a helicopter and other aircraft is simply that the helicopter has no mainplane. This means that the engines and fuel tanks are very close to the cabin area and that in the event of a crash a helicopter is less likely to remain upright, due to the high centre of gravity caused by the rotors, rotor head and engines - all being in the top half of the airframe.
4. It is easier to run hand lines around a helicopter and there is considerably less sheltered ground beneath the airframe.
5. The shorter throw of CO_2 and Dry Chemical Powders (DCP) and their rapid effect may be crucial owing to the close proximity of the cabin, fuel tanks and engines.

6. Another significant factor is that a helicopter can take off and land without forward speed. A helicopter accident during take off or landing does not necessarily involve severe deceleration. Generally therefore there is less disruptive damage to a helicopter and the occupants are more likely to survive. Figure 2 shows the various possible stages a helicopter could go through from impact to its final resting position.

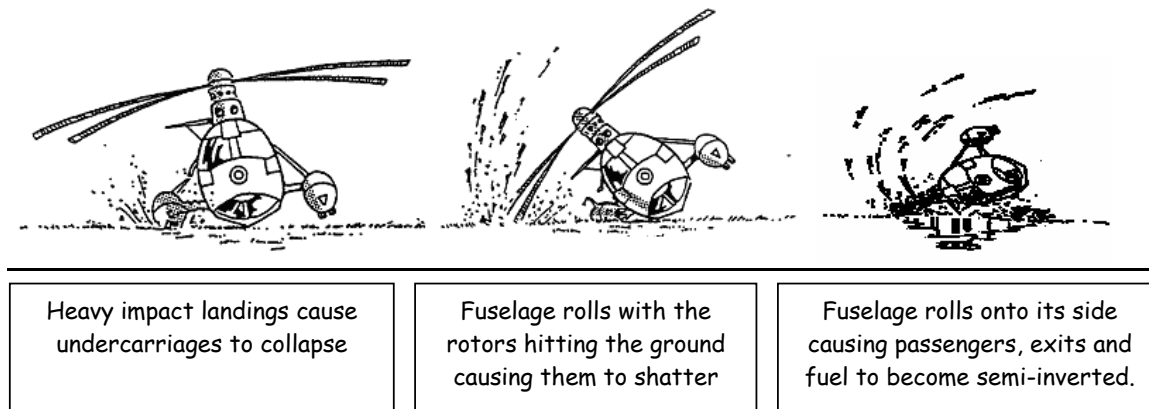


Figure 2

7. The basic firefighting technique is the same as a fixed wing aircraft - whatever agents are available should be discharged at high output rates to suppress the fire as quickly as possible. Where it is known that CAAM exists on the type of helicopter involved operations must be amended accordingly to take this into account. Comparatively high proportions of magnesium alloy components are also used in helicopter construction and therefore a helicopter crash could include one or more pockets of persistently burning magnesium.

Rescue Factors

8. It has been mentioned that a crashed helicopter may come to rest lying on one side, doors and hatches are however provided on both sides. As the doors and hatches of helicopters are very much simpler than the flush fitting double action hinges, which are typical of fixed wing aircraft, they are much more likely to jam due to their lightweight construction. If they are jammed, it should be possible to lever them open. Moreover, the doors of several helicopters can be jettisoned by pulling an external handle, which unlocks the hinges or door rails.

9. If forcible entry is necessary the lighter gauge metals used in helicopters make this a less difficult task than it would normally be on other aircraft.

10. Simple lightweight seats are used and the seating arrangement is usually less formalised than in passenger carrying types of aircraft. Passengers may be accommodated on folding benches with ordinary seat harnesses being used, and the only

service connection for the aircrew may be the telemic (radio) lead. If the helicopter is lying on its side, the occupants must be supported carefully when the seat harness is released.

11. The cabin floor is low but, since it is likely that a crashed helicopter would be lying on its side, it would be advantageous to have a short ladder available. Water actuated devices known as buoyancy bags or inflatable bags are fitted to helicopters, which operate over water. These bags can be found in wheel hubs, carried on sponsons which are fixed to the fuselage on struts, mounted on skids or as on the Sea King integral in the undercarriage housing. The bags are intended to give stability to the helicopter on the water in the event of the aircraft having to ditch. These devices are normally activated by immersion in salt water, but may be inadvertently activated by firefighting water or other actions.

Danger from Rotors

12. A feature of helicopters is the danger from the aircraft's rotors. The rotors will continue to rotate for some time after the power is cut. As the speed of rotation begins to diminish, the blades of the main rotor sag to a low level where they could strike personnel. The Chinook is a prime example; anybody approaching the helicopter from the front of the aircraft could be seriously injured as the front rotors sag to a height of 1 metre from the ground. Normal and emergency approach to this helicopter is from the rear of the aircraft. In a crash situation the blades could strike an object and shatter causing fragments to scatter over a wide area.

12. Tail rotors are another hazard at any speed of rotation because of their position at body height. The blades are coloured so that a visible disc can be seen when they are in motion. A 'danger' sign is also painted on the tail boom. On some helicopter types (such as the Gazelle) this tail rotor is enclosed within a metal guard. The latest anti-torque design does not use a tail rotor at all; it has become known as the NOTAR - No Tail Rotor and uses ducted exhaust gases from the engine jet pipe, which are ducted along the tail boom and exit through a variable slot. Whilst this does not use direct thrust like the Harrier, there is a danger to firefighters from these exhaust gases if working in the area.

Pyrotechnics and Armaments

13. Helicopters carry signal cartridges like any other aircraft, usually in a case situated either on the flight deck or on Search & Rescue (SAR) aircraft in the main cabin area. Additionally a helicopter may carry stores appropriate to its role, for example:

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- a. Search and Rescue(SAR). SAR helicopters may carry smoke and flame floats, marine markers and winch cable cutting devices.
- b. Assault Support. Assault Support helicopters may carry a mixed armament, the most common arrangements being machine guns and anti tank missiles fitted both internally and externally. Armaments may be carried internally while re-supplying forward areas.
- c. Anti Submarine Warfare. Anti Submarine warfare helicopters may carry mixed armaments including marine markers, carried internally and either torpedoes or depth charges carried on mountings underneath the fuselage.

Normal and Emergency Entry

14. The normal and emergency entrances into helicopters are similar to normal aircraft and they are marked with opening instructions in the same way. Owing to the low speed and low altitude of helicopters, however, it is possible for their entrances to differ from those of other aircraft in small details, which ease the work of the rescue team. For example:

- a. External fittings need not be flush fitting.
 - b. Raised door handles are fitted which are simple in operation.
 - c. Doors only have to be moved in one direction when opening them.
 - d. Raised handgrips to assist in climbing in or out of windows are provided.
 - e. As helicopter fuselages need not be as aerodynamic as fixed wing aircraft steps are often provided outside of doors.
 - f. Helicopters often fly with their doors open.
15. The types of doors, which are characteristic of helicopters, are:
- a. Sliding doors which run on external rails.
 - b. Conventional outward opening hinged doors.
 - c. Ramps or canopies.

Note: The Sea King helicopter has a crew door on the port side which when opened, falls down to reveal a set of steps, which obstructs the external door opener.

Conclusion

16. When firefighters respond to a helicopter crash fire:
 - a. The appliance driver(s) should be prepared to take their vehicles in to closer positions than with fixed wing aircraft. As there is no main plane to create a barrier there may be a real advantage in positioning a vehicle at the nose or tail, according to the wind direction, so that both sides of the fuselage are accessible to hand lines. This is certainly necessary where a single fire appliance has to deal with a large helicopter, which may have a fuselage of up to 14 metres in length.
 - b. Firefighters with branches should approach the cabin, pressing in to very close quarters as quickly as possible to suppress flames surrounding the cabin and gain access to the fire in the vicinity of fuel tanks, which are usually beneath the cabin floor or behind the rear bulkhead.
 - c. DCP may be more effective than foam against internal fires.

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ROAD TRAFFIC ACCIDENTS

Introduction

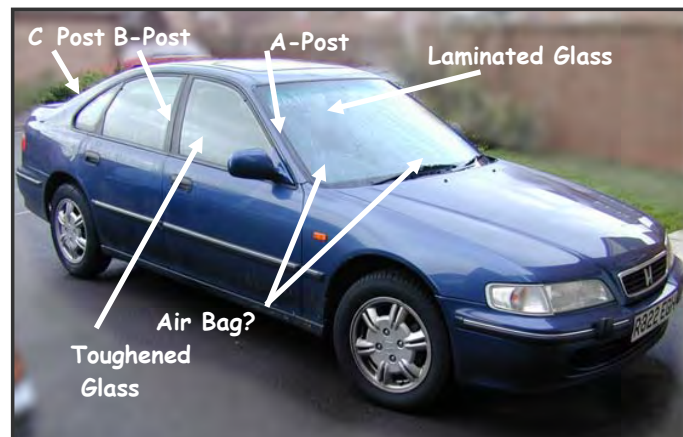
1. Fire services are often called to assist in the extrication of persons trapped in motor vehicles following a Road Traffic Accident (RTA). Many of these incidents occur on motorways and other major roads where firefighters performing rescue operations may be in danger from approaching high speed traffic, a problem which is amplified during adverse weather conditions and/or darkness.
2. Although all RTA's are different, with each presenting different factors to be borne in mind when considering rescue, firefighters in general should have extinguishing media ready in case of fire, be dressed appropriately and should be prepared to enter vehicles as soon as practicable to give moral and physical support to those awaiting rescue.
3. The most common accident that occurs involves a front or near frontal impact, with the vehicle remaining on all four wheels and with only one person in the vehicle however, this is far from the only type of incident that will be attended. In all RTA situations, the main priority lies with the casualty, who should remain the focal point for all operations undertaken by the emergency services.

RTA Equipment

4. A variety of equipment may be carried on first attendance appliances. Personnel should be trained to operate the equipment confidently and safely in different weather and visibility conditions. The equipment will need to be serviced and tested regularly to ensure its effectiveness is maintained. Knowledge in the various uses of the equipment is important as often ingenuity and improvisation is required to extricate casualties.

Vehicle Construction

5. All modern cars are constructed in a similar fashion incorporating a strengthened passenger cell with front and rear crumple zones that are designed to absorb the impact in the event of a collision. Some important points as far as rescue is concerned are indicated in the diagram.



Approach

6. The approach by appliances arriving at the incident should be slow and controlled for the following reasons:
- a. Weather conditions and visibility.
 - b. Road conditions.
 - c. Obstacles and debris in the road.
 - d. Casualties wandering around in a dazed state or thrown on to roadway.
 - e. Build up of traffic due to the accident.
 - f. Following traffic will be slowed down.
 - g. Crew members will be able to exit the vehicle with traffic cones and warning signs if necessary.
 - h. The OIC can make a brief assessment of the incident.

Safety Provisions

7. Safety provisions for personnel at the incident are important considerations when attending RTA's. Appropriate additional protective clothing including Hi-visibility jackets, (BS EN 6629:1985), heavy duty and/or surgical gloves and goggles/glasses should all be worn, with consideration being given to the use of ear defenders. All crewmembers should dismount from the appliance on the safe side (ie away from approaching traffic). If cones are to be placed it is important that the correct coning off procedure is followed - face traffic and set first cone then walk backwards 8 paces and out (into the roadway) $1\frac{1}{2}$ paces to set second cone. Continue until all cones are laid out. All crewmembers should stay within the coned area and avoid other lanes and carriageways particularly if working in the vicinity of a central reservation. Do not work under vehicles without adequate chocks and blocks in position (vehicle stability).

General Safety at Incidents

8. The Police will normally be first in attendance and should have placed 'Police Accident' signs and cones in appropriate positions. Blue flashing lights may also have been laid out to help divert traffic away from the accident. In those instances when the fire brigade arrives first, the continued protection of the crews at the incident is paramount. By arrangement with Chief Constables many brigades carry 'Police Accident' signs. If only

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one 'Police Accident' sign is carried, it should ideally be positioned 900m before the incident, particularly on motorways. If through manpower limitations this is not feasible, the minimum recommended distance is 400m. On roads other than motorways, the positioning of signs will depend on the weather and road conditions, the layout of the road (bends, bridges, junctions etc) and vehicle braking distances relating to the general speed of the traffic. The effectiveness of the signs can be increased by day or night by placing a blue flashing light on a tripod above and behind sign. Appliances should be deployed, if safety allows, 50 meters before the incident (taking into account the wind conditions) and at a slight angle to fend-off approaching traffic therefore protecting the rescuers and occupants. The appliance is however, to remain within the confines of the accident lane.

9. Blue flashing lights on the fend-off appliances should be operating and in adverse weather conditions rear fog lamps provide additional warning. At night time or during adverse weather, a searchlight may be erected to illuminate fend-off appliances without blinding oncoming traffic. It is vital that sufficient firefighting equipment should be laid out to cover the whole of the incident.

Setting up the Working Area

10. Setting up the extrication scene correctly will enhance the possibility of a successful conclusion to the incident. An exclusion zone of 10 meters needs to be established around the vehicles where radios are not to be used, in case of inadvertent airbag operation. A zone of 3 meters should be maintained free from unused equipment and tools. A catchments area or 'equipment dump' should be set up by spreading a salvage sheet. This allows for the controlled depositing of equipment and is conducive to a clear, safe working area suitable for the immediate requisition of equipment that could otherwise be misplaced. Good house keeping is essential, even to the point of maintaining the working area free from unnecessary personnel, particularly those who are not properly protected.

Vehicle Stability

11. While the casualty is awaiting extrication, it is imperative that the vehicle is stabilised by the insertion of blocks in all four corners between the sill and the ground, this prevents flexing in the floor pan and any movement or rocking whilst work is being undertaken. It is important to remember that as vehicle parts are removed the weight is reduced and the vehicle will tend to lift from the blocks. It may be possible to remove the valves from the tyres once the blocks are in position - flat tyre blocking - which would allow the vehicle to sit on the supports with no movement however, this should only be carried out with the approval of the police and only then if the vehicle is likely to be moved to assist in further rescue operations.

Battery Isolation

12. If the battery is to be isolated it should be disconnected from the negative terminal to prevent the possibility of electrical 'arcing' between the positive terminal, chassis and tools being used. The terminal should not be cut as it then allows for re-connection by any subsequent police investigation team. In a safe area, consideration should be given to leaving an undamaged battery connected as this allows many systems in modern vehicles to operate even after impact (electronic door locks, windows, seat adjustment mechanisms etc). Should the battery remain connected it must be remembered that wiring looms often run through sills and posts increasing the danger of electrical arcing when cutting.

Note: Although most motor vehicles are 'negative earth' it is possible to come across vehicles, which are 'positive earth' in which case the positive terminal should be disconnected.

Glass Removal

13. At all times whilst removing glass from a vehicle, the casualty should be protected by use of either soft protection (eg blanket or salvage sheet) or hard protection (casualty shield). The casualty shield is preferable as not only does it provide greater protection but also it is clear so the casualty can observe what is going on. Firefighters should wear goggles or safety glasses.

14. There are two principle types of glass in motor vehicles laminated and toughened but many more are being introduced. Toughened glass can be found in any windows in a vehicle but is more commonly found in side and rear windows. When broken it breaks into thousands of pieces that often cling together producing a 'frosting' effect. The force required to break glass is approximately 10,000 psi, which can be easily achieved using a spring loaded centre punch or glass hammer. Laminated glass is significantly different from toughened glass both by its characteristics and the problems it creates. It can be easily identified by examining the screen for markings. Laminated glass consists of a plastic layer sandwiched between two layers of glass. When broken, the plastic holds the screen together in long sharp pieces.

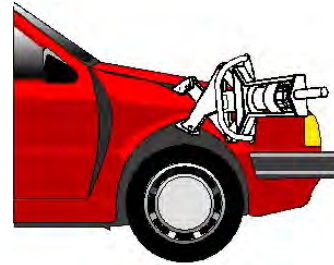
Vehicle Entry

15. At all RTA's the nature of the casualty's condition should determine the nature of the rescue method employed. Prior to commencing physical rescue activities, it is essential that:

- a. Vehicles have been adequately stabilised.
- b. The glass has been safely managed.
- c. Hard protection is available for placement between rescue tools and the casualty.

Note: If immediate life support is required (ie casualty is not breathing) do not wait for stabilisation.

16. Gaining access into the vehicle before any cutting is commenced may be needed to allow medical aid to commence. A combi-tool can be applied to the wing of a vehicle to open a gap between the wing and door to enable the combi-tool to be used to open the door from the hinge side. The combi-tool can also be placed in the shut line of the door at the lock side. It may be useful to gain a slight gap with a large screwdriver or small crow bar before placing the tips of the combi-tool on the door. A gap should be created by closing the spreader tips together and then moving the tool round in an arc shape to reveal the door hinges.



Primary Roof Removal

17. There has been considerable debate about whether 'roof off' or 'side out' is the correct procedure to start with at a difficult entrapment. However, when adopting a casualty-centred approach the arguments in favour of removing the roof first become difficult to challenge; the advantages are:

- a. It creates the maximum amount of space to work in, in the minimum amount of time, invariably facilitating full access for the medical assessment of casualties.
- b. It gives unrestricted access to the casualty's airway and allows for in-car intubations should the need arise.
- c. It facilitates the placement of spinal immobilisation devices (eg cervical collars, Kendrick Extraction Device (KED) and long spinal boards).

18. Several points should be borne in mind when carrying out roof removal:
- a. All cuts with the exception of the 'C' posts should be made as low as possible, to reduce the hazard from sharp metal.
 - b. The last cut should be made nearest to the casualty in order that there is no danger of an unsupported roof dropping and causing injury. This also frees other personnel from having to support it from the first cut to the last.
 - c. Where possible, roofs should be removed totally as opposed to merely 'flapping' them back. One of the main advantages this provides is that it permits the unrestricted use of long spinal boards.
 - d. Roof flaps are useful in allowing rapid access to the interior of the vehicle particularly when full removal entails cutting two wide "C" posts with a combi-tool. This procedure should however be viewed as the first stage of full roof removal.

Note: All posts that have been cut should be covered with a 'sharp edge protector' or suitable alternative (off cut of hose, salvage sheet etc).

19. The correct method of making a roof flap is to cut both 'A' posts (at low level), both 'B' posts and then to make two relief cuts either side of the roof, adjacent to the 'C' posts. The roof can then be flapped back at this point.

20. Folding the roof over the front of the vehicle is an alternative method of roof flap, which may be necessary if the rear of the vehicle is embedded under an obstacle or vehicle. The removal of the roof in this way has the advantage that the bonded laminated windscreen will not have to be removed.

21. To carry out this procedure, start the cuts as far from the casualty as possible making the nearest cut to the casualty last. When cutting the 'A' Post leave 100-150 mm at the base in case a Dashboard Roll needs to be carried out.

Note: These techniques can be achieved using either a combi-tool or Rem saw.

Note: Where the vehicle has a steel or reinforced sliding sunroof, the folding back of the roof structure becomes less advisable.

Danger: Do not cut through hydraulic struts on hatchback or estate vehicles due to the release of fluid or gas which may cause a projectile hazard.

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Danger: When performing roof removal be sure to remove inside trim to expose the wiring loom, then be careful not to cut through any yellow or orange wiring, as these are generally associated with supplementary restraint systems.

Remember: Do not be too hasty in removing roofs as they give vehicles strength which might be needed to perform other techniques (eg cross ramming or B post rip).

22. On certain older vehicles the tailgates (estate cars) have springs to assist the opening operation which when cut can fly up with considerable speed and force. This can cause severe injury to personnel who may be unaware of their presence. This problem is not encountered on newer vehicles as they have hydraulic or gas struts.



23. When the roof is removed, the underside of the vehicle should be blocked to support it particularly where all the doors are opened and the sill needs shearing. This will avoid flexing of the floor pan adding further strain, which could result in increased crushing or trapping of the casualty.

Side Removal

24. Side removal can be considered as the first stage in making space. It reassures the casualty, who sees progress being made, and is relatively quick to perform. In the case of severe trapping it will be necessary in extricating the casualty. Where the trapped casualty is seriously injured the base of the 'B' post should be weakened, as this will prevent unnecessary movement of the vehicle when levering the rear door or the 'B' and 'C' posts. To clear the working area and in the interest of safety the rear door and 'B' post should, wherever possible, always be removed. With the advent of modern rescue equipment it is unacceptable to manoeuvre a casualty over a disjointed structure and jagged metal.

25. Removing a door from the hinge side is achievable with the combi tool. However, the usual option is to remove the door from the lock side, which can stop the door protruding in on the casualty if badly damaged. If access can be gained through a window before removing the door try to put a small wedge into the interior door handle so that it releases the pin in the lock which will make the door removal easier as it has less resistance to overcome.

26. When removing a door with a combi-tool it is important that the tool is not spread too wide in the early stages as the skin of the door may become detached thus preventing the tool from getting a good purchase. Always start from the top of the door so by the time the lock is reached you are forcing the door outwards and not against the hinges, which are the strongest point. This will also prevent the skin of the door tearing.

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When the door is to be removed completely it is important to spread the lower hinge first; if you don't the door may dig into the ground and affect the stabilisation of the car and make it unsafe.

27. Precautions should be taken to avoid injury to personnel, or leaving the casualty unsupported when forcing doors as invariably they open abruptly and have sharp edges at head level. To avoid the jettisoning effect when conducting the forced opening of doors, the door should be held and bodily supported. Power operated hydraulic spreading tools are designed to work efficiently and quickly with considerable force. Therefore the folding in of the door on the casualty must be avoided.

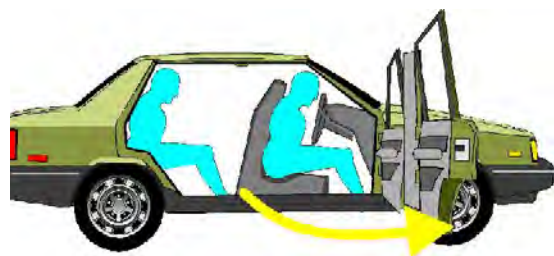
Cross Ramming

28. This technique may be required when a vehicle has had severe side impact. When performing this technique it is important to make sure the ram does not slip because this could further injure the casualty. When using the smaller ram you may have to perform this technique from the transmission tunnel running through the middle of the car because the ram does not extend enough from the opposing side of the vehicle.

B Post Rip

29. The first actions for this technique are to gain access to the 'B' post by opening the rear door by spreading with the combi-tool to spring the door lock. A combi-tool or REM saw should be used to cut the top of the 'B' post and the REM saw should be used to make a horizontal cut at the bottom of the 'B' post.

30. Make the horizontal cut at the bottom of the 'B' post just above the seat belt mechanism. The rear door and 'B' post are now ready to be spread. Place the combi-tool, in the closed position, between the bottom of the rear door and the sill as close to the 'B' post as possible and then open the tool as far as possible. The tool should rip the 'B' post away from the sill, which then brings the front door away with it to completely remove the side of the vehicle. This enables paramedics to give a full head to toe assessment of the casualty.



Danger: Beware of seat belt pre-tensioners. If they are fitted make sure the seat belt of the casualty is cut so that there is no danger of it retracting on the casualty or the rescuer.

Dashboard Roll

31. This technique enables the dashboard and steering column to be pushed away from the casualty. You must remember to block beneath the 'B' post, which is where the sill brace will be positioned and check that the front chocks are not too far forward so they impede the dashboard roll.

32. Make a horizontal cut at the base of the 'A' post on each side of the car. Do not cut into the sill. These cuts can be made with a combi-tool or REM saw. Position the sill brace against the 'B' post, as this gives a good strong platform for the ram to be extended from. Position the ram against the sill brace and 'A' post. It is important that the ram has a good purchase and cannot slip. This is why it is important to leave 100-150 mm of the 'A' post when performing the roof removal. Extending the ram will push the dashboard away from the casualty and create space in which to work. Once the dashboard has been pushed away insert a wedge in the horizontal cut on each side of the vehicle to prevent the dashboard coming back onto the casualty if the ram slips or is removed.

Lumbar Support Removal

33. This technique is required when the winding mechanism on the seat has been damaged. Remove the covering on the rear of the seat (by cutting if necessary). Use the combi-tool or pedal cutter to cut through the tubular supports on the seat, making the cuts as low as possible. (The REM saw could be used but it will cause vibration through the seat). The casualty can be reclined onto a spine board to await removal after performing this technique.



Note: It is important that a spine board, or some form of improvisation (eg parcel shelf) to protect the spine, is in place before this technique is performed.

Simultaneous Activity

34. Simultaneous activity means that many jobs can be performed at the same time as long as they do not interfere with each other; this includes ambulance crews and fire crews.

Conclusion

35. In conclusion, it should be understood that work at an RTA will thoroughly test the knowledge, ability, skills, and teamwork of all crews involved. Only through regular and thorough training at all levels and with other services, will incidents of this nature be dealt with in a satisfactory and efficient way.

AIR LIFTING BAGS

1. Air Lifting Bags are specially designed for Fire Service use. They are mainly intended for the rescue of trapped persons in a variety of operational situations encountered, primarily at road accidents, aircraft crashes, collapsed tunnels and trenches, where conventional jacking methods may be difficult or impossible to apply without lengthy preparation. Air Lifting Bags can be inflated either by a powered compressor or by compressed air (often BA) cylinders via a control unit.
2. Air Lifting Bags are divided into 2 types - low pressure (also known as Air Cushions) and high pressure (also known as Power Mats). Low pressure air bags are generally made of neoprene coated nylon fabric, whilst high pressure air bags are made of high quality rubber reinforced with layers of kevlar or steel wire and finished with an outer layer of neoprene.
3. Operating pressures are 1 bar for the low pressure type and 10 bar for the high pressure type. Lifting capacities range from 2 to 5 tonnes for the low pressure and upto 9.4 tonnes for the high pressure. High pressure air bags are smaller and thinner than the low pressure type and can be used where there is very little clearance to give a start to the lift before, if necessary, changing over to a low pressure bag.

Safety Precautions

4. Safe and effective operational use of air bags and air cushions depends on the correct assessment of the situation to determine priorities, the preservation of stability, careful assessment and observation and safe limits being established and observed during use. Additionally the following points must be considered:
 - a. Ensure delivery hoses are well laid and not 'kinked'.
 - b. Determine the best location for inserting air bags.
 - c. Avoid contact with sharp or jagged surfaces, particularly on sidewalls (hot exhausts should be covered with a folded fire and heat resistant blanket).
 - d. Position air bags as far as possible under the load but, if this is impractical, inflate to obtain clearance, pack and re-position cushions.
 - e. Before inflating, consider the effect of the lift on the stability of the object to be lifted.

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- f. In the case of low pressure air bags (air cushions) ensure the sidewalls are folded inwards in a regular fashion and that the upper working surface is 'square' with the loops placed at quadrant positions.
5. Remember to take the normal precautions against the danger of outbreak of fire, such as laying out charged lines of hose or foam branches as appropriate.

Operational Procedures

6. The following procedures should be followed when using air bags:
- a. Ensure all levers on the control unit are in the 'off' position.
 - b. Connect delivery hoses to the control unit maintaining a clear line to each cushion.
 - c. Couple the control unit to air supply.
 - d. Before inflating, reconsider the effect of lift on stability.

Remember: A three point lift is the safest, ie one side or end of the object to be lifted in contact with the ground and two air cushions in use wherever possible.

- e. Commence inflation by moving appropriate control levers, balancing air input by attention to control gauges.
- f. Pack and block as the lift proceeds, taking care to see blocks are so placed that, if necessary, they can support the load.

Note: Loops are provided to hang cushions between shuttering, collapsed trenches or vehicles, skips etc which are tight to walls.

- g. Ensure only trained personnel use equipment.
- h. Never inflate air bags without the appropriate control unit.
- i. Keep clear of any load that is unsupported by chocks during lifting operations.
- j. Ensure the operator is positioned away from direction of anticipated thrust.
- k. Do not use hoses or inflation port for retrieving or re-positioning cushions.

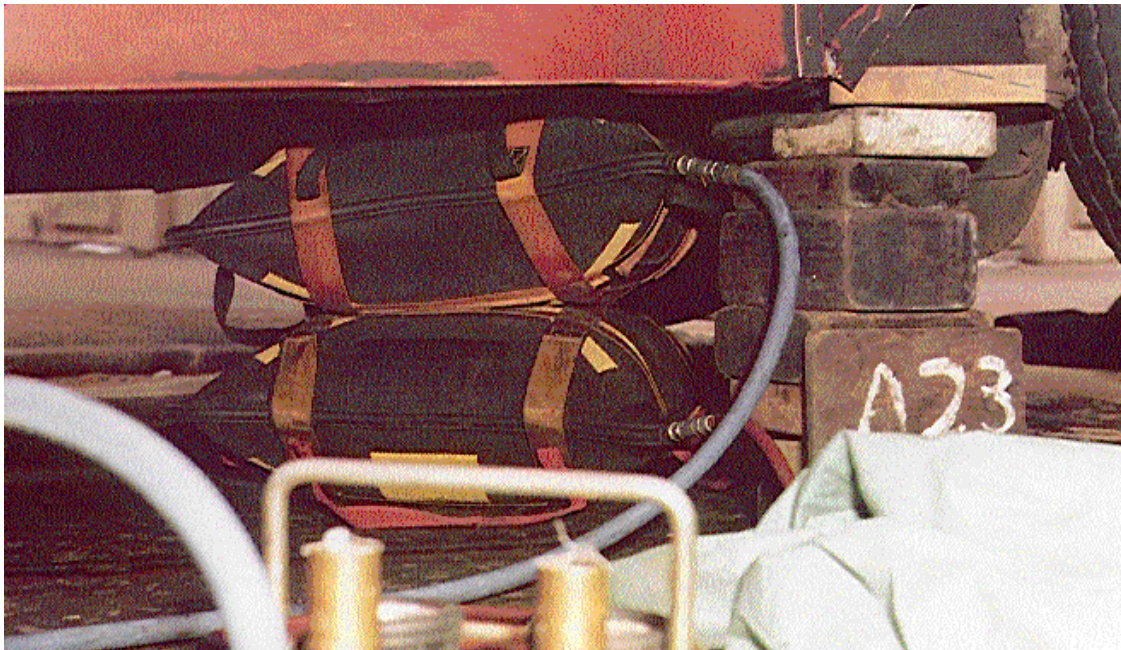


Figure 1. Example of air bags being stacked to gain additional height.

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SAFE WORKING NEAR, ON OR IN WATER

Introduction

1. Incidents inevitably occur in areas containing and involving water from people trapped in liquid filled tanks to floundering in fast flowing rivers or the sea. With the exception of certain stations who receive maritime training, the MOD FS does not currently train personnel to conduct water based rescues however, such incidents are becoming increasingly common and there is a need for information on the subject to be provided to increase firefighters awareness of the hazards involved in such incidents.
2. One of the most important factors in any water-based incident is pre-planning. This involves identification of water stretches which possess the potential to flood or freeze; rivers and canals where there is empirical evidence of road traffic accidents; lakes which seasonally attract large groups of people etc.

General

3. Working near, on or in water is inherently hazardous, and is an area where fire service and rescue experience is currently limited to pumping operations and infrequent rescues therefore training is essential.
4. In any rescue scenario members of the public as well as "volunteers" from organisations may become involved. Fire and rescue service procedures should provide clear guidance for Incident Commanders (IC) on what to expect and do in such situations. Organised volunteer rescuers may not be familiar with fire service operational management procedures at incidents and may well impede rescue efforts. However, in some situations such volunteers may have skills and expertise, which will be of value to the IC.
5. The pre-planning for operational incidents involving water rescues should include appropriate liaison with organised volunteer groups wherever their assistance is likely to be offered.
6. The term 'Water Related Incidents' is in itself a generic term and can encompass fast flowing water, still ponds, canals, weirs, areas of mud and slurry. Climatic extremes can add further to the complexity of these incidents and significantly change the approach required to particular problems (eg extreme cold resulting in water courses forming ice and presenting a new set of hazards to crews).
7. These physical scenarios confronting rescuers can then be exacerbated by the nature of the emergency and what is involved. Some examples might be submerged cars,

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boats or aircraft, people or animals requiring rescue or recovery, or environmental protection issues, such as chemical spillages.

Response

8. The response to water related incidents provided by fire and rescue services could be described as having three sequential levels.

- a. Awareness Level. To make personnel, who may be expected to work near water as part of their service role, aware of the hazards associated with working in such areas.
- b. Initial Operational Response Level. First attendance crews, with knowledge, experience, training, and safe working practices and procedures for attempting those rescues advised upon in this document.
- c. Specialist Crew Level. Specially trained crews with appropriate knowledge and experience, and a range of specialist equipment to facilitate more complex rescue operations.

Incident Types

9. Water can be broadly defined under two headings - still and flowing:

Still Water	Flowing Water
Swimming Pools	Canals
Ponds	Rivers (tidal and non-tidal)
Lakes	Floodwater
Reservoirs	Coastal Waters and Sea Lochs

10. Common types of incident include:

- a. Rescues from rivers and canals
- b. Rescues from vehicles in water
- c. Rescues from ice
- d. Rescues from unstable ground

Hazards

11. Firefighters as part of their duties may be involved in activities working with and alongside water. Normally, this involves pumping from ponds, lakes and rivers, but on occasions they will be called upon to rescue persons and animals from water, sometimes in hazardous, time-critical situations.

12. It is essential that personnel appreciate the hazards associated with working near, on or in water, which includes amongst other things:

- a. The current, depth, flow, undertow, eddies, whirlpools, weirs, stoppers.
- b. The force of water.
- c. The temperature.
- d. The water clarity, pollution, contamination and biological risks.
- e. Entrapment, debris, trees, fencing, cars, shopping trolleys, strainers.
- f. Panic from a drowning person.
- g. Fatigue which may lead to drowning.

Force of Water

13. Doubling the water speed, quadruples the force of the water, so standing in fast flowing water is extremely difficult and dangerous.

Entrapment

14. Where fast moving water flows against a solid object, such as a bridge pillar, most objects will tend to be flushed around the obstacle however, a person or boat that hits the obstruction can be pinned against it with considerable force.

Debris

15. All watercourses contain debris of some sort. This can be debris picked up along the way and carried by the flow either on the surface or suspended in the water and may include trees, driftwood and manmade debris. Contact with debris can result in serious injury both to a person in need of rescue and the rescuers.

Temperature

16. The importance of water temperature cannot be over-emphasised. In cold water a strong swimmer can quickly be reduced to a non-swimmer because of the effects of immersion hypothermia. In cold temperatures, survival time may be as little as 2 minutes and death by drowning is a likely consequence.

Note: The wearing of a life jacket will not afford protection against the effects of temperature.

Health Issues

17. There are three principal health issues to consider:

- a. Hypothermia.
- b. Drowning.
- c. Infection.

Action on Arrival

18. En route to an incident the primary task is to begin a Risk Assessment of the location based on existing knowledge. The IC at a water incident may be faced with many difficult decisions, the greatest of which may be in stopping ill-conceived and reckless rescue attempts being made by members of the public, where a rescuer may easily become a casualty.

19. The following must be considered:

- a. Crew safety.
- b. Deployment of safety personnel.
- c. Stabilisation of the scene.
- d. Preparation for oncoming specialist crews.
- e. Only the minimum number of personnel should be used to undertake the task safely as identified by the Dynamic Risk Assessment.
- f. The requirement to rotate crews.

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Note: Weather conditions and the duration of the incident may increase the need to rotate crews.

- g. At night, lighting of the scene is a priority.
- h. In flowing water incidents spotters should be deployed upstream of the location of the rescue operations.
- i. Consideration of alternative measures to cater for a sudden change of situation (preparation of a secondary plan of action). It may be necessary to consider several action plans to achieve a successful rescue.

Rescue Options

20. A hierarchy of options, which may be considered (starting with the option offering the lowest risk to the rescuer), is listed below:

- a. Talk.
- b. Reach.
- c. Throw.
- d. Row.
- e. Go.

Talk

21. Where possible it is important that quick contact is made and maintained with the casualty. Keep talking to them, explain what you are going to do, what you want them to do and above all keep encouraging them.

Reach

22. Equipment from the appliance, such as a ceiling hook, chimney rods or inflated fire hose, may be used to reach the casualty and pull them to safety.

Throw

23. A buoyant object may be thrown to the casualty for stabilisation or the casualty may be pulled to safety by throwing out a floating line.

Row

24. A boat may be available, which in most circumstances is safer than putting someone in the water.

Go

25. Only if all of the above options have been discounted or failed should a firefighter be committed to the water. In such circumstances the person must be appropriately trained and equipped with appropriate PPE, buoyancy aid (life jacket), and specialised helmet. A separate floating safety line attached to a specialist quick release harness must be attached to each rescuer.

Note: By entering the water the rescuer may be exposed to a number of hazards, this option should only be undertaken after a thorough dynamic risk assessment by the IC taking account of all the risks compared with the likelihood of a successful rescue.

26. Where the IC decides that it is necessary to commit a rescuer to the water the following control measures must be put in place before the rescuer enters the water:

- a. All personnel must be fully briefed regarding the rescue procedure and the role of each individual.
- b. A separate Safety Officer should be appointed to supervise each individual in the water and control the individuals safety line.
- c. Effective communications must be established and maintained between the IC, the rescuer and all safety personnel.
- d. Anyone entering the water must be dressed appropriately.
- e. In flowing water, a boom of inflated fire hose or personnel with throwing lines, should be positioned downstream as a safety measure for any casualty or rescuer who may be carried along with the flow. When using throwing lines, the number of safety personnel should reflect the number of casualties and rescuers in the danger area, but in any case must be a minimum of two.
- f. Personnel wearing appropriate PPE (eg a life jacket) and having communication with the IC should be deployed as spotters upstream of the rescue scene to give advance warning of any surface hazard heading towards the area of operations. Their position should be such as to allow adequate time for any rescuers in the water to get clear of the rescue scene before the hazard arrives.

Operational Refresher Course

Student Study Pack

Note: In situations where it has been determined that a swimming rescue will be attempted, aids to buoyancy such as inflated fire hose, may be used to assist with buoyancy of the casualty and the rescuer.

Note: Raising one hand directly above the head is the recognised method for a rescuer to indicate they are in difficulty and/or need removing from the water. All personnel must understand this signal and the action to take should it be given.

Survival Techniques

27. Situations may occur when a firefighter unintentionally enters the water. The following advice may assist personal survival:

28. Personnel who fall into water should:

a. Tuck their chin into the chest, clamp nose and mouth shut, keep elbows close to the body, protect head and face with hands and ensure legs are tucked together with knees bent (tuck into a ball).

b. Once in the water personnel should orientate themselves and locate the nearest bank, boat etc.

c. In flowing water personnel should position themselves lying on their back, facing downstream with the feet in front, near the surface in order to fend off any entrapment hazard.

d. Strainers present an extreme danger and are best avoided. If contact with a strainer is unavoidable approach head first, make contact with outstretched arms, try to lift yourself onto or over the strainer. If pinned against a strainer, attempt to keep the airway above the water and if possible locate handholds to climb over it but note that the weight of water may make this difficult.

e. Swimming rapidly accelerates heat loss. Only swim if the bank or floating objects can be easily reached.

This document has been withdrawn as the information contained in it is no longer relevant. The course it refers to is now obsolete and no longer offered
<https://www.gov.uk/government/collections/defence-fire-training-and-development-centre>

Operational Refresher Course

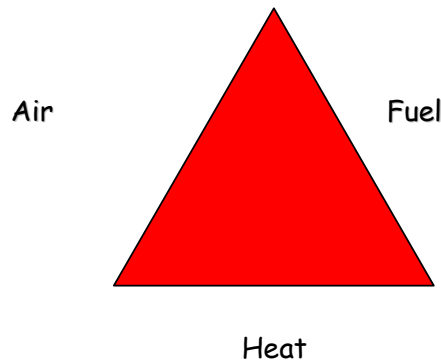
Student Study Pack

Intentionally Blank

Compartment Fire Behaviour Training (CFBT)

Combustion

Triangle of fire requires Fuel, Air & Heat



Combustion

A chemical reaction

Where oxygen combines (reacts) with other substances, which produces heat and light
Very slow combustion (Smouldering fire) may only produce heat.

Pyrolysis

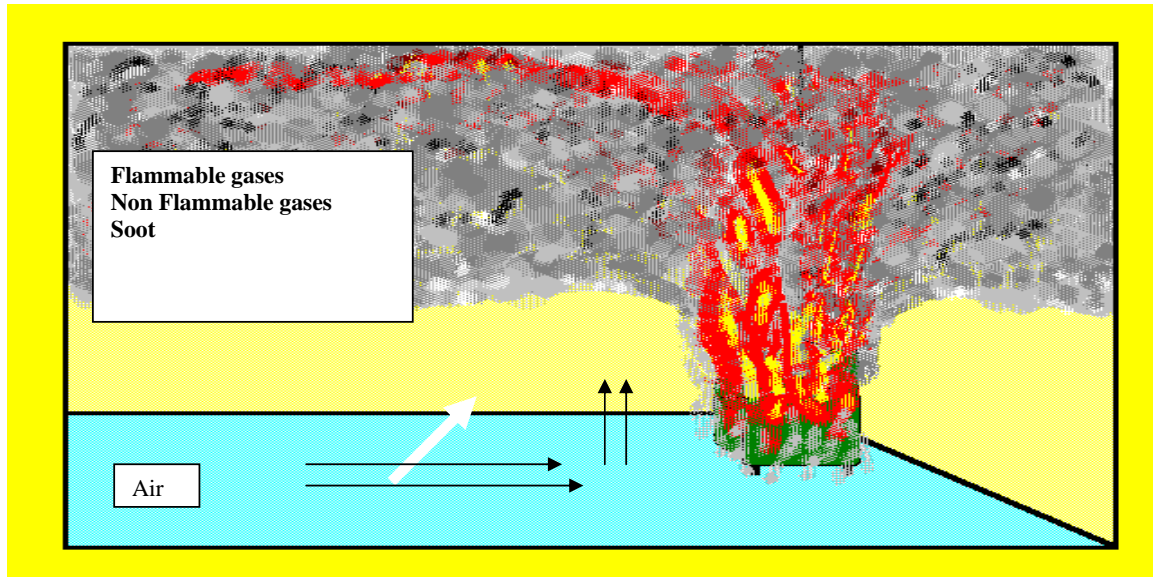
Chemical decomposition of a substance by heat

Example 1

A piece of Wood ($C_6H_{10}O_5$), undergoing pyrolysis would produce the following substances:

- Carbon, Hydrogen and Oxygen
- Carbon dioxide (CO_2)
- Water (H_2O)
- Carbon Monoxide (CO)
- Soot (Carbon particles, C)

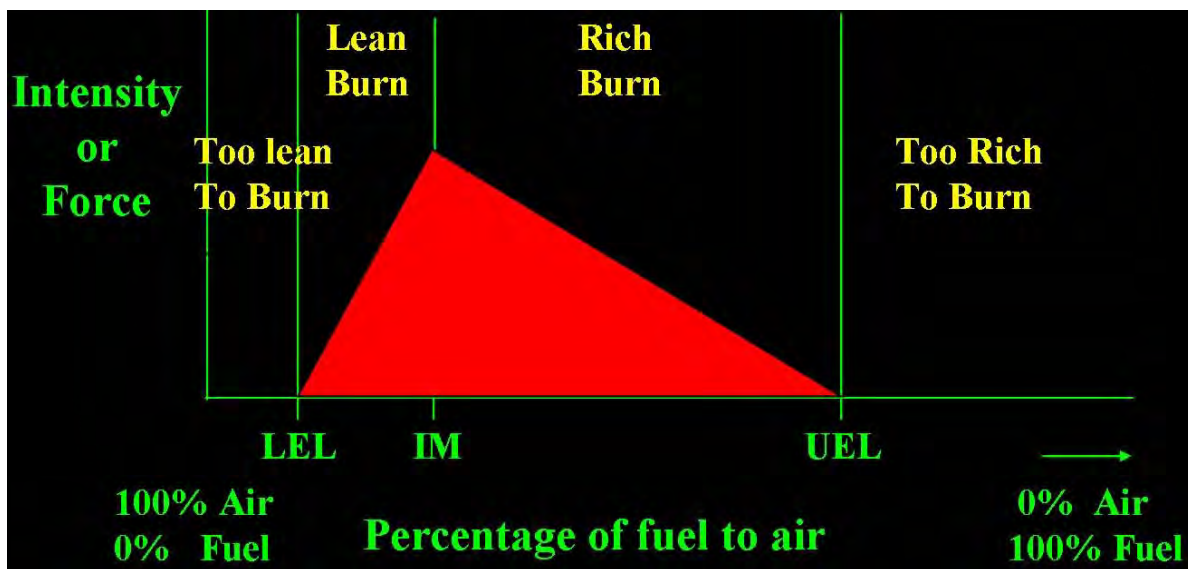
These substances form the substance we USED to call smoke; they are now called 'FIRE GASES'



Fire Gases

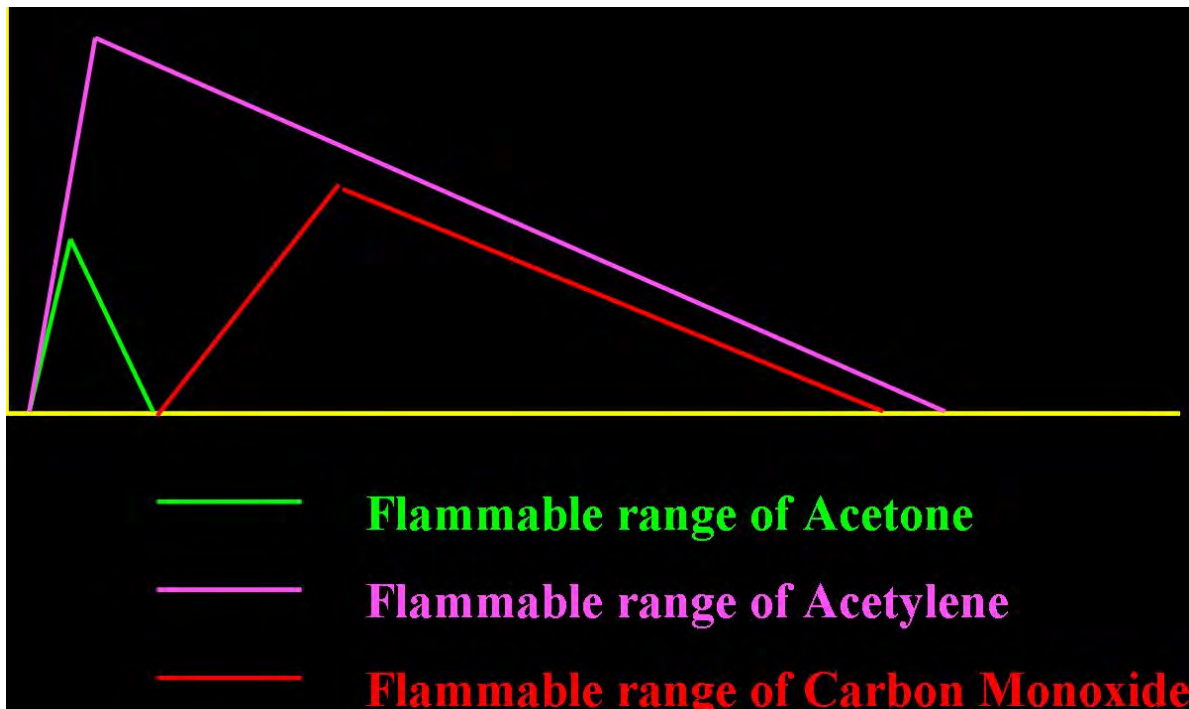
Certain flammable fire gases have to be present in various quantities (percentages) to form an explosive mixture. This percentage mixture is commonly known as its 'Flammable Range' or 'explosive range'

Flammable Range



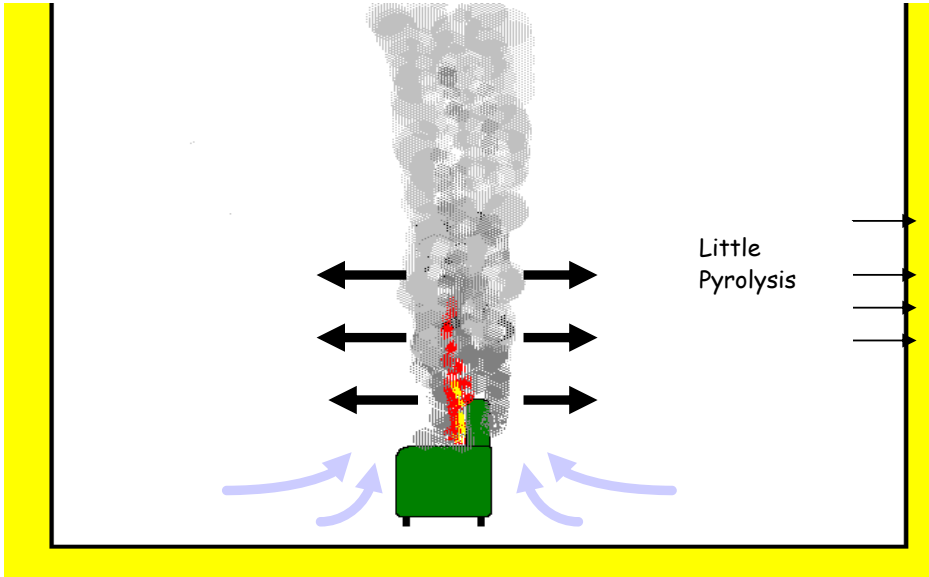
Definitions within Flammable range.

- **LEL** Lower explosive limit
Lowest concentration of fuel to air that will just support a flame
- **IM** Ideal mixture
Most efficient concentration of fuel to air that produces, highest temperatures, largest and quickest reaction
- **UEL** Upper explosive limit
Highest concentration of fuel to air that will just support a flame

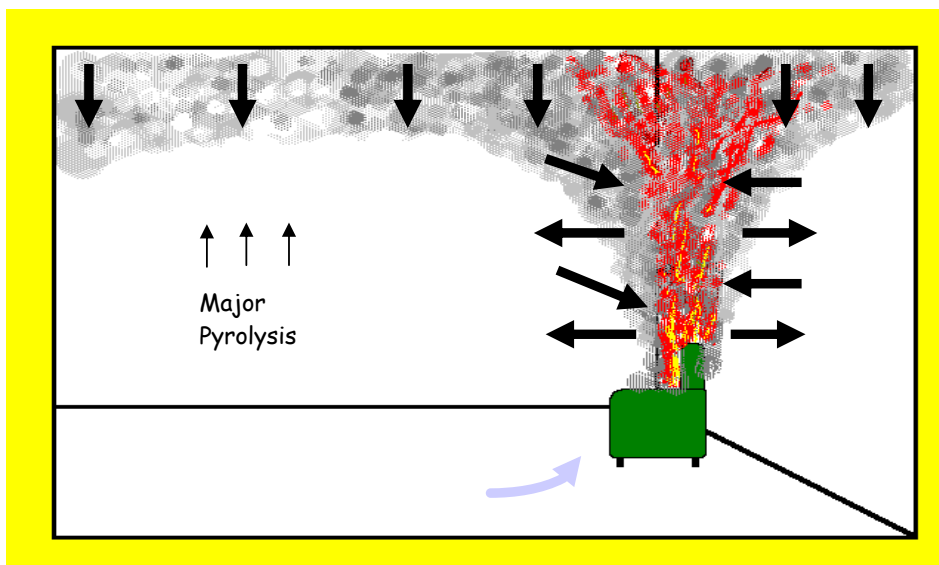


Examples of Pyrolysis (creating flammable range Fire gases)

Initial Fire (in the open)

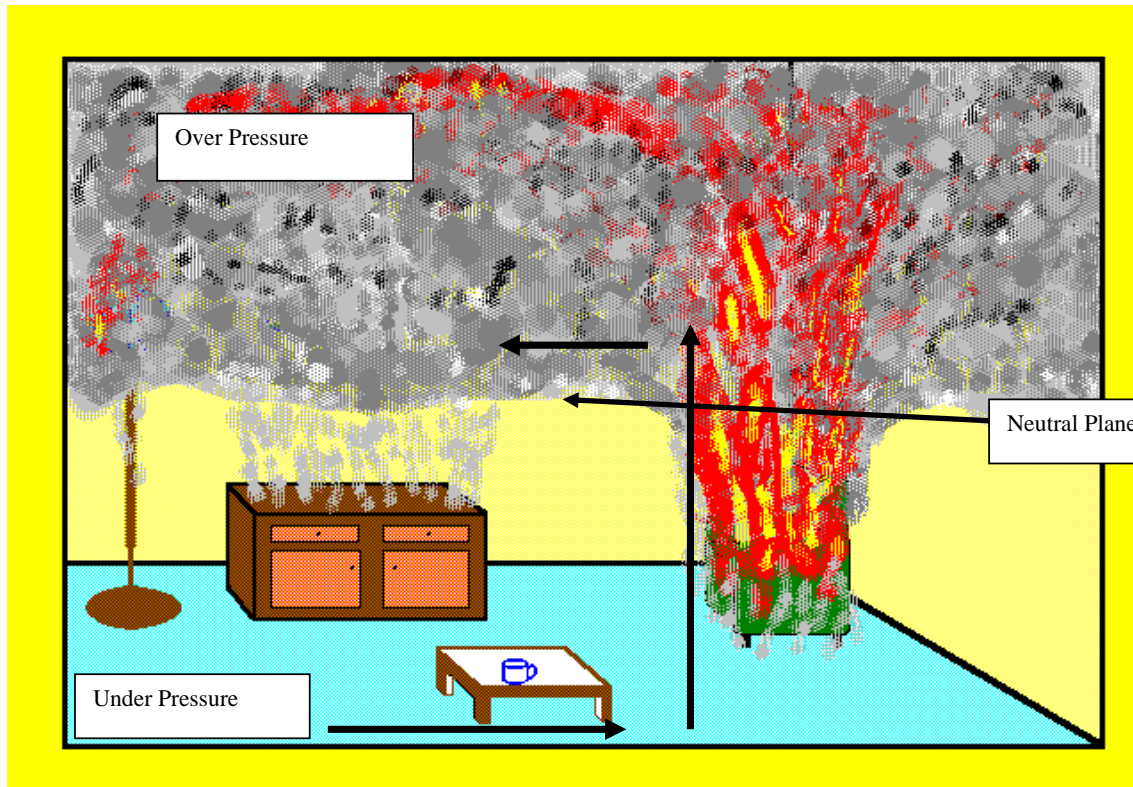


Initial Fire (in the corner)



Example of Different pressure regions within a compartment fire.

Pressure areas inside compartment



Flashover

Stage in a compartment fire when the total thermal radiation from the fire plume, hot gases and hot compartment boundaries causes the generation of flammable products of pyrolysis from all exposed Combustible surfaces within the compartment which, given a source of ignition, this will result in the sudden and sustained transition of a growing fire to a fully developed fire. **Flashover has occurred**

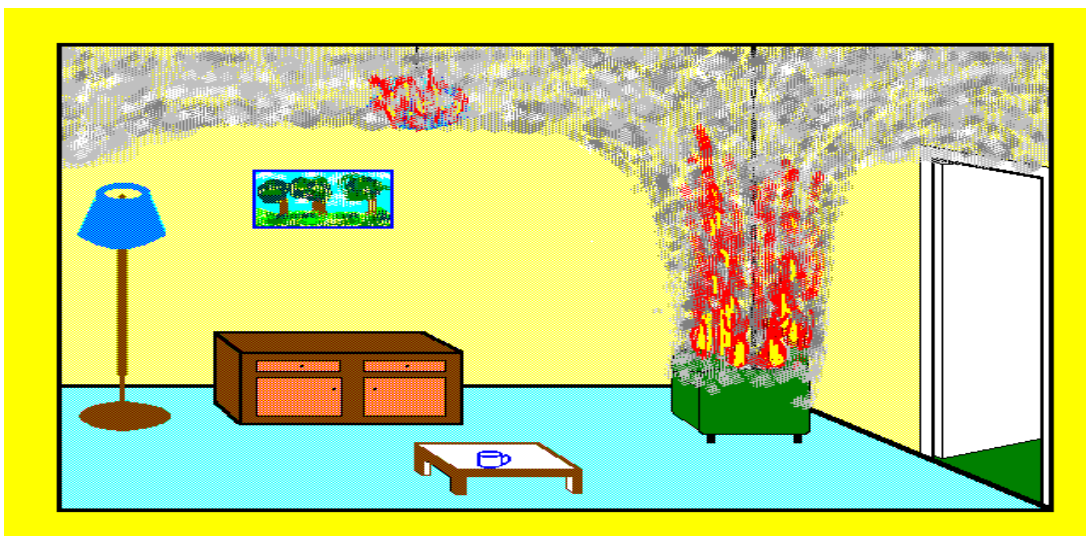
Fire Development in a ventilated room

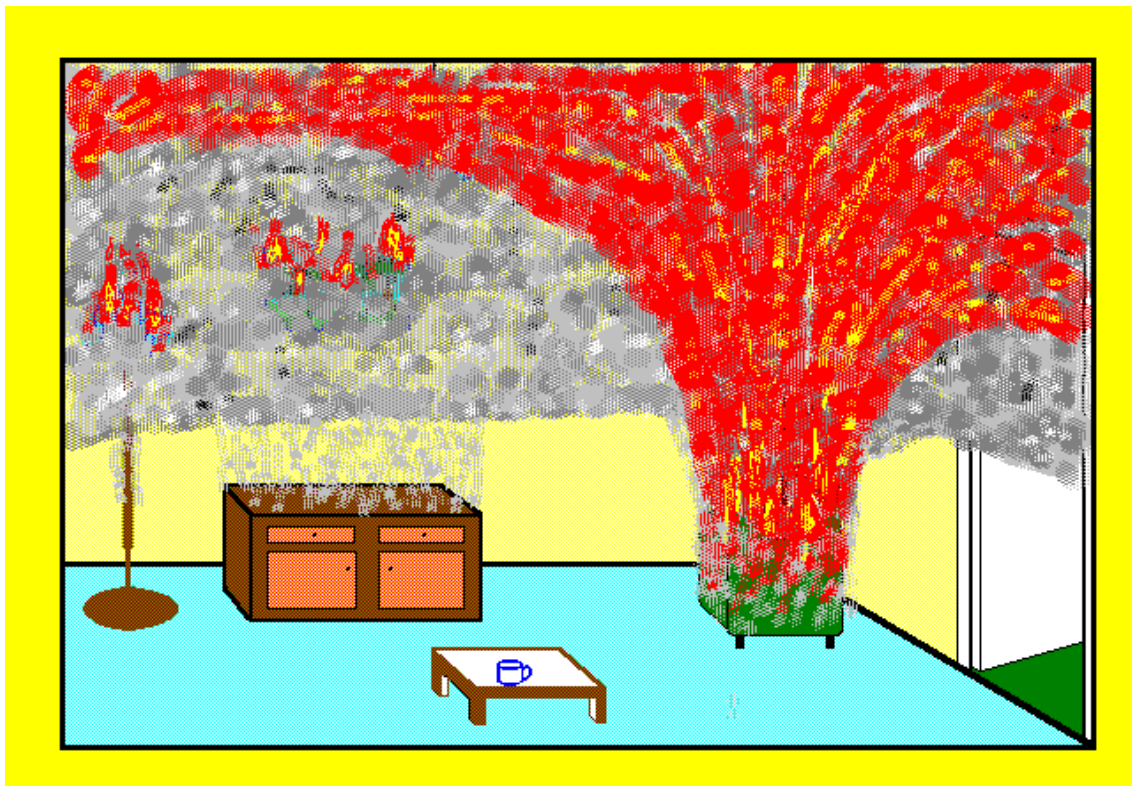
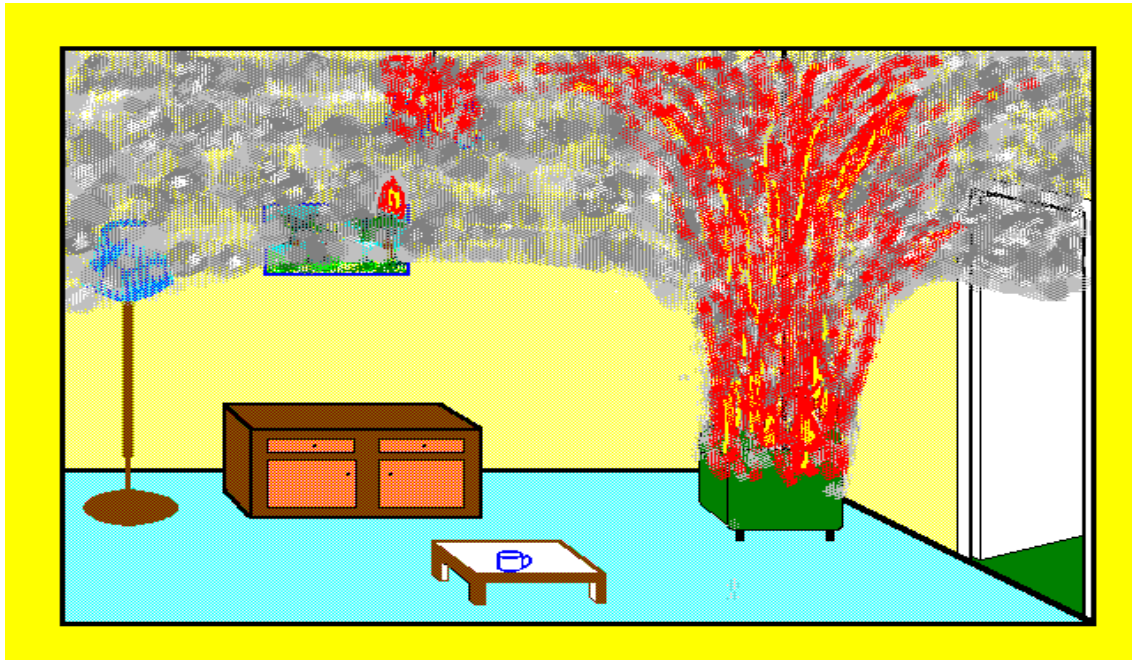
Sequence of events, of an initial fire developing to a fully developed fire

Initial Fire



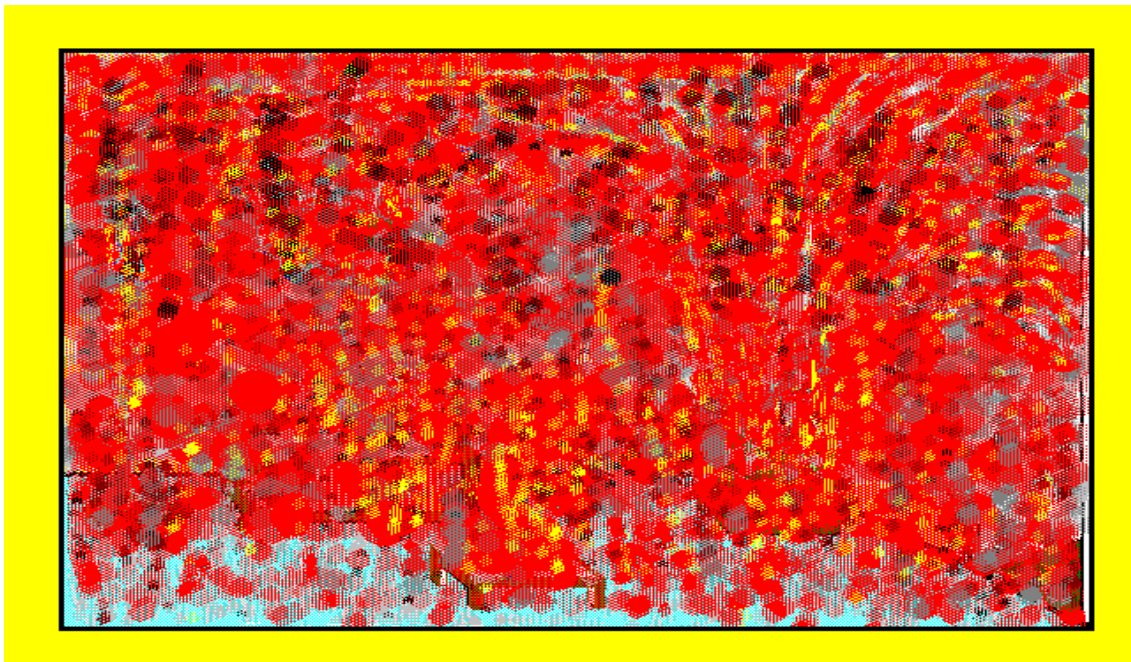
Developing Fire







Flashover has occurred



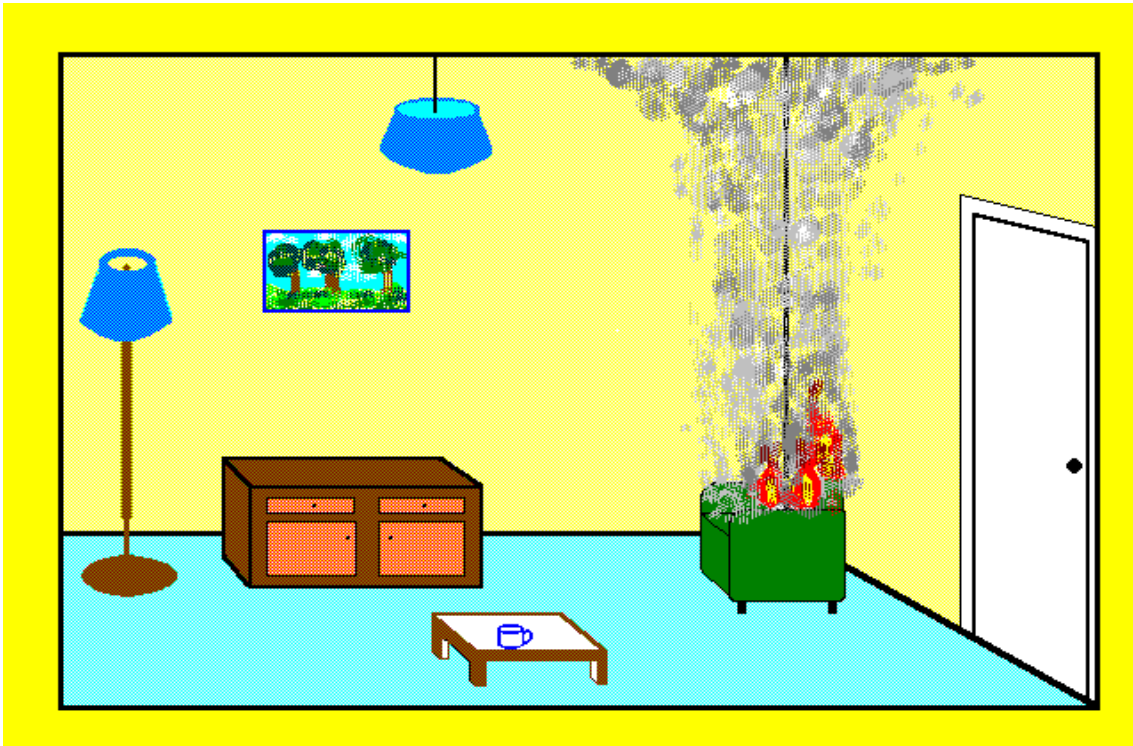
Backdraught

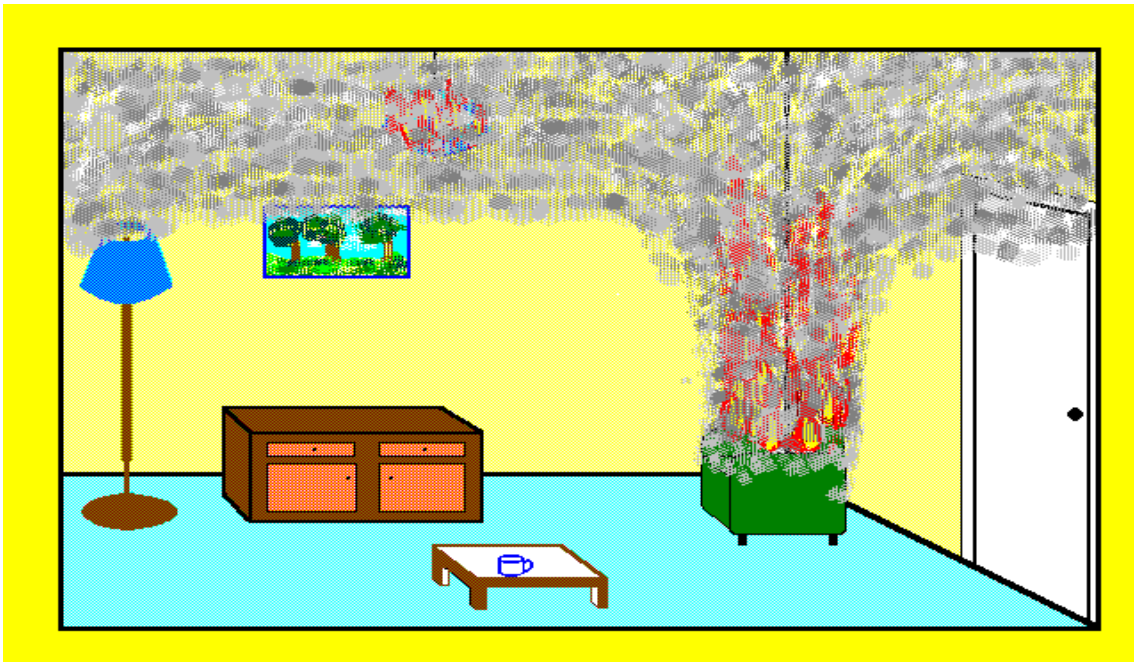
Limited ventilation can lead to a fire in a compartment producing fire gases containing significant proportions of incomplete combustion and unburned products of pyrolysis. If these have accumulated, when an opening is created and air enters the compartment it can lead to a sudden deflagration through the opening.

Sequence of events:

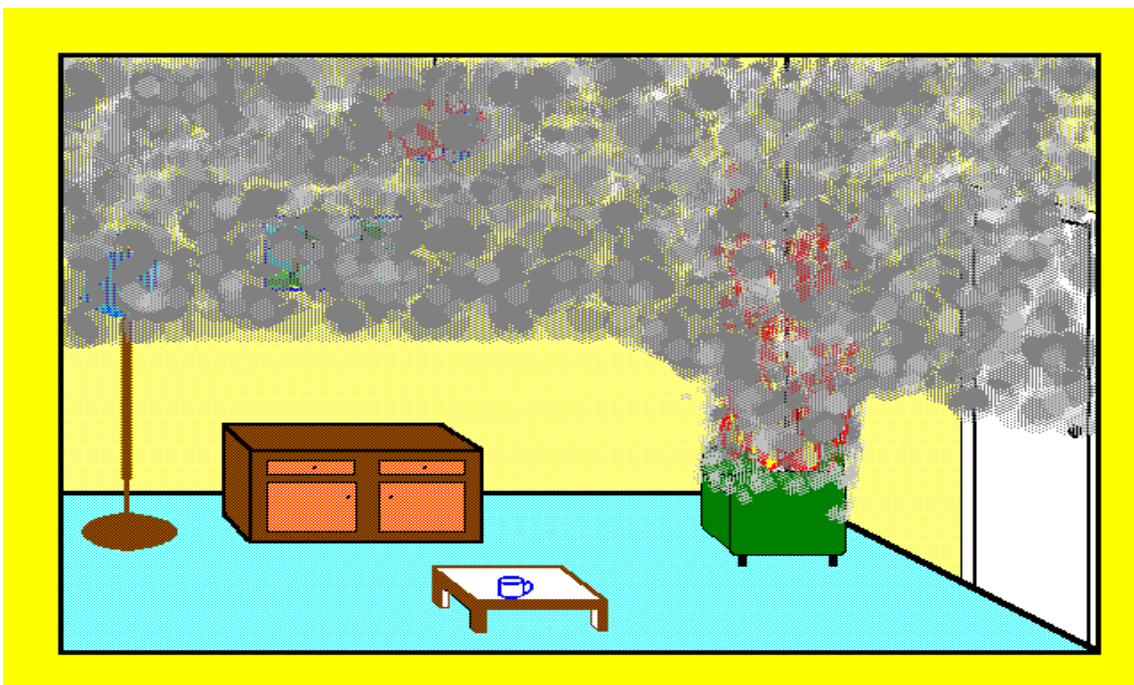
- Fire has developed with restricted ventilation
- Fire gases have reached a 'too rich' mixture'
- An opening appears
- Dilution of fire gases
- Ignition source appears
- Ignition of fire gases - **Backdraught**

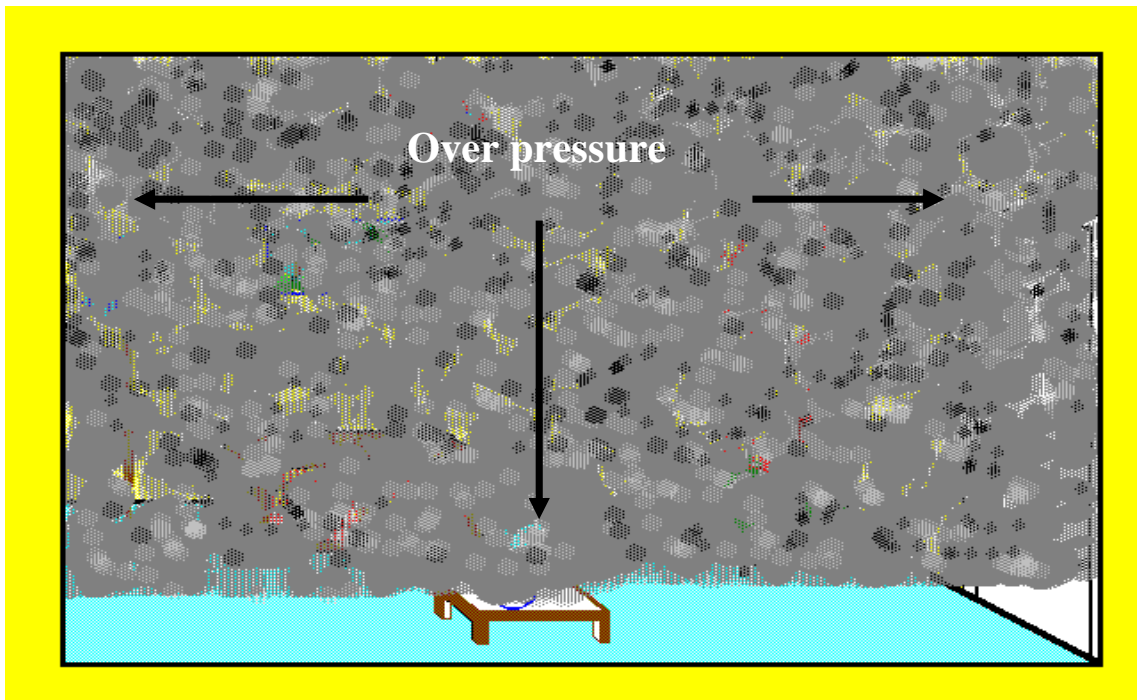
Fire Development in an unventilated room



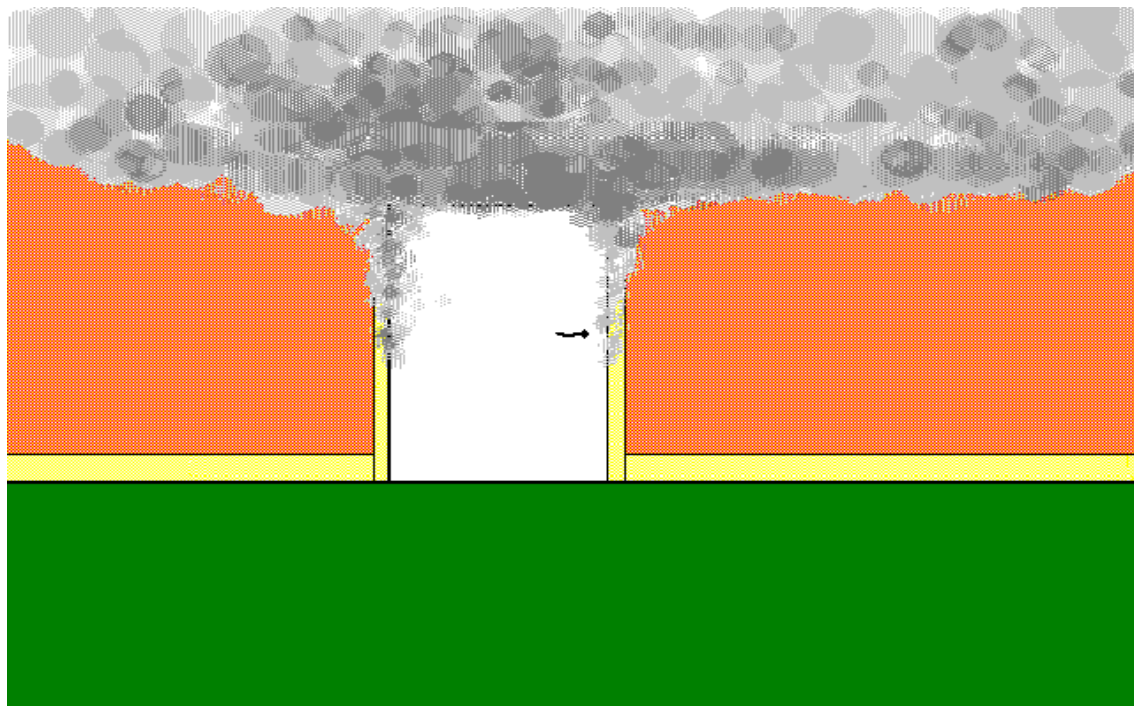


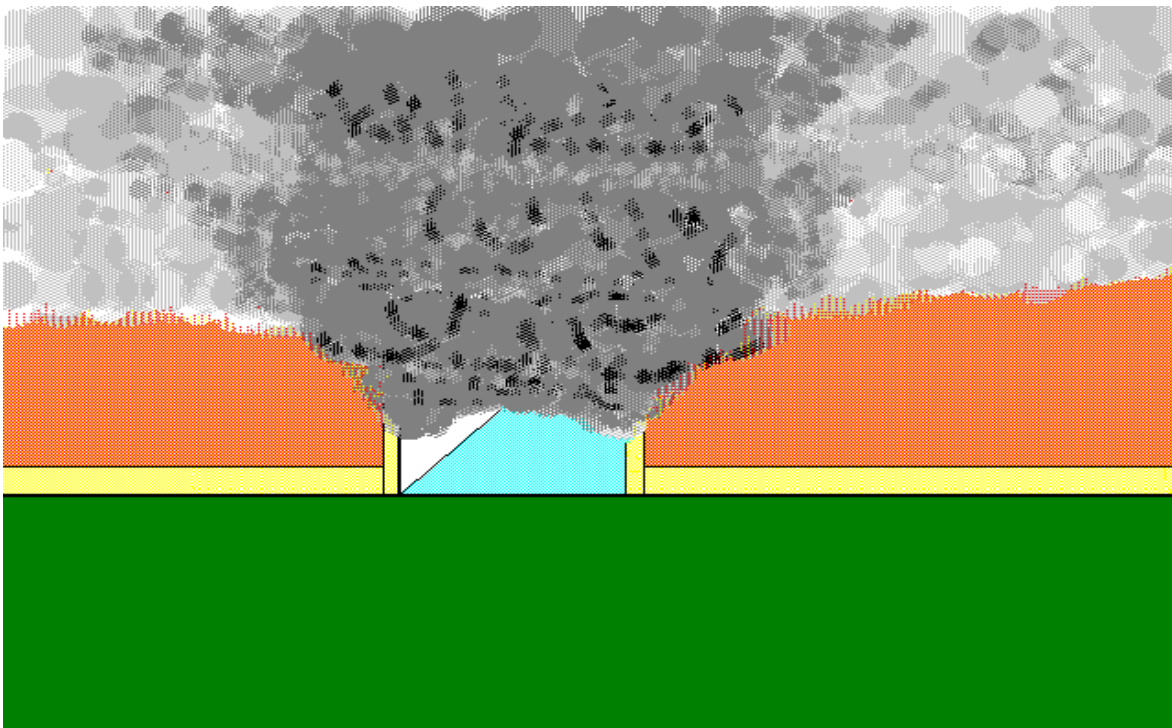
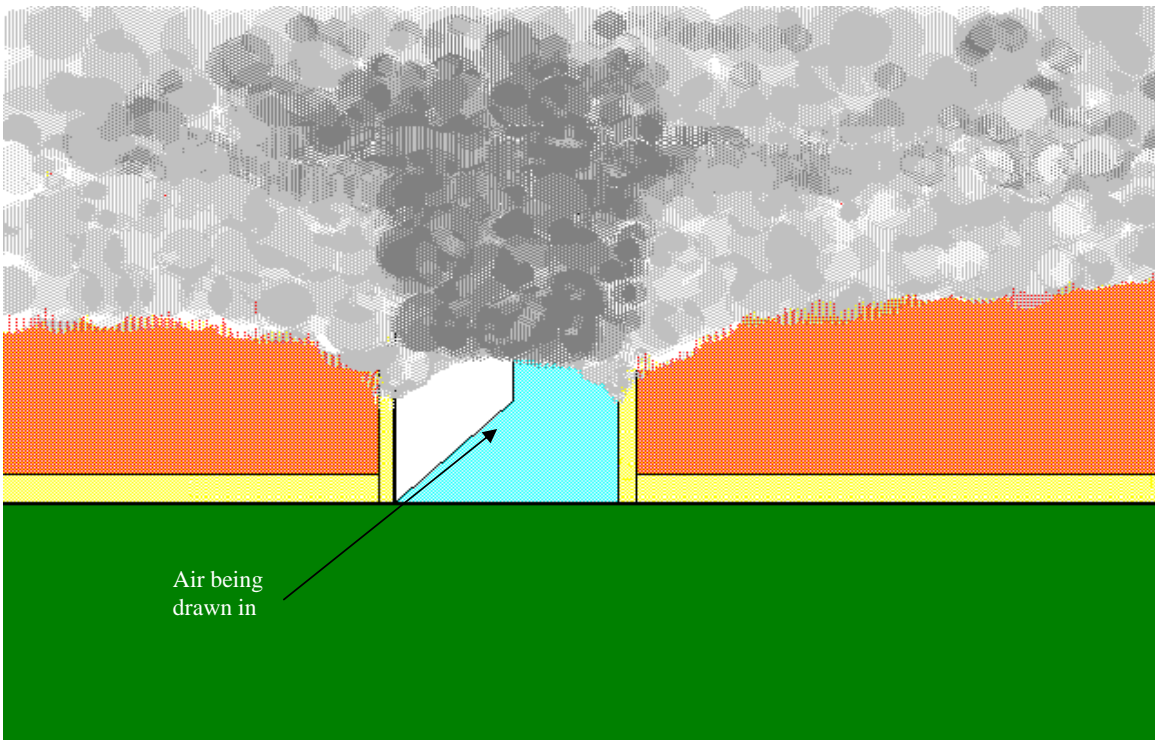
Flammable gasses becoming 'too rich'.(lack of oxygen)

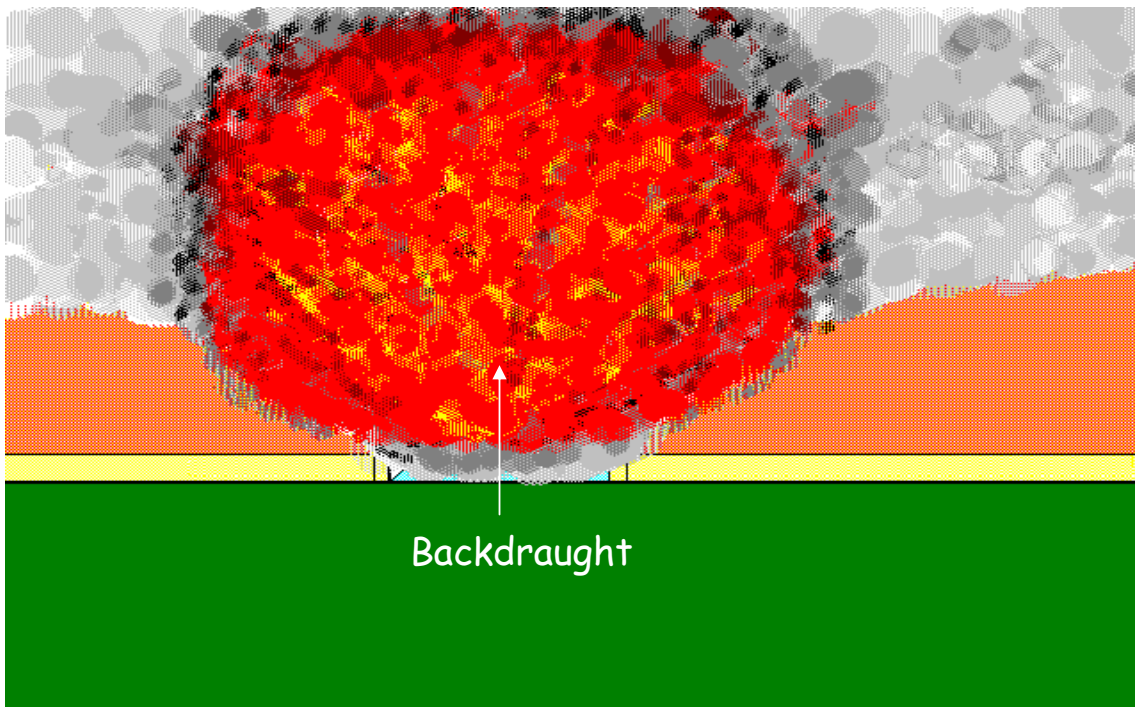




Outside the door







Backdraught

Signs & Symptoms - External

- Fire burning for some time with limited ventilation
- Smoke being pushed out under pressure from building
- Windows blackened with no obvious flames within

Signs & Symptoms - Internal

- Neutral plane almost at floor level
- Smoke 'pulsing' from small openings, under doors, etc
- Inrush of air when compartment opened
- Whistling or hissing sounds

Delayed Back draught



Fire almost out or embers - no immediate ignition source.

Air enters when opening made & begins to form flammable mixture

Air continues to mix with gases whilst crew enters.

Ignition source reappears due to increase in air supply and fire-fighter actions

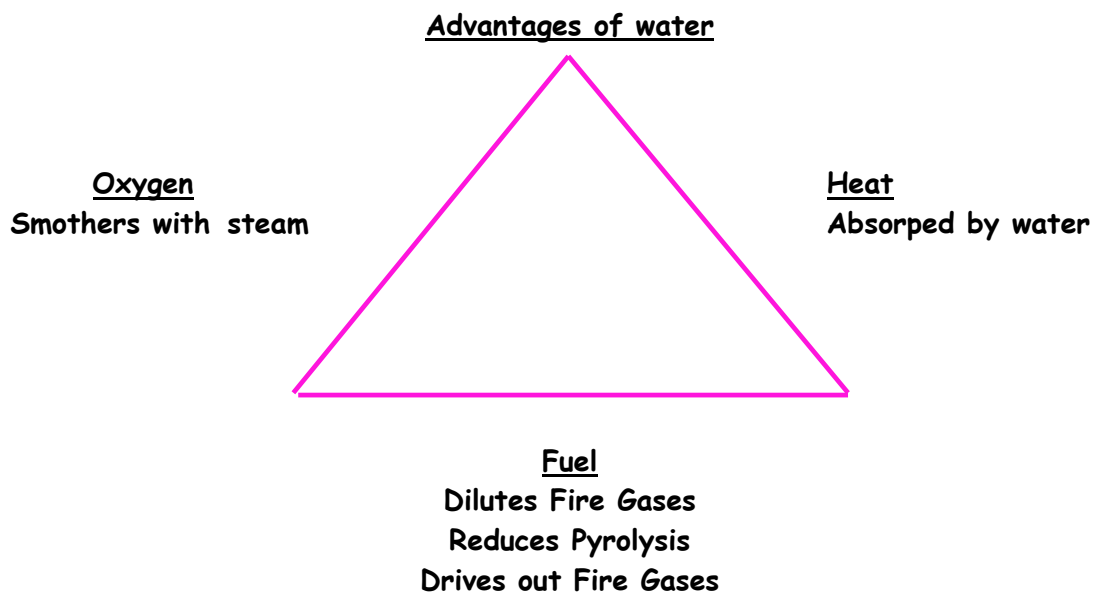
Delayed Backdraft occurs with fire-fighters inside compartment.

External Gas Explosion



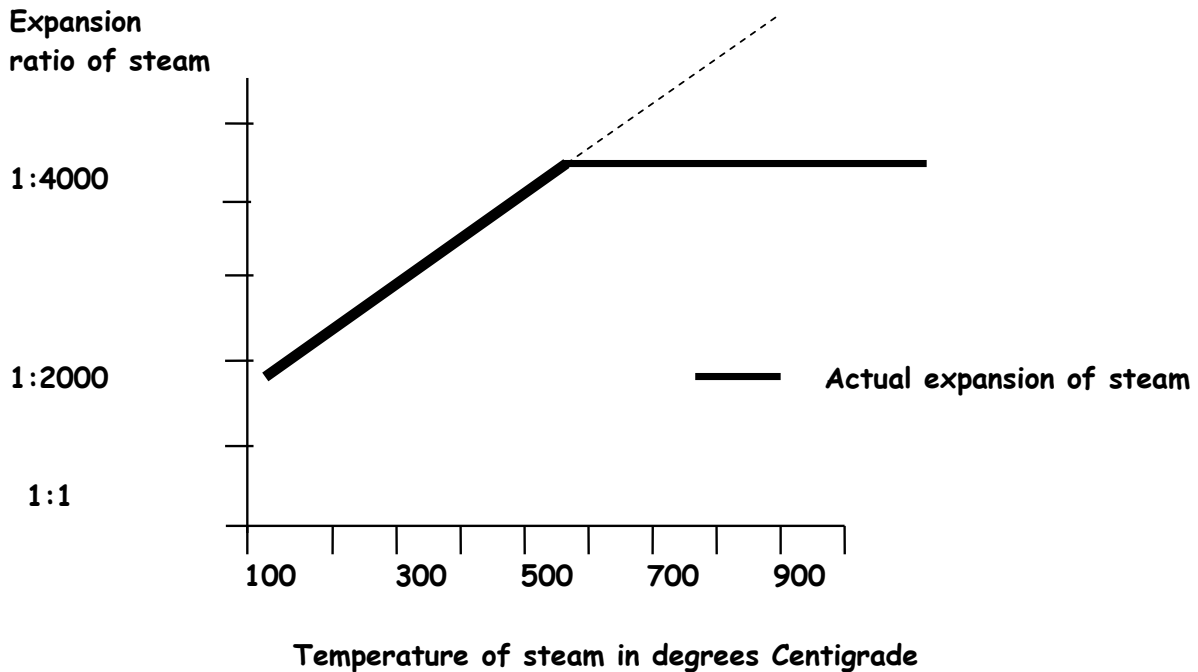
- Gases have spread from original compartment & formed flammable mixture outside
- Ignition source exposed when crew opens up, causing explosion which spreads into mixture outside compartment
- Area immediately outside fire compartment most at risk but.....
- may cause rapid fire spread throughout building

Extinguishing Techniques



Expansion of Water to Steam

Water expands at a ratio of 1700:1 at 100 degrees centigrade



Example1.

Well developed fire in classroom

Classroom volume 75,000 litres

Open Hose reel branch 5 seconds delivers 7.5 litres water

Steam produced approx.... 25,000 litres

5 secs worth of water will fill room with 1/3 of steam.

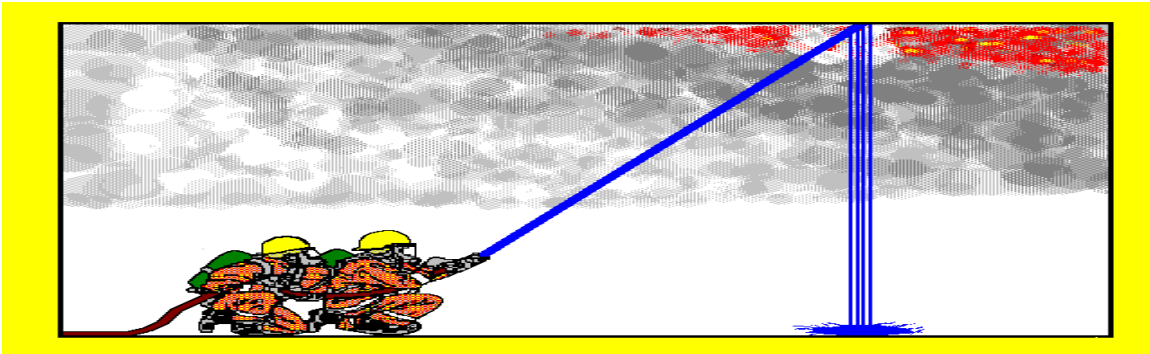
Effective use of water

Is a Balance *between* enough water to control the fire without lowering the neutral plane, thereby protecting fire-fighters from rising temperatures and steam, and helping to maintain vision

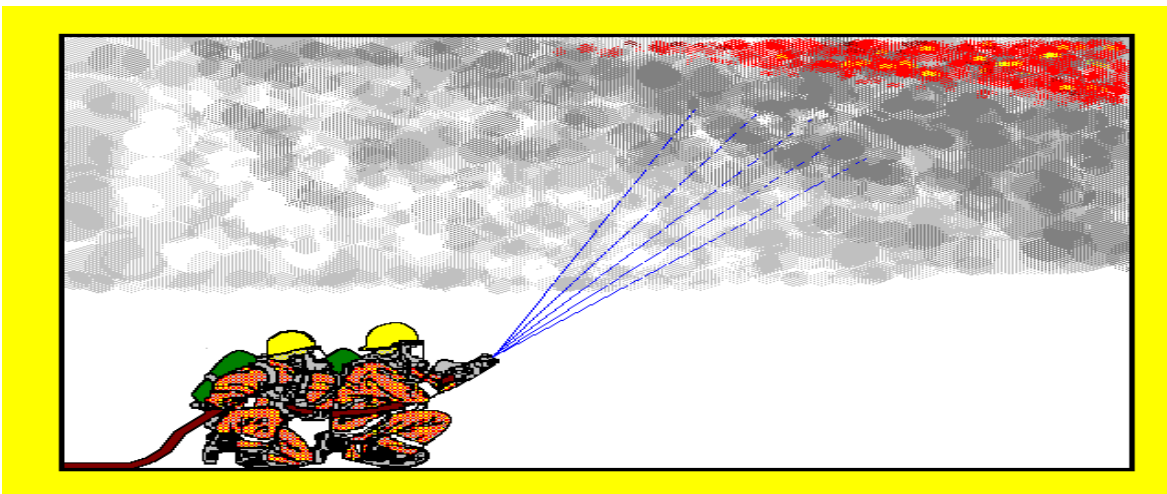
Droplet size

Effect of different size droplets

Large droplets



Small droplets



Extinguishing Techniques

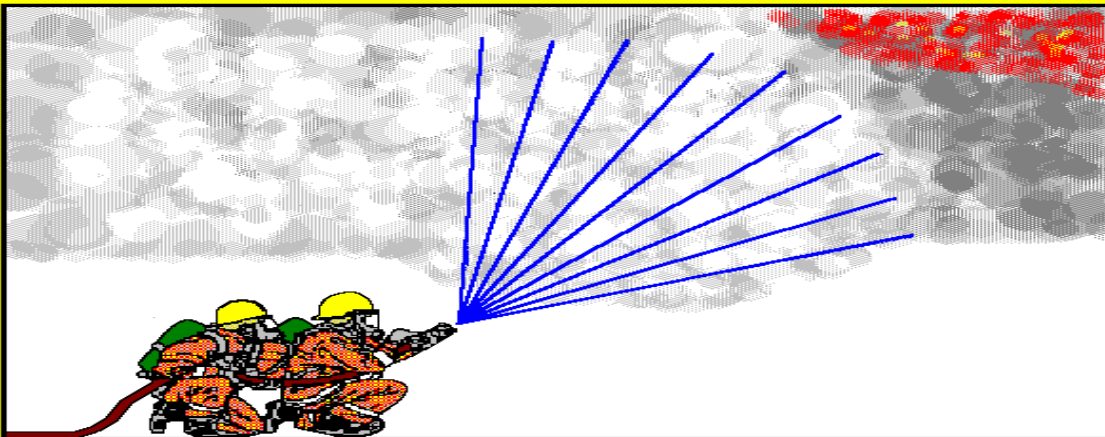
Methods

- GAS COOLING (cooling and shrinking fire gasses)
- INDIRECT (cooling the surfaces that are creating pyrolysis)
- DIRECT (controlled extinguishment of the actual fire)

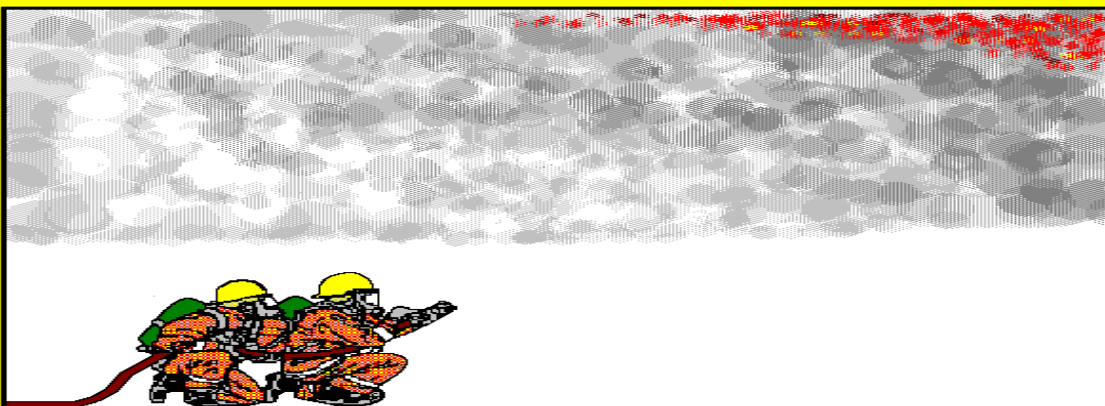
Gas cooling



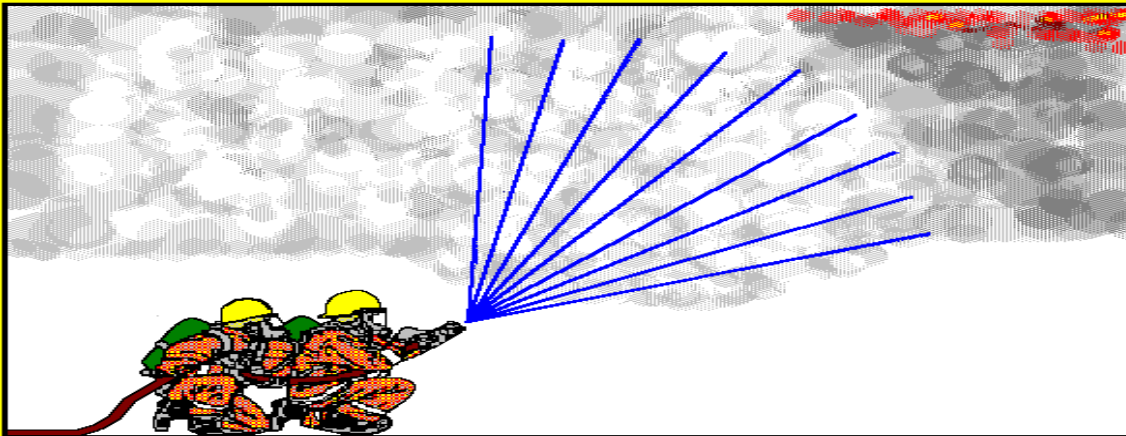
Wide angle



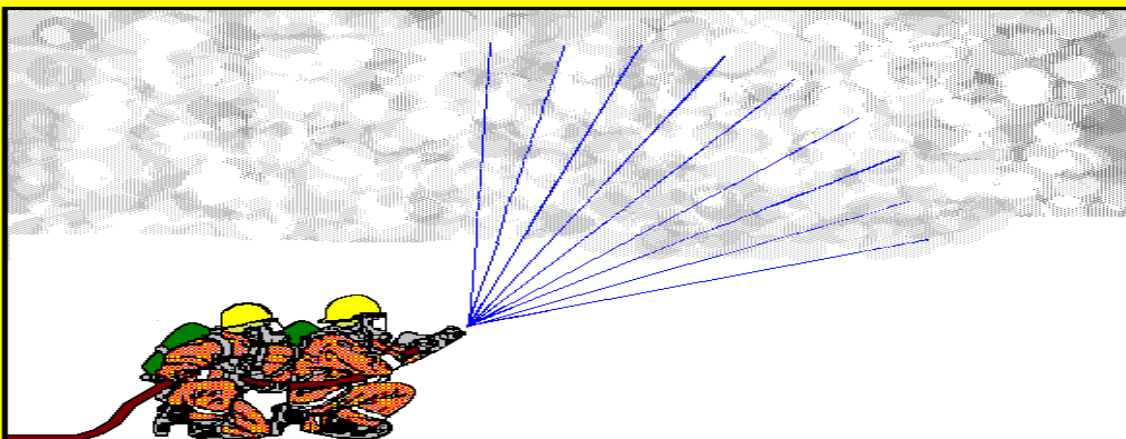
Wide angle



Wide angle

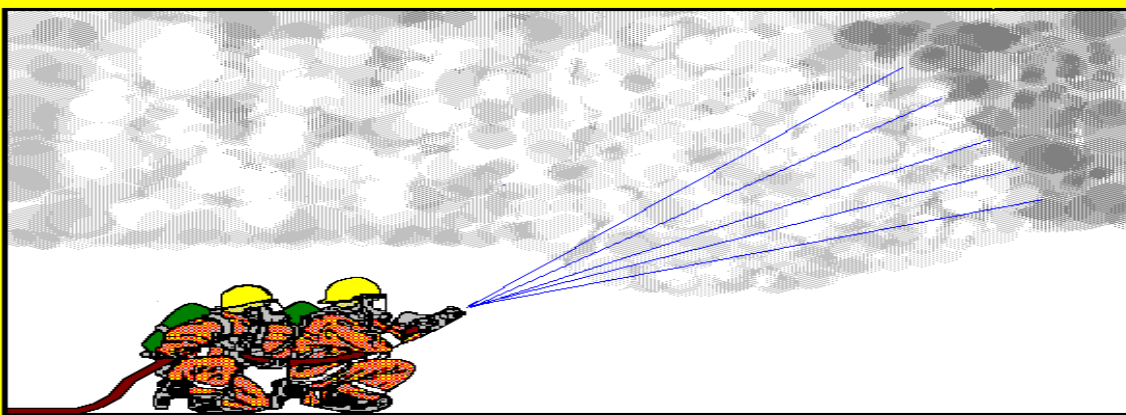


Wide angle



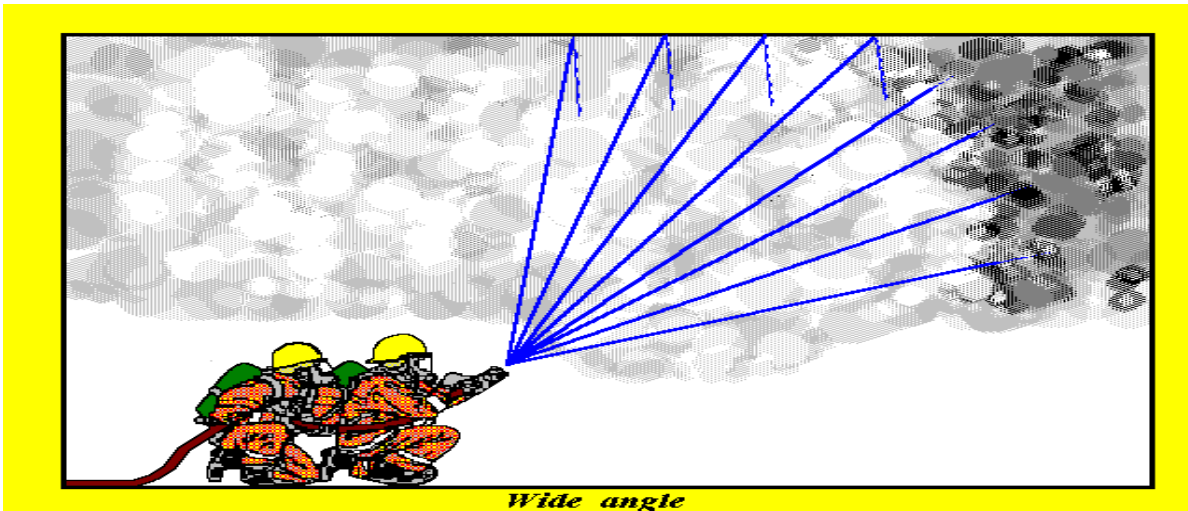
Wide angle

Narrow Angle Gas cooling.

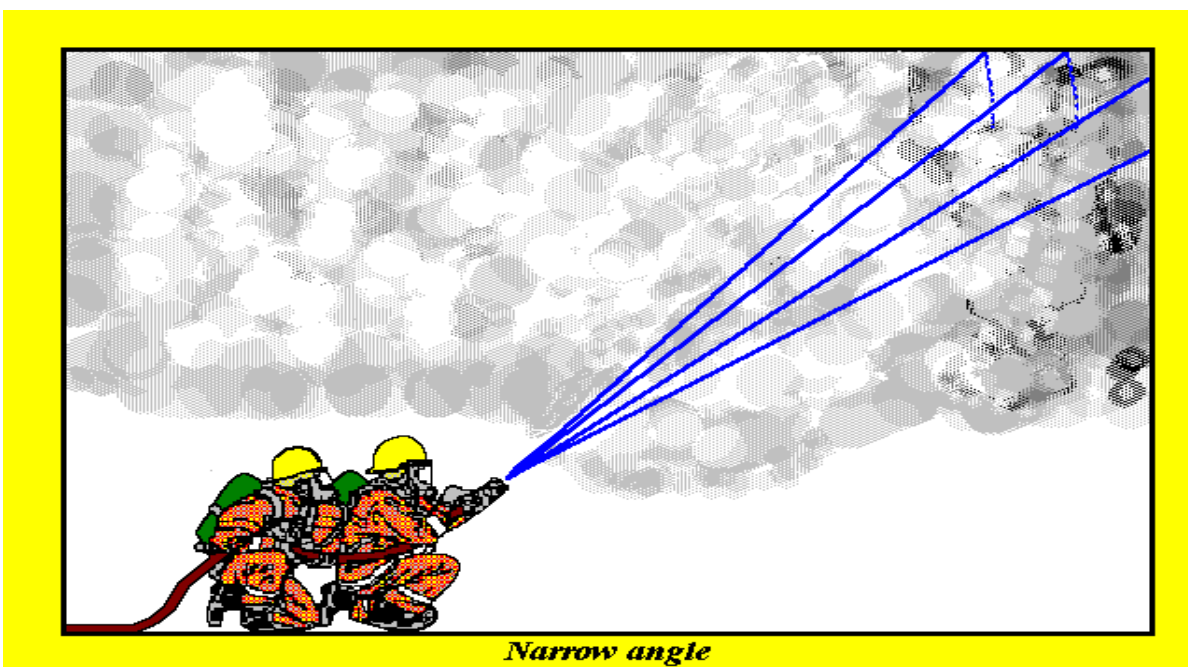


Narrow angle

Indirect Cooling (Wide angled branch)



Indirect Cooling (Narrow angled branch)



Note: The primary purpose of Indirect cooling is to cool the walls/ceilings etc. This will reduce the amount of Pyrolysis thereby reducing the fire gases.

Direct Cooling



Note: The primary purpose of direct cooling is to extinguish the fire. This will reduce the heat causing the Pyrolysis thereby reducing the fire gases.

Glossary of terms:

Fire Gases: Technical term for smoke.

Pyrolysis: Process where a substance breaks down into its chemical constituents due to being heated. This breakdown causes the fire gasses to be produced.

Flammable Range: also known as '**Explosive Range**'. This is the percentage range where the fire gasses may have the correct amount of fuel and oxygen to create combustion. Either side of this range indicates that the mixture may be 'too lean' or 'too rich' to burn.

LEL - Lower explosive limit

Lowest concentration of fuel to air that will just support a flame

IM - Ideal mixture

Most efficient concentration of fuel to air that produces, highest temperatures, largest and quickest reaction

UEL - Upper Explosive limit

Highest concentration of fuel to air that will just support a flame

Flashover: Stage in a compartment fire when the total thermal radiation from the fire plume, hot gases and hot compartment boundaries causes the generation of flammable products of pyrolysis from all exposed Combustible surfaces within the compartment which. Given a source of ignition, this will result in the sudden and sustained transition of a growing fire to a fully developed fire. **Flashover has occurred**

Backdraught: Limited ventilation can lead to a fire in a compartment producing fire gases containing significant proportions of incomplete combustion and unburned products of pyrolysis. If these have accumulated, when an opening is created and air enters the compartment it can lead to a sudden deflagration (**Backdraught**) through the opening.

Gas Cooling: Controlled systematic water spray through longest path of fire gasses. Water will cool gasses and cause them to shrink, allowing Fire-fighters the ability to make progress. Must be controlled and balanced. Too much water could make situation worse.

Indirect Cooling: Process that allows Fire-fighters to cool surrounding walls and ceilings. By cooling these areas, it should reduce the amount of pyrolysis being created, thereby reducing the amount of fire gasses.

Direct Cooling: Controlled direct application of water onto the actual fire. This should begin the process of extinguishing the fire thereby reducing the heat which is causing the pyrolysis.