



# **Best Practice Manual for the Investigation of Fire Scenes**

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ENFSI

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# Best Practice Manual for the investigation of fire scenes

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## 1. AIMS

This Best Practice Manual (BPM) aims to provide a framework of procedures, quality principles, training processes and approaches for the examination of fire scenes<sup>1</sup>. In this series of ENFSI Practice Manuals the term “BPM” has been maintained for reasons of continuity and recognition.

This BPM can be used by Member laboratories of ENFSI, and other forensic science laboratories to establish and maintain working practices in the field of fire scene investigation that will deliver reliable results, maximize the quality of the information obtained and produce robust evidence. The use of consistent methodology and the production of more comparable results will facilitate interchange of data between laboratories.

This BPM provides guidance for the examination of fire scenes including a set of appendices which refer to detailed processes and specialist areas.

**The term BPM does not imply that the practices laid out in this manual are the only acceptable practices used in fire scene investigation.**

## 2. SCOPE

This BPM is an overarching document relating to the investigation of fire scenes which is underpinned by a set of subject specific appendices.

This BPM is aimed at experts in the field and assumes prior knowledge in the discipline. It is not a standard operating procedure. The BPM addresses the requirements of judicial systems in general terms only.

This document does not address laboratory examination of items, individual competence of practitioners (including training requirements), specific jurisdictional requirements, or country specific legal requirements.

## 3. DEFINITIONS AND TERMS

For the purposes of this Best Practice Manual (BPM), the relevant terms and definitions given in ENFSI documents, the ILAC G19 “Modules in Forensic Science Process”, and in standards such as ISO 9000, ISO 17000 and 17020 apply. Other relevant and specific definitions are presented in each of the appendices.

## 4. RESOURCES

Management of the resources required for a fire scene investigation must take into consideration the appropriate and applicable areas of quality standards. It must also be recognised that many aspects of fire scene investigation will not be specifically addressed in such standards.

### 4.1 Personnel

Fire scene investigators have a wide range of experience, training and background knowledge which can be obtained through a variety of routes (academic, continuous professional development, vocational training, operational experience etc.).

<sup>1</sup> Fire scenes are defined as scenes involving fire damage and/or scenes involving gas phase explosions.

The classifications of fire investigators have been defined in general terms and are presented in appendices A1<sup>2</sup> and A2<sup>3</sup>.

#### 4.1.2 Competence requirements

Fire scene investigators must be competent and trained to their relevant national standards.

Table 1 indicates knowledge and skills recommended for fire scene investigators.

**Table 1: Knowledge and skill set**

1.	Understanding the importance and relevance of health and safety at scenes and that this may vary depending on the scene.
2.	Understanding the importance of a structured, systematic methodological approach to fire scene investigation and excavation including the recording (e.g. written, photographic, video) of the scene investigation.
3.	Awareness of aspects of fire science and fire engineering which may have a relevance to fire investigation (e.g. fire dynamics, structural performance, passive and active fire protection systems, fire tests, and human behaviour in fire).
4.	Understanding the mechanisms of heat transfer.
5.	Understanding the differing types and mechanisms of ignition.
6.	Understanding the physical and chemical properties of solid, liquid and gaseous fuels and materials as they relate to their thermal decomposition including pyrolysis and combustion and how such fuels and materials will react when exposed to heat and to fire fighting activities.
7.	Understanding the mechanisms and influencing factors of fire growth and development in a wide range of circumstances.
8.	Understanding the interpretation of post fire indicators (including their limitations) and the use of such indicators in the determination of the area(s) of origin of a fire.
9.	Understanding the potential involvement of electricity as a cause of fire and awareness of the post fire indicators of electrical involvement.
10.	Awareness of the importance of the examination of fuses and electrical appliances and the appropriate means of securing electrical appliances post fire.
11.	Awareness of diffuse phase explosions and gas explosions including the pattern of damage.
12.	Understanding the factors which may contribute to fire fatalities including aspects such as toxicity of products of pyrolysis and combustion.
13.	Understanding the procedures relating to the recovery of items (including human fatalities) from fire scenes including the importance of continuity and integrity of evidence and chain of custody.
14.	Understanding the requirements for contamination control, appropriate packaging materials and the importance of control and comparison samples in the collection of fire debris suspected to contain ignitable liquids.
15.	Understanding of the general characteristics that suggest the production of either chemical substances or home made explosives (Appendix C1 and C2).

<sup>2</sup> Practical Guide for First Responders to Fire Scenes, ENFSI Fire and Explosion Investigation Working Group.

<sup>3</sup> Practical Guide for Level 2 Fire Investigators, ENFSI Fire and Explosion Investigation Working Group

16.	Understanding of the fire investigators role and responsibilities in relation to interviewing witnesses taking into consideration national legal requirements.
17.	Understanding that fire scene investigation is a destructive examination process that makes the original observations impossible for re-examination.
18.	Keep accurate and original records of casework. Prepare reports and/or statements appropriate for the national criminal justice systems. Give testimony and communicate their involvement in the case, their findings and conclusions, in a transparent, traceable and appropriate manner within their field of expertise.
19.	Understanding of the local working practices in relation to multi agency responses to fire and explosion scene investigation.
20.	Awareness of the wider specialisms as they relate to fire scene investigation (e.g. forensic chemist, forensic biologist, forensic anthropologist, technical specialists including electrical specialists, engineers etc.) and the requirements of such specialists within the investigative framework.
21.	Understanding the requirements of local criminal justice systems and in particular the rules of evidence and the obligations of being a witness with fire investigation expertise for the courts.

#### 4.2 Equipment

A variety of equipment is used during a fire scene investigation some of which is detailed in the appendices to this BPM (Appendix A1 and A2). When using equipment in fire scene investigation consideration should be given to the following points:

- Equipment should be calibrated and maintained according to the operating manuals and periodic calibration and calibration checks must be recorded in a log book associated with the piece of equipment.
- All tools and non disposable personal protective equipment and clothing must be cleaned and free from contaminants or replaced between use at different scene locations or situations where potential cross contamination would be an issue.
- Equipment and tools must be regularly inspected and replaced if damaged to an extent that cleaning procedures are ineffective.
- Where possible, cleaned utensils and tools should be sampled prior to use and the samples retained for further testing if required.
- Equipment must be stored in such a way as to ensure minimal risk of biological or chemical contamination prior to use.
- Cleaning and sampling records of non disposable equipment must be kept where reasonably practicable.
- Where contamination may have occurred, this must be documented in the examiners scene notes.

#### 4.3 Reference materials

Not Applicable

#### 4.4 Accommodation and environmental conditions

Not Applicable

#### 4.5 Materials and Reagents

In circumstances where the fire scene investigator is competent to carry out presumptive

testing, then only validated materials and reagents (for example for the presumptive testing for blood, or the swabbing of suspected blood) may be used.

## 5. METHODS

A comprehensive methodology for the investigation of fire scenes is presented in appendices A1 and A2.

Further appendices present the methodology for the investigation of specific types of fire scenes.

## 6. VALIDATION AND ESTIMATION OF UNCERTAINTY OF MEASUREMENT

### 6.1 Validation

The validation of the fire scene investigation process is heavily dependent on the (1) investigating organisation, (2) the skills and competency of its staff and (3) the techniques and equipment used.

- (1). The investigating organisation must provide the appropriate resources to facilitate the fire investigation process to be undertaken
- (2). The fire scene investigator must be appropriately qualified and competent. Their training must be documented, assessed and they must undertake both continuous professional development and maintain and demonstrate their skills and competency
- (3).
  - (a) The equipment used in fire scene investigation must be validated by testing repeatability, reproducibility, selectivity, sensitivity and robustness (including robustness at the scene using control samples where appropriate) either through reference to the professional literature or manufacturers specifications or by in-house methods.
  - (b) The investigative techniques (for example the recognition and interpreting of burn patterns) used in fire scene investigation can be validated using known ground truth data, literature and testing.

### 6.2 Estimation of uncertainty of measurement

The fire investigation process is dependent on the knowledge and skill set of the fire investigator as detailed in Section 4.1.

The identification and specification of the main sources of uncertainty relating to the decision making and hypothesis testing associated must be stated. The determination of origin, cause and, if required, subsequent fire development in a fire scene investigation must be recorded in the investigators documentation and presented in the final report.

Uncertainties in the entire fire scene investigation process arise from a number of sources which include (but may not be limited to):

- Competence of the investigator and their specific expertise and experience.
- The amount and quality of information received.
- Assumptions made during the investigation process.
- Specific environmental conditions.

- Destruction of evidence due to the fire.
- Fire fighting activities.

### 6.3 Peer Review

Review of reports is mandatory in some jurisdictions. It is strongly recommended that reports be critically reviewed to check that the presentation of the report is fit for purpose and to ensure that the information available at the time of the investigation and derived from the scene investigation has been interpreted appropriately. Such reviews must be recorded.

## 7. PROFICIENCY TESTING

There are no proficiency tests currently available for fire scene investigation. Fire investigators are advised that they should take part in a relevant collaborative exercise/test for fire scene examination periodically so that their competence can be demonstrated and assessed. This can be an internal or an external test. “Guidance on the conduct of proficiency tests and collaborative exercises within ENFSI” provides information for the ENFSI Expert Working Groups (EWGs) on how to organise effective proficiency tests (PTs) and collaborative exercises (CEs) for their members.

## 8. HANDLING ITEMS

### 8.1 At the scene

Appendices A1 and A2 provide a comprehensive methodology for the recovery of items from fire scenes including the avoidance of contamination. Further appendices provide additional information relating to specific types of fire scenes.

### 8.2 Sampling, preservation, packaging, labelling and documentation.

Appendices A1 and A2 provide a comprehensive methodology for the recovery of items from fire scenes including the avoidance of contamination. Further appendices provide additional information relating to specific types of fire scenes.

### 8.3 Transportation

The transfer of recovered items must be carried out according to local operating procedures and legislated responsibilities used by the investigating authority or the fire investigator.

During this process the fire investigator must ensure that they witness the handover of recovered items to another person or organisation and ensure that there is a written record within their notes or items list.

Items must be transported and stored in a manner which prevents contamination, degradation or damage while maintaining the security and integrity of the exhibits.

### 8.4 In the Laboratory

Not applicable

## 9. INITIAL ASSESSMENT

Within a given case, an initial scene assessment strategy must be established with all investigators involved in the process. This must be based on the information provided to them at the time and continually reviewed in light of new circumstances and information. The scene



investigation strategy must also take into account other information and evidence relevant to the specific case. This is expanded upon within the appendices.

## 10. PRIORITISATION AND SEQUENCE OF EXAMINATIONS

Prioritisation and the sequence of scene investigation must normally be agreed between the fire investigator and investigating authority and in accordance with local agreements (for example a memorandum of understanding or other formal agreement between agencies).

Prioritisation and the sequence of scene investigation must be documented so that decisions are recorded and reviewed and must involve an assessment of (but is not limited to) the following:

- Initial information received.
- Initial observations of the external/internal examination of the scene.
- Potential value of the examination and/or recovery of specific items within a scene to the overall investigation.
- Order of requirements of other specialists if they are required (for example, forensic chemist, forensic biologist, forensic pathologist, forensic anthropologist, technical specialists including electrical specialists, engineers etc.)
- Time constraints (which may lead to loss of potential evidential materials such as volatile compounds).
- Health and safety implications.
- Environmental conditions.

This is expanded upon within the appendices.

## 11. RECONSTRUCTION OF EVENTS

Reconstruction of events can be particularly relevant in fire scene investigation and can be undertaken in a number of different ways. The assumptions and limitations of reconstructions should be noted.

- *Physical reconstruction* is a process where items are replaced (as far as possible) in their original positions prior to the fire. This can assist in the fire investigator's interpretation of the area of origin, cause and subsequent fire development.
- *Ad-hoc* testing (e.g. a test burn for flammability of a material) can be carried out either at the scene or at a later stage in the investigation and must be fully recorded including any assumptions made and the value and limitations of the test.
- Use of *computer modelling* must be approached with caution and all assumptions, limitations and uncertainties associated with the models clearly recorded.
- *Full scale fire reconstructions* can be carried out in controlled conditions after the initial fire scene investigation and must use validated equipment e.g. thermocouples and other monitoring devices.

Further information is available in appendix A2.

## 12. EVALUATION AND INTERPRETATION

A range of hypotheses must be considered during the evaluation and interpretation of all of the information received and gathered relating to a specific scene investigation process. This is expanded upon within the appendices.

Each hypothesis must be explored systematically and, in light of this information, an overall opinion formed of the most likely origin and cause of the fire. Interpretation and an evaluative approach of the information and physical evidence presented must be used to support or reject each hypothesis. Further information is available in the ENFSI *Guideline for Evaluative Reporting in Forensic Science*.

### **13. PRESENTATION OF EVIDENCE**

The overriding duty of those providing expert testimony is to the court. As such, evidence should be provided with honesty, integrity, objectivity and impartiality. Evidence can be provided to the court either orally or in writing.

The manner in which evidence is presented will differ depending on different legal jurisdictions. Fire investigators must comply with their legal obligations and accreditation requirements within the jurisdiction in which they are collecting and presenting their evidence.

Presentation of evidence should clearly state the results of any evaluation and interpretation of the examination.

Written reports should include all the relevant information in a clear, concise, structured and unambiguous manner as required by the relevant legal process. A checklist of the information suggested is expanded upon within the appendices.

Written reports must be peer reviewed where this is a jurisdictional requirement. Reports should clearly state the results of any evaluation and interpretation of the examination.

All viable hypotheses must be evaluated and conclusions supported by an up to date understanding of accepted methodologies and literature.

Recommendations associated with the production of written reports are expanded upon within the appendices.

### **14. HEALTH AND SAFETY**

Health and safety, risk assessments and personal protective equipment are expanded upon within the appendices.

In addition;

- The relevant national Health and Safety Legislation must be complied with.
- Specialist equipment operated at the fire scene must be used only by those trained to do so.
- Where fire scenes contain specific risks to health and safety, for example chemical or biological hazards, special precautions and personal protection equipment (PPE) are required and are detailed in the relevant appendices.
- Counselling should be available to investigators.

## **15. REFERENCES**

Bibliography can be found in Appendix A0

## **16. AMENDMENTS AGAINST PREVIOUS VERSION**

- The missing Appendix A2 has been included.
- References to the Monopoly Programme 2012 have been removed.

## **17. TABLE OF APPENDICES**

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A1 - ENFSI Fire and Explosion Investigation practical guide for first responders to fire scenes.

A2 - ENFSI Fire and Explosion Investigation guide for fire Investigators and specialists.

B1 - Investigating fire fatalities

C1 - Clandestine manufacture of controlled substances

C2 - Clandestine manufacture of home made explosives

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ILAC G19:08/2014, International Laboratory Accreditation Cooperation, <http://ilac.org/news/ilac-g19082014-published/>

## APPENDIX A1 – FIRE AND EXPLOSION WORKING GROUP PRACTICAL GUIDE FOR FIRST RESPONDERS TO FIRE SCENES.



### FIRE AND EXPLOSION INVESTIGATION WORKING GROUP

<b>PRACTICAL GUIDE FOR FIRST RESPONDERS TO FIRE SCENES</b>			
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This material is part of a global educational programme for all people involved in fire investigation in Europe, including the fire investigators and forensic specialists.

This work is a harmonisation of current knowledge and material available, and is the result of a large study of the best practice used by forensic laboratories in Europe.

This guide is the result of a unique collaboration and would not have been possible without the efficient and consistent participation of the following ENFSI laboratories and guest members:

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*National Laboratory of Forensic Science - Sweden*

*Ecole des Sciences Criminelles, Lausanne - Switzerland*

*Police Cantonale Neuchateloise–Service d'identification judiciaire - Switzerland*

*Forensic Science Service - UK*

*Centre for Forensic Science, Strathclyde University - UK*

*M-Scan Ltd - UK*

*Police Forensic Science Laboratory Dundee - UK*

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## 1. SUMMARY

This guide is aimed at first responders attending fire and explosion<sup>4</sup> scenes and those individuals involved in fire and explosion scene investigation with the aim to improve their efficiency and awareness and to improve the quality of scene investigation.

Many years of experience has shown that in order to carry out fire investigation efficiently and with maximum return it is necessary to carry out the investigation in a specific order from the arrival of the first responders to any subsequent laboratory analyses. This guide indicates the key steps required of the first responder in order to ensure that subsequent examinations can be carried out effectively. An overview of the basic knowledge required to perform the first responder role is detailed as well as the information needed to facilitate the work of specialists and forensic experts acting later in the process.

Correct and contemporaneous documentation and photography is essential. This means photographing with the time and date recorded, writing notes of your activities with the time, date and your signature on every page. The importance of taking accurate and sufficient notes at the time of the examination cannot be over stated. These are your record of your actions.

### How to use this guide?

We have decided to separate responders into three categories:

1. First responders to the scene are classed as level one
2. Level two are fire and explosion investigators with some specific training
3. Level three are fire and explosion investigators (specialists) with specific experience and expertise

This guide provides specific information for first responders (fire brigade and police personnel) in order to ensure that specific initial information and evidence is not lost. There are 5 areas of broad activity covered and the role of the first responder is explained for each stage. A checklist is provided in order to help with the collection of information.

This document is a guidance document and should be used in conjunction with other reporting and documentation required by your specific authorities including health and safety and quality system policies and procedures.

If you want to search on a specific topic, please refer to the contents and go directly to the chapter concerned. Overall investigation process at a fire scene - Look first at the summary to have an overview. Follow the advice chronologically and note relevant information using the data collection sheet. Technical terminology - See the glossary.

Use the data collection sheet to ensure that the complete information is recorded at each stage.

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<sup>4</sup> In this practical guide when mentioning fire (scene) investigation it also includes all aspects of the investigation of dispersed phase and mechanical explosions.



## 2. INTRODUCTION

### 2.1. Preliminary comments

Remember having always the same systematic approach to each scene is essential in order to perform your role correctly and safely.

**Preparation is key before attending fire scenes. You should have the following basic equipment:**

- Personal Protective Equipment (PPE) (overalls, safety boots, gloves, hard hat, face mask. etc. as appropriate)
- Video and camera
- Other equipment (tools, cordon, markers, pens, sampling containers etc.)

It is advised that you prepare your own checklist of PPE and other equipment in order that you are fully prepared before attending the scene. This PPE equipment should be put on prior to entering the scene.

### 2.2 Safety

**At the incident site safety is key.**

It is necessary to carry out a risk assessment of the scene both outside and if possible inside. This is obviously of major importance and if serious risks or hazards are noted, consideration must be given as to whether or not it is possible to enter the scene. Think about your environmental conditions at any time and **don't take any risks.**

**Risk assessments should be updated regularly during attendance at the incident.**

Hazards include structural damage to walls and roofing making them insecure, electrical hazards, gas supply, partially damaged fuel tanks, hot or cutting metallic parts, the presence of flammable and/or toxic vapours and fumes for example pressurised gas bottles that can explode several hours after the fire has been extinguished (acetylene: up to 24 hours), etc. Consideration should also be given to the possibility that there may be incendiary devices present which have not operated.

Briefing meetings to pass on this information should be held.

## 3. EXTINGUISHING THE FIRE

All information should be recorded on a data collection sheet. The data collection sheet in this document may be adapted for you / your own organisations specific needs.

### 3.1 Record activities/details on approach/arrival, during rescue, during fire fighting and post fire period

#### 3.1.1. En route, and near the site

Record information such as:

- The time of call and any information initially given
- People who are present (witnesses, bystanders, reporters, others)
- Cars which are present
- Anyone leaving the scene as you approach.
- Strange or specific activities of any individuals present

The prevailing weather conditions: general wind; velocity and direction should be recorded. Any changes in weather should also be recorded, this information can help in some cases to explain the spread of fire.

### 3.1.2. At the scene

Assess safety, evacuate/rescue personnel and stop/extinguish the fire. Make sure public safety is ensured. Record your activities as soon as is practical.

The number of fire appliances in attendance and the activities of fire fighters should also be recorded.

Observe those who are present as bystanders, if they seem to be especially interested or if they show unusual behaviour. Photographing bystanders can also be useful. Ensure that photographs are correctly dated and time is included.

Record when the owner arrives at the fire scene and their reactions to receiving the information relating to the incident.

### 3.2. Recording the scene (video, photographs and notes)

It is important to undertake photography and documentation as early as possible in order to record the scene fully. This should include all angles and aspects of the scene including parts which may not be on fire at the time.

Take photographs of the fire fighting activities paying particular attention to the positions of smoke and flame at the time of arrival. Recording the incident using video is also useful. Ensure that the video is dated and includes the time.

### 3.3 General data recording: first part of the data collection sheet

At this stage it is also possible to start collecting information from the rescue service commander (or equivalent) and the fire fighters. You can also obtain valuable information from witnesses and the property owner at an early stage. Complete the relevant parts of the data collection sheet.

### 3.4. Minimise damage to scene/alteration of the scene

It is important to any subsequent investigation that nothing within or outside of the scene is moved unnecessarily. While it is recognised that fire fighting activities will result in the movement of some objects and damage (e.g. to gain entry) the removal of such objects from the scene must be minimised, photographed (with time and date) and written down (with time and date). First responders should be aware that trace evidence (not always visible to the naked eye) can be added to or removed from the scene by them. Such evidence includes footwear impressions, DNA and fingerprints etc. Potential for contamination and disturbance must be carefully considered. Ways to avoid this may be by ensuring the use of items such as

disposable gloves, overshoes and scene suits together with restricting access.

First responders should be aware that any modification to the scene before arrival of the fire investigator (level 2 and/or level 3) must be recorded and well documented.

#### **4. SECURE AND GUARD THE AREA**

Strict surveillance and security measures must be put in place and maintained before and during the fire investigation.

##### **4.1 Place a sufficiently large cordon around the area and related areas to restrict access**

Cordon off a sufficiently large area around the scene of the fire in order to protect evidence and avoid damage to the scene. Ensure that as few people as possible have access to the area. You may use an inner and outer cordon if that is best practice. Ensure that the outer cordon is sufficiently large as to encompass all areas of possible evidence.

##### **4.2. Maintain a physical presence at the cordon until informed otherwise**

Cordoning off with cordon tape alone is not an efficient means of preserving a site; it is enough to keep the general public away, but it will not stop or prevent entry into the site. For this to be effective a human presence (police officer or fire fighter) at the cordon is vital. This presence should ideally be maintained at the scene until the fire investigation is complete.

##### **4.3. Record the identity of all individuals entering and leaving the cordon.**

The identity and contact details of all individuals entering the scene needs to be recorded and logged. If the scene is declared a crime scene then normal crime scene practices of maintaining a cordon log should be used. Bear in mind that the property owner or workers at the incident may become suspects at a later date and their entry to and from the premises must be monitored.

##### **4.4. Carry out risk assessment**

The outside area should be assessed for risks and hazards. These include structural safety of the building (mechanical, electrical, roof, walls, the presence of sharps such as glass or other debris etc). If necessary specialist advice may be required.

Other information about the contents and possible hazards within the site should also be noted (eg. electrical gases, asbestos, chemical hazards, other hazardous contents, aerosols and potential danger of secondary explosions).

This information needs to be communicated to the all personnel on site and in particular to the level 2 and level 3 investigators on their arrival.

#### **5. PRESERVATION OF EVIDENCE**

**Fire investigation is a field of forensic science where preserving evidence is of major importance**

##### **5.1. First responder activities which may result in alteration to the scene.**

It is important for any subsequent investigation that the activities of the first responder are recorded and the information given to subsequent investigators. Such information should include:

- Breaking of doors or windows
- General and specific fire fighting activities
- Subsequent damping down activities

In particular if items are moved from their original positions this must be recorded.

5.2. Do not remove any items from the scene if it can be avoided

The technical investigation of the fire is completely dependent on the preservation of evidence in and around the scene of the fire. Make sure that objects are not taken from the area and if possible discuss with fire service, health and safety and insurance company personnel how much of the scene needs to be demolished and what must be preserved.

**IT IS MOST IMPORTANT THAT AS FAR AS IS POSSIBLE YOU SHOULD MOVE NOTHING WITHIN THE SCENE. It is very important that everything is kept in its original place.**

5.3. If items are removed, record removal of items and where they are placed in consultation with level 2

If items must be removed from the scene, their original positions should be photographed and documented correctly. Only after this is completed should the items be removed. Items should only be removed if there is no alternative. The packaging should be in the container designated as suitable for the collection of fire samples or flammable liquids (for example metal cans, glass jars, nylon or duo bags) in accordance with relevant protocols. Items should be packaged separately to avoid cross-contamination. Particular care should be taken where packaging involves wet or damp material, sharp or heavy objects, volatile materials, potentially dangerous materials e.g. biohazards, corrosive, explosives etc both to prevent loss and avoid contamination.

All items taken should be labelled with a unique identifying mark, to allow the name of the person responsible for collecting and packaging the material to be identified, a concise and accurate description of the material, when the item was taken, location or person from where or from whom the material has been taken.

Once removed the items should be packaged and then disturbed as little as possible. Items should be stored carefully to minimise damage and contamination and signed over to the appropriate level 2 or level 3 investigator as soon as practicable.

5.4. Record/cover fragile evidence

Where there are items of potential evidence which are fragile they may require protection in situ at the scene. Their original positions should be photographed and documented correctly. The items should be covered in situ with an appropriate container and marked as fragile. Such items include footwear marks, toolmarks and other forensic evidence such as fingerprints.

If a fire or intruder alarm is present there may be only a few hours in which information can be recovered from it therefore immediate steps must be taken to secure this.

5.5. Report relevant activities to level 2 and level 3

All activities undertaken involving the gathering of information, scene preservation or the gathering of potential evidential material should be communicated to the appropriate level 2 or level 3 investigator as soon as practicable.

## 6. INFORMATION GATHERING TO HELP THE INVESTIGATION

After a fire, the police officer, fire fighter, fire investigator or specialist may find themselves with two extreme situations:

1. Fire propagation is limited: it is therefore quite easy to localise the origin of the fire.
2. Severe or complete destruction of a property. Extensive excavation may be required to determine the origin of the fire.

The information gathered by the first responder can help in both of these types of investigations. Some information is time dependent such as surveillance images or alarm system information and should be recovered by an appropriate person.

### 6.1. Complete data collection sheet

Ensure that the data collection sheet can be completed to aid in gathering the maximum amount of relevant information.

### 6.2. List witnesses

Make a list of possible witnesses and their contact details.

### 6.3 If appropriate, gather information from witnesses

Within your jurisdictional role as a first responder it may be relevant for witness interviewing to be undertaken. Ensure that such interviews comply with legislation.

Alternatively gathering information (as opposed to formal interview) from witnesses may be undertaken.

Make sure a written record is kept with the witness name and contact details. Make sure to date and sign the written record.

## 7. TECHNICAL INVESTIGATION

The technical investigation is carried out normally by level 2 or level 3 fire investigators. The objective is to determine the origin and cause of the fire as well as gathering information about fire spread throughout the scene.

Technical investigations may also be more specific in nature and involve the inspection of specific electrical appliances, vehicle components or chemical analyses, scene reconstructions and computer modelling amongst other activities.

### 7.1. Provide assistance to level 2 and level 3

Provide such assistance to the scene investigation as required by appropriate level 2 or level 3 investigators.

### 7.2 If appropriate, if cause is clear (or evidence will be destroyed) undertake basic investigation in consultation with level 2 and level 3

If appropriate level 2 or level 3 investigators are not available and evidence may be lost or destroyed carry out a basic examination of the scene to determine the origin and cause of the fire. Remember to take measures to avoid contamination. Also to record and document items in situ before removal, package and label any items taken appropriately, maintain

contemporaneous notes and sign and date all notes relating to the incident. On occasion it may be necessary to consult other experts e.g. Forensic Scientists. **Be careful not to overstep your area of expertise.**

## 8. GLOSSARY – MAIN TECHNICAL TERMS

**Accelerant:** an easily ignitable fuel used to speed up the rate of fire growth or facilitate fire spread; normally an ignitable liquid, but could also be a chemical mixture.

**Backdraft:** a deflagrative explosion of gases and smoke; occurs when air (oxygen) is introduced into a confined area where an established fire has depleted the available oxygen via the combustion process.

**Combustion:** a chemical reaction (oxidation) producing heat and light.

**Contemporaneous:** something that happens or is made/produced at the same time.

**Cordon:** a barrier encircling an area so as to prevent or control access into and out of it.

**Deep-seated:** fire occurring deep within a body of fuel as opposed to on the surface.

**Deflagration:** very rapid combustion producing a low energy pressure wave that travels at a speed less than the speed of sound (subsonic); for example, a gas explosion.

**Detonation:** extremely rapid combustion producing an intense, high energy pressure wave that travels at a speed equal to or greater than the speed of sound (supersonic); damage tends to be acute and most severe at the point of origin; possible presence of a crater.

**Device:** any chemical or mechanical entity used to initiate a fire or explosion.

**Dropdown:** collapse of burning material that causes separate, low level ignition; “curtain effect”.

**Explosion:** sudden conversion of energy producing a mechanical pressure wave; deflagration or detonation event.

**Fire load:** the total amount of fuel involved in a fire.

**Flame:** a cloud of burning gas that produces heat, light and often smoke.

**Flameover:** flaming ignition of the high-level hot gas and smoke layer in a developing compartment fire.

**Flashover:** the transition phase at which all combustible items within a compartment ignite; the final stage of fire growth.

**Fuel:** any material capable of combustion.

**Ignition:** to set on fire/cause an explosion; occurs when sufficient energy, normally in the form of heat, has been transferred to a fuel so that combustion results.

**Ignition, spontaneous:** internal chemical or biological process that produces sufficient heat to ignite the reacting fuel; occurs without any external ignition source.

**Liquid, combustible:** liquid that is capable of burning but which cannot be ignited at ambient temperature; requires heating for ignition to occur.

**Liquid, ignitable:** liquid that can be ignited at ambient temperature; combustion is self-sustaining.

**Origin, point of:** the exact location at which a fire or explosion was first ignited.

**Oxidation:** chemical reaction involving the combination of oxygen with a fuel.

**Plume:** the column of hot gases generated by a flame; gas movement occurs by convection.

**Propagation:** fire spread from one area to another.

**Scene:** cordoned off area that is of interest to an investigation.

**Seat of fire:** general area where the main body of fire damage was sustained; not always the point of origin.

**Smouldering:** combustion without visible flames; direct reaction between a solid fuel and atmospheric oxygen that produces heat and often light and smoke.

**Soot:** solid residue, produced by incomplete combustion, that is deposited on objects as a result of a fire.

**Trailer:** fuel that physically links more than one area of a scene, deliberately placed so as to facilitate fire propagation.

**Vented:** fire and/or smoke that extends outside of a structure or compartment; occurs through destruction of windows, doors and/or the roof.

**Volatile:** combustible substance that evaporates easily; liquid with a low boiling point.

**“V” pattern:** pattern produced on a vertical surface that results from the combustion of a compact area of fuel; not necessarily the point of origin.

## 9. DATA COLLECTION SHEET

<b>INITIAL CALL</b>	
Date: _____	Time: _____
Location /address of incident:	
Type of property:	
Owner:	
If the fire involved a vehicle	
Manufacturer: _____	Model: _____ Colour: _____
VIN: _____	Number Plate: _____
Type of Fuel: _____	
Details of the call:	
Recorded call (yes / no)	
Signature/initials: _____	Date: _____

<b>FIRST RESPONDER</b>	
Name/Organisation: _____	
Phone number: _____	
Date and time of call to the scene _____	
Date and time of attendance _____	
Signature/initials: _____	Date: _____



**FIRE BRIGADE**

Date and time of call \_\_\_\_\_

Date and time of arrival at the scene \_\_\_\_\_

Date and time fire was extinguished \_\_\_\_\_

What fuel-driven equipment did the Fire Service use? Indicate the equipment and type of fuel

\_\_\_\_\_

Signature/initials:

Date:

Details of access gained by Fire Service

Signature/initials:

Date:

What methods of extinguishing were used by the Fire Service (where and when)

Signature/initials:

Date:

What damage to the property was caused by the Fire Service? What tools were used?

Signature/initials:

Date:

**SAFETY**

Have you carried out your risk assessment of the scene YES/ NO

Has the building been assessed for safety YES/NO

Is there electrical supply? YES/NO

Has electric supply been disconnected? YES/NO

Is there a gas supply? YES/NO

Has gas been disconnected? YES/NO

Is it worth noting down hazards identified?

Please give details including contact details of anyone involved in any of the above.

Signature/initials:	Date:

Were any flames observed from the gas supply if present? YES/NO

Any other available information on safety aspects of the property (e.g. from the owner)

Signature/initials:	Date:

**GENERAL INFORMATION**

Colour of Smoke \_\_\_\_\_ Smell of Smoke \_\_\_\_\_

Flame Colour \_\_\_\_\_ Intensity of flames \_\_\_\_\_

If appropriate – record this here for different areas of the fire.

Signature/initials:	Date:
---------------------	-------

General weather conditions during fire (wind speed/direction, thunderstorms etc.)

Signature/initials:	Date:
---------------------	-------

Any fire/smoke/burglar alarms? (Delete as appropriate)

If yes, have you contacted anyone to ensure the recovery of available information. YES/NO

Any obvious signs of forced entry? YES/NO

Details of windows (any breakages, caused by fire/other, order of breaking/ signs of force)

Signature/initials:	Date:
---------------------	-------



Details of victims and current location (either within the scene or elsewhere). If a fatality record the position of the body and clothing at the time of your attendance.

Signature/initials: _____	Date: _____

Details of occupants (name/date of birth /sex/ contact details etc.)

Signature/initials: _____	Date: _____

Details of witnesses (name, address, contact phone number).

Signature/initials: _____	Date: _____

Further observations regarding witnesses (injuries, clothing etc)

Details of any other persons in the vicinity of the scene and their activities. Have these people been noticed at scenes before? Were they acting unusually?

Signature/initials: \_\_\_\_\_ Date: \_\_\_\_\_

Are there any tyre tracks or footwear marks leading to/from the scene.  
If yes have you ensured their protection – give details.

Signature/initials: \_\_\_\_\_ Date: \_\_\_\_\_

'Could bloodstaining, fingerprints or other forensic evidence be important? If yes have you ensured their protection - give details'

Have you noticed any surveillance cameras nearby? YES/NO  
(note the location on your sketch)

Have you alerted the relevant authority so the images can be seized? YES/NO

Did any member of the public make any video recording or take photographs of the fire? If so give contact details.







<p>Signature/initials: _____</p> <p>Date: _____</p>
---

Has any Infra Red video/photography been used? If so give contact details.

<p>Signature/initials: _____</p> <p>Date: _____</p>
---

Using separate sheet, sketch the property and indicate extent of damage on arrival and fire progression. Indicate on the sketch the position of any stock/furniture and electrical and gas appliances. Also indicate if any items that have been moved or modified by the fire brigade during the extinguishing process and any unusual blockages of furniture which may have been present. Also indicate the position of any bodies, tools or weapons discovered.

**SKETCH of the site**

Smoke traces		Indicate North on the sketch
Outline of fire as seen by the first witness		
Partial burned areas		
Heat effected areas		
Outline of burned area		
Flame progression		
Signature/initials:		Date:



Signature/initials: \_\_\_\_\_ Date: \_\_\_\_\_

Signature/initials: \_\_\_\_\_ Date: \_\_\_\_\_

Signature/initials: \_\_\_\_\_ Date: \_\_\_\_\_

## **10. APPENDIX – AIDE MEMOIRE**

### **ACTIONS FOR THE FIRST RESPONDER TO FIRE SCENES**

- Consider your personal safety and that of others.
- Record all activities using video, photographs and notes at all stages including the date and time.
- Secure the area to restrict access.
- Minimise damage or alteration of the scene.
- Preserve evidence in situ whenever possible.
- Gather information using the data collection sheet.
- Contact the appropriate investigator as soon as possible and pass all information including the data collection sheet on to them.

## APPENDIX A2 – FIRE AND EXPLOSION WORKING GROUP PRACTICAL GUIDE FOR FIRE INVESTIGATORS AND SPECIALISTS.



### FIRE AND EXPLOSION INVESTIGATION WORKING GROUP

PRACTICAL GUIDE FOR FIRE INVESTIGATORS AND SPECIALISTS			
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National Criminal Investigation Services	Norway
National Forensic Laboratory	Slovenia
Portugese Forensic Laboratry	Portugal
National Forensic Center	Serbia
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Fire And Explosion Investigation Working Group Fire Scene Investigation  
September 2016

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## 1 AIMS

This practical guide aims to provide a framework for fire and explosion investigators and specialists, both from the public and private sectors. It offers recommendations for how to conduct an investigation at the scene of a fire and/or explosion in order to achieve the best possible results.

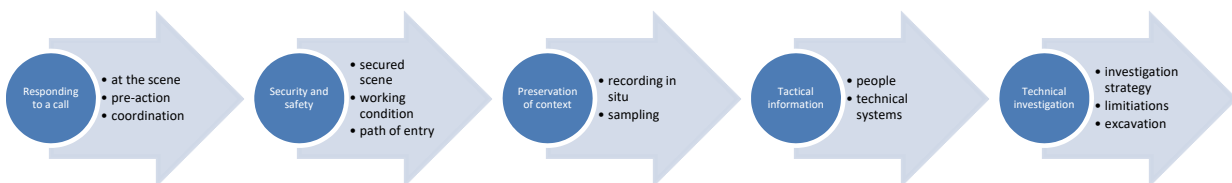
A fire and explosion investigator is someone who is involved in determining the origin, cause and development of a fire and/or explosion.

This work brings together current available knowledge and material and is the result of an extensive study of current practice used by forensic science laboratories and institutes throughout Europe.

**The term ‘practical guide’ does not imply that the practices laid out in this manual are the only acceptable methods used in fire scene investigation.**

## 2 SCOPE

This guide provides specific information for the fire and explosion investigators<sup>1</sup> in order to ensure that specific initial information is not lost. There are five broad phases of activity covered here (figure 1) and, for each phase, the role of the fire investigator is explained.



**Figure 1** Stages of an investigation

The different phases should not be considered separately and, during some investigations, there is no strict chronological order in which they must be done. They are interwoven and the activities in each phase can link into others.

People involved in the investigation of fires and explosions are divided into three levels and can all be involved in determining the origin, cause and development of a fire and/or explosion:

*First responder*

*Fire and explosion investigator*

*Specialist*

The boundaries between each of the different levels are not clearly defined. Each fire has its own challenges and a fire investigation, which initially seems simple, can turn out to be very complicated and may need to be dealt with by a specialist.

<sup>1</sup> In the rest of the guide the title Fire investigator is used for *Fire and Explosion Investigator*.

This document is a guide and must be used in conjunction with other reporting guidelines, procedures and documentation required by specific national legal and investigative authorities. This may include for example health and safety protocols and legal requirements of expert witnesses.

It is important that you know the limitations of your knowledge and expertise. It is better to ask an appropriate specialist for assistance than to carry on, risk in failing to identify a crime due to an inaccurate or an incomplete investigation or making mistakes and potentially contribute to a miscarriage of justice. There are other suitable principles and practical guides that can be of support in investigations i.e ENFSI's Guide for explosion investigation and NFPA 921.

### 3 DEFINITIONS AND TERMS

For the purposes of this practical guide, the relevant terms and definitions are given in ENFSI documents and other relevant documents<sup>2</sup>, Other relevant and specific definitions are presented in section 5 - methods.

Definitions of involvement and different phases of the investigation (for details, see *appendix A Investigation phases*)

Name	Definition
First responder	The first 'official' person or agency who responds to the scene (i.e. police, fire service).
Fire and explosion investigator	People who are called in by the first responder or the investigating agency when the fire investigation is considered to be more complex.
Specialist	People who have special competence or knowledge combined with specific experience and expertise in their chosen field. The specialist is called in by the fire investigator or by the investigating agency.

### 4 RESOURCES

#### 4.1 Personnel

The fire investigator(s) and specialist(s) must verify that they have demonstrable competencies and experience that are relevant to the task at hand.

A conclusion will qualify as scientific findings if the fire investigator/specialist can demonstrate that it is the product of a sound scientific method.

The 'scientific method' is the process of formulating hypotheses and then conducting experiments/ analyses to provide support for or against the hypothesis that is considered relevant at the time. This may lead to the formulation of further hypotheses as the process is repeated.

<sup>2</sup> (Bell, 2012), (De Haan & Icove, 2012), (Drysdale, 2011), (National Fire Protection Association, 2014)



The fire investigator and the specialist are qualified as an expert by knowledge, skill, experience, training and education and may give evidence in the form of an opinion, or otherwise if:

- The expert's scientific, technical, or other specialised knowledge will help the court to understand the evidence or to determine a disputed fact .
- Their testimony is based on sufficient facts or data.
- Their testimony is the product of reliable principles and methods.
- The expert has reliably applied the principles and methods to the facts of the case.

#### 4.2 Equipment

See section 5 – Methods.

#### 4.3 Reference Materials

See section 15 - References.

#### 4.4 Accommodation and Environmental Conditions

See section 5 - Methods and section 14 - Health and Safety.

#### 4.5 Materials and Reagents

Not applicable.

#### 4.6 Allocation of Responsibilities

All activities, involving scene preservation or the protection/recovery of potential evidential material, must be communicated to the appropriate people/agencies as soon as practicable. When assistance is required in specialised fields, expert advice must be sought. Where assistance had been sought, any specialists involved should, if required, have experience of fire scenes. See appendix A - Investigation Phases.

The following is a selection of experts who *could* be of assistance during fire scene investigations:

- Forensic Science Laboratory
  - o electrical, chemical experts
  - o gas and mechanical experts
  - o fire protection engineers analysis
  - o heating appliances and chimney experts
- Fire and Rescue Service. Can assist in the fire investigation at the scene and in drawing up a statement of risk for the fire spread.
- Forensic anthropologist, can assist in body recovery at fire fatalities.
- National Electrical Safety Board, or similar, can assist in the fire investigation at the scene.
- Medical examiner/pathologist/odontologist can assist in identifying bodies and examining suspects.
- National Maritime Administration can assist in drawing up statement on risk for fire spread on ships.
- Chimney master/sweeper can assist in fire investigation at the scene.

The fire investigator must also consider what parties to inform when it comes to fire protection programs, i.e. product manufacturers, insurance companies etc.

#### 4.7 Collegiate Approach

'Collegiate approach', means an investigation team composed of various colleagues of equal standing working together on the investigation. These could include, for example:

- Forensic fire investigator
- Forensic Locksmiths
- Forensic motor vehicle examiners
- Forensic electrical engineers
- Claims Staff
- Private sector investigator

A collegiate team approach is a good way to maximise the identification of the full scope of the available physical evidence and can assist in ensuring the identification of the origin and cause of deliberate fires, where possible..

## 5 METHODS

### 5.1 Responding to a Call

The fire investigators are not normally directly involved in this phase of an incident. They must ideally obtain the "data collection sheet" or similar information from a first responder and liaise with him or her to obtain relevant information prior to attending the scene. See appendix A - *Investigation phases*.

#### 5.1.1 En-Route and approaching the scene

En route and near to the scene – information to be recorded / obtained:

- 1) The time of call and any information initially given
- 2) People present (witnesses, bystanders, reporters, others)
- 3) Vehicles present
- 4) Anyone seen leaving the scene as you approach.
- 5) Strange or specific activities of any individuals present
- 6) The prevailing weather conditions: (general wind speed and direction as well as any changes in weather). This information can, in some cases, help to explain the spread of fire.

Approaching the scene - information to be recorded / obtained:

- 1) Your activities (safety assessment, evacuation/rescue of personnel and extinguishing the fire).
- 2) The number of fire appliances in attendance and the activities of fire fighters.
- 3) Those who were present as bystanders, particularly if they seemed to be especially interested or if they showed unusual behaviour. Photographing and filming bystanders can also be useful. Ensure that all photographs and videos are documented, dated and retained.
- 4) When the owner arrived at the fire scene and their reactions to receiving the information relating to the incident.

### 5.1.2 At the Scene

Take appropriate photographs and make suitable notes as soon as possible in order to fully record the scene. Photographs and notes must include all angles and aspects of the scene, including areas which may not be on fire at the time.

Take photographs of the fire fighting activities, paying particular attention to the location of smoke and flames when you arrive. Recording the incident using video is also useful. Ensure that the video is dated and includes the correct time.

### 5.1.3 General Information for Documentation

At this stage it is possible to start collecting information from the incident commander (or equivalent) and the fire fighters. You can also obtain valuable information from witnesses and the property owner at an early stage. Complete the relevant parts of the data collection sheet. See appendix B.

### 5.1.4 Initial Scene Presevation

Any modification to the scene before arrival of the fire investigators must be recorded and well documented.

It is important for any subsequent investigation that nothing within or outside of the scene is moved unnecessarily. While it is recognised that fire fighting activities will result in the movement and/or damage of some objects (e.g. doors and windows to gain entry) the removal of any objects from the scene must be minimised. Any items which do need to be moved, damaged or removed must be photographed and noted (with the time and date) beforehand. Be aware that trace evidence, not visible to the naked eye (i.e. DNA and fingerprints), can be left at the scene by first responders. Appropriate anti-contamination precautions must therefore be taken where appropriate (i.e. forensic scene suits, gloves, masks etc).

### 5.1.5 Communication and Coordination

Be aware that the first responder may contact the fire investigator for advice prior to their attendance at the scene. Such advice may include identifying relevant people to speak to and the type of information that might be required at a later stage.

All activities undertaken involving information gathering must be communicated to the appropriate specialist as soon as practicable.

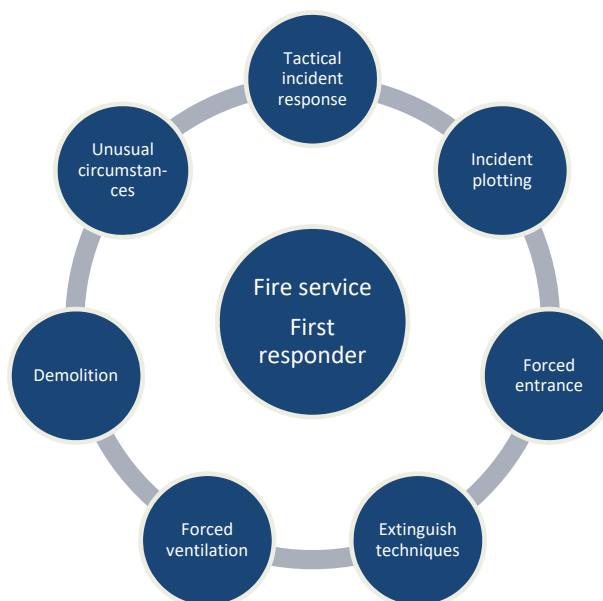
All investigation work at the scene needs to be coordinated and communicated with all parties.

## 5.2 Tactical Information

The fire investigator or specialist may find themselves with two general situations after a fire:

- 1) Fire propagation is limited and it is therefore quite easy to locate the origin of the fire.
- 2) Severe or complete destruction of a property. Extensive excavation may be required to determine the seat of the fire.

The information gathered by others (i.e. the police officer, the fire service and the first responder) can help the investigation in both of these scenarios. Figure 2 is an example of useful topics to discuss.



**Figure 2** Example of tactical information issues.

There are two types of background information – information from people and information which can be extracted from technical systems. See *Appendix B Background information*.

### 5.2.1 Information from People

Obtain the data collection sheet (or equivalent) filled out by the first responder. If this has not been completed, ensure that you gather the remainder of the required information. This may include photographs, videos and/or incident recording (i.e. white board plotting). Any additional enquiries must be recorded. Many additional questions are raised during the investigation. It can therefore be helpful to ask the incident commander and/or fire fighters to come to the scene, and account for their observations and actions in situ.

Check with press photographers and TV companies to see if there are any pictures or videos, taken at an early stage of the fire, which have not been published. These can be very useful in helping to establish the point of origin. Social media can also be an important source of information and thorough search routines are recommended. A timetable (i.e. STEP analysis) of important events before, during and after the fire should be prepared.

### 5.2.2 Information from Technical Systems

Consider interrogating any suitable technical system and, if it connects to a remote call station, obtain the data logs. These logs may contain detailed information relating to the activation times of the individual detectors, thus allowing the investigator to map the spread of the fire. Some information is time dependent, such as CCTV, smart electric meters and alarm (fire or burglary) system information and must be documented and recovered by an appropriate person.

Some key information sources to consider are:

- Pre-existing drawings and plans (i.e. gas, electrical, structural, building construction)
- Information about specific electrical equipment
- Process information and standard operating procedures
- Data logs and maintenance logs
- Licences
- Regulations and norms (new and old)
- Equipment manuals
- Radio traffic
- Emergency calls
- Technical literature

All activities undertaken involving technical information gathering must be communicated to the appropriate specialist as soon as practicable.

### 5.3 Technical Investigation

#### 5.3.1 General

Prior to, or upon arrival, the fire investigator may be required to give advice regarding preservation of the scene, i.e. fire fighting activities and coordination of scene commanders.

As part of the scene examination, a series of general photographs and videos could be taken as well as acquiring or preparing appropriate plans, drawings/plottings and diagrams. Videos can also be taken. Correct documentation and photography is essential. Exterior documentation should include appropriate landmarks in order to identify the exact location of the scene. It should also include the general surrounding area, e.g. adjacent buildings/structures, and angular views of the exterior of the scene. Multiple views and a series of sequential photographs can be used to contextualise different areas of the scene.

Documentation must also include notes of your observations at the scene and any actions you carried out. These documents must be signed, dated and retained, all according to local regulations and national laws, so that they are able to be retrieved and reviewed at a later date, if necessary.

For further details, see section 8.2.2 - *Recording In Situ*

#### 5.3.2 Interpretation of Available Information

Information may be received from the first responder(s), or from others. It could tell you what occurred prior to, or during the fire and may provide guidance regarding areas of more or less interest to the scene investigation.

All technical investigations must primarily consider the physical evidence at the scene. Treat any witness information with caution as it could be incorrect or misleading. Be alert and verify whether or not it was possible for the witnesses to have observed what they claim to have seen from their original locations.

To optimise the quality of their interpretation, the fire investigator needs to use a scientific method<sup>3</sup> during their examination.

<sup>3</sup> The overall process of a scientific method involves making hypotheses, deriving predictions from them as logical consequences and test them by carrying out experiments/analyses.

This can include (where appropriate):

- Assessment of the fire scene
- Validated analysis (i.e. STEP<sup>4</sup>, ACCIMAP<sup>5</sup>)
- Appropriate use of technical methods (i.e. hydrocarbon dogs, lab tests, fire experiments)
- Hypothesis testing

### 5.3.3 Investigation Strategy

The main focus of fire scene examinations is on fires in buildings. However the same general principles apply to the majority of all fires that will be investigated.

- Strategy for the forensic investigation
- Safety protocol for working conditions

Each scene investigation must be planned carefully and as soon as possible. Before entering, it is of extreme importance that you are fully aware of all the relevant, known circumstances relating to the fire. Make sure that you are familiar with relevant background information gathered by the first responder(s), fire fighters etc.

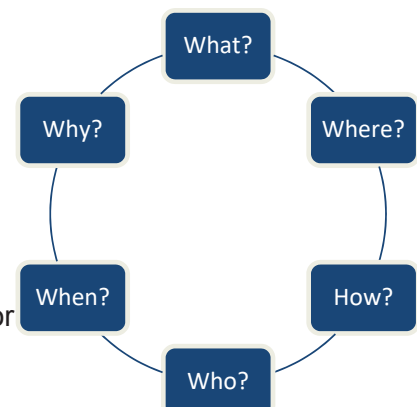
If you need more information, you must get it before you start the scene examination, where possible. This will help you to plan the investigation. Starting the examination with a lack of information can result in a poor investigation and there is a risk of accidentally destroying evidence. See Appendix A Investigation Phases.

It is recommended that the investigation is carried out in teams, where possible. Depending of the nature of the scene, these teams can comprise different types and numbers of people. Ensure that every team member is aware of his or her role (i.e. evidence collector, photographer etc.). Make sure that your tools and equipment (including PPE) are clean, correctly functioning and ready to use.

It is recommended that at least two fire investigators are present at the scene so they can support each other and keep each other from taking a blinkered approach. Each fire investigator must be comfortable with the type of investigation they are carrying out and must not be afraid to call for assistance, if necessary.

Fire investigation is a scientific process in which a systematic approach is taken to answer specific questions relating to the fire, its development and its cause. This is carried out by collecting and recording data through the detailed examination of the scene.

This information is then evaluated using the investigators own knowledge, experience and expertise. From this, the investigator sets up a number of hypotheses based on the evidence found at the scene.



**Figure 3** Questions that are to be used in the investigation strategy.

4 Sequential Timed Event Plotting

5 Systems-based technique for accident analysis

Each of these hypotheses is suitably tested, resulting in a robust conclusion or conclusions, allowing an accurate determination of the origin, cause and fire spread at the scene.

The fire scene investigation must cover the following points (Figure 3):

- 1) Establishment of the fire development – WHAT? and HOW?
- 2) Establishment of the seat of the fire – WHERE? and WHEN?
- 3) Establishment of the fire cause – WHAT?

The technical investigation focusses on the above but will also aid where possible, the investigation as to WHO? and WHY? (i.e. the motive).

#### 5.3.4 Initial Overview

If possible, try to gain access to a nearby building, use a fire service ladder or a drone, to look at the damaged building from above. From a higher vantage point, it can be easier to see the way the fire has spread and where it breached/vented through the roof.

If you suspect that an explosion has occurred, consider referring to the Explosion Investigation guide<sup>6</sup> alongside this one.

A structured approach to the scene investigation should be followed (figure 4).



**Figure 4** Example of a structured approach to the scene

#### 5.3.5 Surroundings

Other buildings, garages, storerooms and cupboards used to store cleaning materials should be checked for the presence of ignitable liquids. Are any objects of interest, such as petrol cans, bottles and matches found close to the property?

#### 5.3.6 Exterior

Study the signs left by the fire on the exterior of the building:

- Which facade was most damaged by the fire?
- What does the outer wall or roof above the windows and doors look like? Is it covered in soot or has the soot burned away? Remember soot can be burned away at high temperatures.
- Which windows have fire patterns above them and what do they look like? Normally, fire venting from a window, results in a fire damage or soot pattern above the window in the form of a 'V' spreading upwards..
- Could the wind or ventilation, the building construction, the fire service's tactics/ techniques have affected the evidence left by the fire?
- Does the evidence left by the fire suggest that the fire damage has been caused by a fire inside or outside the property?

<sup>6</sup> referring to dispersed phase and mechanical explosions

### 5.3.7 Interior, Fatalities and People

It is important to inspect all areas, access routes, and undamaged rooms to find and collect forensic clues associated with the fire. Clues as to help identify the perpetrator are often found outside the scene. Is there any evidence of another fire (or fires) somewhere other than close to the point of origin?

- Study the evidence left by the fire on the building.
- How has the fire damaged the walls, ceilings, floors etc?
- How and where have people been injured by or fatalities been caused by the fire?

Always inspect all rooms and spaces, even if they don't seem affected by the fire.

### 5.3.8 Glass Panes and Openings

Glass and the soot around openings can provide an indication of the fire spread and ventilation. This can help lead you to the seat of the fire.

During the rough and detailed excavations, pay attention to where pieces of glass lay in the remains. Study pieces of broken glass from windows; both those which remain in the frame and those which are lying inside and outside the building.

Consider whether the window has been broken from the inside or from the outside. Or take a sample for comparison purposes, especially if a suspect has been arrested and it is thought that a window may have been broken to gain access to the building.

### 5.3.9 Setting the Physical Boundaries of the Area of Investigation

The point of origin (or seat) of the fire is the place or places where the fire started. In principle, the whole area in the building, affected by fire, must initially be considered. As the investigation proceeds, this area may reduce. The final area/point of origin can vary in size depending on the scale of the fire damage and how difficult it is to interpret what is found in the fire remains.

In any fire investigation there will be a well defined area of investigation. Any decision as to where the physical boundaries of the investigation lie must be clearly recorded. The reason for this is found in the interpretation of fire patterns, validated background and technical information.

## 5.4 Excavation

In order to determine the seat of fire/point of origin, it is important to excavate the area of interest. This is carried out by removing fallen debris and other items from the surrounding area to reveal the original content of the area of origin. This involves removing layers in a systematic manner, similar to an archaeological excavation<sup>7</sup>.

There are several different types of excavation that can be used. The most appropriate method will be determined by the particular fire investigation approach being taken at the time. The approach can be limited by time, weather and decomposition of the fire scene. Routines are to be used in:

- Single context recording system (see details in section 8.2 Preservation of context)
- Stratigraphic excavation
- Physical methodology of excavation

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7

EAC Guidelines 1, D/2014/6860/017 (Europae Archaeologia Consilium)



The fire investigator in charge is responsible for ensuring that under-cutting<sup>8</sup> or over-cutting<sup>9</sup> is avoided during the excavation.

#### 5.4.1 Stratigraphic Excavation

Stratigraphy is a key concept in modern archaeological theory and practice. Modern excavation techniques are based on stratigraphic principles, as applied to fire investigations:

- Original horizontality
- Lateral continuity

The best practice of stratigraphic excavation, in its basic sense, involves a cyclical process of “trowelling back” the surface at a fire scene. The excavation must start from the outside of the area and proceed inwards, towards the presumed point of origin, in order to preserve any evidence on the way. Excavation follows from the area of least damage to the area of most damage in this way.

#### 5.4.2 Physical Methodology of Excavation

The process of excavation can be carried out in many ways. The basic method is to remove layers and items by:

- working from the known to the unknown
- working from the top to the bottom
- using all senses in the process!

During this process one should be able to establish the location and layout of the furniture, its composition and what other materials are present. This will provide information on the patterns of burning and can allow the area/point of origin to be refined further. It is during this stage of the excavation that odours of ignitable liquids and other specific smells may become apparent.

#### 5.4.3 Mechanical Excavation and Organisation of Workforce

There are several different machines to aid excavation, when it comes to type, size and function. Using a mechanical excavator is the quickest way to remove non-critical debris (i.e. fallen roofing or walls) and to prepare the surface for closer excavation by the fire investigator.

It is also possible to get some help from a work team - “*muscles and shovels*”. Before a work team is allowed in the fire scene there is a need to go through the basic protocol for:

- Security and safety
- Preservation of evidence
- Excavation

When using mechanical excavation, with or without the addition of a work team, it is even more important that the fire investigator has a detailed excavation strategy and supervises the working progress closely.

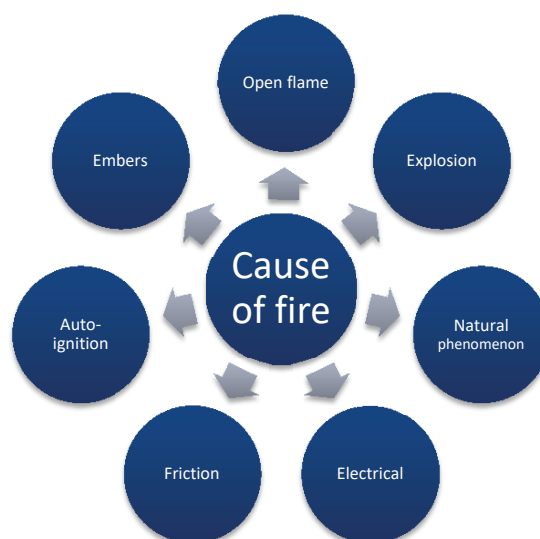
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8 Contexts are not excavated fully and some remainder of context is left in situ masking the nature of the underlying contexts.

9 Contexts are unintentionally removed from i.e. the point of origin.

#### 5.4.4 Cause of the Fire

In order to establish the cause of a fire you should normally have determined a point/area of origin beforehand. Document all possible objects within the previously identified point/area of origin that could have caused the fire. Call in appropriate specialists or recover and send items of interest to them. If items are to be sent to specialists, or if specialists are to visit the site, it is beneficial for the items to remain in exactly the same state as when they were discovered. See *Appendix C – Examples of Fire Causes (Figure 5)*.



**Figure 5** Examples of Fire Causes

General questions to ask throughout the hypothesis testing are:

- Do the fire damage patterns and timings fit?
- Does the fire damage pattern (in general) agree with the point of origin being in this area?
- What remains in the area of origin (consider samples to analyse)?
- What was the ventilation like? How did the fire develop?

## 6 VALIDATION AND ESTIMATION OF UNCERTAINTY OF MEASUREMENT

### 6.1 Validation

The minimum requirements for considering a method validation (and where appropriate, software validation) should be outlined. Some factors to be considered include, as appropriate, sampling, precision (repeatability, reproducibility), bias (matrix/substrate effects, specificity), working range (limit of detection/sensitivity, linearity), robustness (environmental susceptibility) and competency of personnel.

### 6.2 Estimation of uncertainty of measurement

Where relevant, guidance should be provided on identifying and quantifying the main sources of uncertainty and reporting the uncertainty.

## 7 PROFICIENCY TESTING

Fire investigators are advised to take part in relevant collaborative exercises and/or proficiency tests periodically so that their competence can be demonstrated.

## 8 HANDLING ITEMS

### 8.1 At the Scene

As a first responder the “*ENFSI Fire and Explosion Investigation practical guide for first responders to fire scenes*” provides a comprehensive methodology.

## 8.2 Preservation of Evidence

### 8.2.1 Dialogue with the First Responder

Be aware that the first responder may contact the fire investigator for advice prior to their attendance at the scene. The general recommendation is to preserve the scene, and thereby, the evidence. In other situations the advice may concern the correct actions to take when deciding to remove or preserve potential evidence. If any items are moved from their original positions this must be contemporaneously recorded.

Upon arrival at the scene, the fire investigator should liaise with the first responder, if possible, to determine whether any potential evidence has been removed, altered or preserved prior to their arrival. It is important for any further investigation that all activities are recorded and that this information is given to any subsequent investigators. (See appendix B).

Such information should include:

- Breaking of doors and/or windows
- General and specific fire fighting activities
- Activities after the fire has been extinguished

### 8.2.2 Recording In Situ

As part of the initial examination of the area, a series of general photographs and/or videos should be taken. In addition to this, diagrams of the fire scene should be made.

Exterior documentation should include landmarks in order to identify the exact location of the scene. This would include the surrounding area, e.g. adjacent buildings/structures, and angular views of the exterior of the scene, as appropriate.

Multiple views and a series of sequential photographs can be used to contextualise different areas of the scene. A mosaic/collage of photographs can be useful if a wide angled lens is not available.

360° photography, drones, 3-D recording and other scanning techniques could be considered as part of the recording process in combination with alternative light sources. Bear in mind that other forensic evidence may need to be protected and recorded prior to its removal, e.g. fingerprints, glass, tool marks, footwear/tyre marks, fibres, blood (including blood patterns), DNA, etc.

All photographs taken can be recorded on a log and/or diagram, detailing the number of each photograph, where it was taken and the direction from which it was taken. Any notes and other documents made during the scene examination must be signed, dated and retained so that they can be retrieved at a later date, all according to local regulations and national laws.

Even rooms, which are less badly damaged by fire or have no fire damage at all, should be photographed and documented.

### 8.2.3 Sampling

#### 8.2.3.1 *General*

When investigating the cause of a fire, bear in mind that other forensic investigations may also be needed, such as fingerprints, fibres, blood etc. All work should be carried out according to the appropriate best practice guidelines. For specific packaging requirements, refer to the appropriate and current recommendations in your jurisdiction. Coordinate and document all activities at the crime scene as required.

Recovered samples will mostly be examined by a certified specialist.

Finding items of interest i.e. matches, cigarette butts, candle wicks, night-light (tea light) holders, wick holders etc. in the point of origin may be of significance when the cause of fire is to be determined by hypothesis testing.

It may also be necessary to obtain other items such as bedding or furniture for further examination or testing. Advice regarding this could be obtained from a specialist.

Samples must not be destroyed without authorisation from the appropriate<sup>10</sup> body because they could be required for further examination.

#### 8.2.3.2 Ignitable Liquids

If there is any suspicion that an ignitable liquid is involved in the fire, suitable samples should be recovered and preserved in appropriate packaging. Samples would normally be taken:

- from places where the liquid might have been protected, such as behind skirting boards, under doorway thresholds
- from the outer edge of a very burned area, the insulation between floors, cracks in the floor, floorboards etc.
- from items into which liquid may have been absorbed by capillary action, for example, flat surfaces such as table tops or the bottoms of drawers
- from areas where the liquid could have been adsorbed (i.e. charred materials near the point of origin)
- from below windows and external doors both inside and outside.

Throughout the investigation, especially during excavation, be aware of strange smells, e.g. from possible ignitable liquids. This is especially important when dealing with materials that have the capacity to absorb liquid, such as cloths, carpets, paper, wood, etc.

Hydrocarbon dogs, electronic sniffer devices or alternative light sources can be used to help search for ignitable liquids.

When taking samples at a scene, it may be appropriate to take a reference sample. Some materials such as different kind of plastic foams, rubber mats and inks can contain chemicals that are also found in some ignitable liquids. As such, they may give a result that needs to be compared to a suitable reference sample to help with the interpretation of the result.

The samples must be placed in suitable packaging, as appropriate for your laboratory/country. To avoid cross contamination be careful to clean your tools between taking each sample or use disposable tools when possible. It is recommended that disposable gloves are also used (and changed as necessary). Furthermore, be aware of any other sources of potential contamination, i.e. petrol-driven machines which have leaked fuel or oil and additives which may have been used in some extinguishing foams or waters. For the same reason you must remember to be careful if you use a petrol-driven electricity generator at the scene. Don't refill the generator with petrol inside the scene and use disposable gloves, which must be kept out of the scene.

<sup>10</sup> Normally the destruction of items is governed by the relevant legal procedures under which you are working. These can vary from country to country, by who has overall responsibility for the investigation (i.e. Police, Fire Service, etc.) and depending on whether the case involves any criminal or civil investigation. If you do not know what the relevant retention period is for any of the items taken from a scene, seek advice before doing anything further with the items.

### 8.2.3.3 Bottles and Cans

The contents of bottles and containers found at the scene should be considered for recovery and analysis. Even a seemingly empty container can be sent for analysis since traces of an ignitable liquid may remain in it. Remember that there may be fingerprints or DNA on the container. Liquid containers with some still in them must be well sealed and sent in as they are, or the contents should be decanted into an appropriate container. If a small sample of the liquid has to be taken, use a clean pipette rather than pouring the liquid out of the container. Sampling or decanting of liquid must be carried out away from the area of interest to avoid potential contamination.

### 8.2.3.4 Technical Systems

It is best for a relevant specialist to attend the scene and carry out these examinations. However, if this is not possible then advice must be sought.

During the investigation, note and photograph the positions of items and which are particularly damaged by the fire. It may be beneficial (or necessary) to remove these items, along with part of whatever they are attached to (i.e. wall panels and the like).

- Make a record of the item in situ.
- Do not take the object apart.
- Note their orientations (i.e. which way is up and which is down).
- Do not touch any dials or knobs.

### 8.2.3.5 Fatalities

As long as the body and surroundings are not completely burned or charred, evidence may remain on the body, clothes or things nearby which can give valuable information about what happened before the fire. It may be useful to involve a Forensic Anthropologist in the excavation of the scene and body recovery.

If you suspect that an ignitable liquid was used to deliberately aid the rate of growth and extent the fire then you must take samples. To best preserve such evidence one must take the deceased's clothes together with material from under the body, such as bedding, chair cushions, carpets, flooring, car seats etc. Loose clothing can be taken directly from where the body was found. Clothing, which can't easily be removed can be cut up and taken, but consider other possible trace evidence (i.e. fibres). In both cases clothing can only be taken as long as it doesn't affect the subsequent post-mortem examination. Remember to inform the pathologist what has been changed or removed.

### 8.2.3.6 People/Witnesses

Bear in mind that the police or insurance investigator may need to consider looking for evidence on a living person (i.e. a suspect) from the scene. The fire investigator and the specialist can give advice regarding potential evidence recovery and packaging.

Visible fire remains, which you think may be on a suspect's clothing, should be secured by carefully removing the clothing. Clothing and shoes may need inspection under a microscope to decide whether they have been subjected to flame wash or high temperatures. The entire garment must be taken whole, wherever possible.

Clothing and shoes that are taken must be packaged appropriately to preserve any ignitable liquid traces as soon as possible. The sampling of hands, if required, can be done by using

suitable gloves or absorbent material. The sampling is to be done as quickly<sup>11</sup> as possible. It is recommended that the sampling procedure is discussed with the laboratory beforehand.

A medical examiner should inspect the suspect's body as soon as possible to see if there are burns to skin, hand hair, eye brows, eye lashes, beard or head hair. Samples may be taken for further examination by a specialist. Scorching or direct burns to a suspect's body must be documented by photography.

#### *8.2.3.7 Documents*

If you find documents or bank notes during a point of origin investigation, which need to be secured for subsequent examination, photograph them in situ and carefully place them between stiff sheets of cardboard and package them in a rigid box (a photograph box is suitable). If large quantities have been recovered then they can be packaged as they were found in a sufficiently large box. Make sure that the material is secured in the box during transport, so that it does not move about and damaged further. Damp material must be sent for investigation as soon as possible.

#### *8.2.3.8 Spontaneous Combustion*

When you suspect that spontaneous combustion has caused the fire you should take samples from the point of origin and also from less damaged areas where you suspect that self-combustible material is present. A specialist must be contacted for further advice and obtaining reference samples and any additional information needed.

#### *8.2.3.9 Packaging and Removal of Fragile Items*

If items need to be immediately removed from the scene, or are likely to become damaged, they should be photographed in situ and documented appropriately. Clearly show the location of the item in the building, vehicle or area from which it was taken. It is often appropriate to do this by taking photographs and marking the location on a fire scene plan.

Once removed, the items must be packaged appropriately and disturbed as little as possible. Items should be stored carefully to minimise damage and contamination, then signed over to the specialist, if necessary.

#### *8.2.3.10 Maintenance of Sampling Equipment*

When it comes to maintenance of the equipment used for sampling, each organisation and country should have detailed procedures as to how this is done. This should include details of what equipment is to be cleaned, how and how to clean it. It should also specify when to dispose of old equipment and when to only use fresh equipment.

The manufacturer of each piece of equipment may be able to provide details concerning the lifetime of their product(s) and recommended cleaning schedules, if applicable.

#### *8.2.3.11 In the laboratory*

Not applicable.

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<sup>11</sup> Research, done by the National Forensic Center, Swedish Police, recommend that samples are taken within 3 hours of the start of the fire.

## 9 INITIAL ASSESSMENT

See section 5 - Methods.

## 10 PRIORITISATION AND SEQUENCE OF EXAMINATIONS

See section 5 - Methods.

## 11 RECONSTRUCTION OF EVIDENCE

After the excavation has been done, items that have been recovered from the area should be replaced in their original positions, if possible. This reconstruction must be compared to the owner's sketch of the area, if one is available. When this is done the investigator can continue with their interpretation of the fire patterns.

The reconstruction can be aided by features such as furniture marks on the floor and clean surfaces on the walls where objects have stood and provided protection. When the items have been replaced, they can be compared to the relevant fire damage patterns on i.e. the floor, the ceiling and walls, and the fire damage to furniture.

The fire investigator can carry out fire experiments in situ at the scene and/or in the laboratory. When performing scientific fire experiments in a laboratory, the recommendation is to use a certified one with clear documentation of standards.

There are several reasons for carrying out fire experiments in situ. As mentioned above, an experiment can be one way of testing a hypothesis. It can also help visualise the fire development or show a possible cause of fire. There are two main categories of fire experiments carried out in situ:

### 1) Single parameter

The purpose of this is to gain specific knowledge i.e. a naked flame will affect a specific item/ materiel, such as a piece of a curtain.

### 2) Multi-parameter

The purpose of this is to reconstruct several parameters at the scene. The parameters can, for exemple, be the source of ignition, the fabric of the curtain (including facts as weight per m<sup>2</sup>, thickness etc.) and so on. If the experiment is conducted outside, the general conditions should be the same as at the time of the fire i.e. wind direction, temperature etc..

When conducting fire experiments in situ is it important to meticulously document and photograph continuously.

Factors to consider when setting up fire experiments in situ are:

- Geometric circumstances
- Narrowing down the parameters
- Choice of method
- Repeated experiments
- Structure of the documentation and quality control

Documentation of the reconstruction is essential. Photograph and video the cleared area, both

with and without the items in place. Make a sketch of the rooms, noting the recovered furniture and any other items of interest.

## 12 INTERPRETATION

### 12.1 Analysis and hypothesis - Develop hypothesis

A preliminary working hypothesis (or hypotheses), based on empirical data should be developed to explain the fire's cause and development. The hypothesis (or hypotheses) would be based upon:

- observations made at the scene (fire patterns, fire dynamics, results of any technical investigations)
- remaining physical evidence (viable ignition source(s) etc.)
- other information obtained from people and technical systems

Developing good hypotheses initially involves divergent thinking to ensure that all relevant and possible options are considered. Convergent thinking is then used to organise the results and ensure that redundant and irrational hypotheses are eliminated.

#### 12.1.2 Testing the hypothesis (or hypotheses)

The investigator uses his or her knowledge and skills to challenge or test a potential hypothesis in a scientific manner. The hypothesis being considered should be compared with all other known facts. Two important points to consider at this stage are:

- Is the hypothesis testable? (i.e. can evidence be found to actually test the validity of the statement?)
- Or is the hypothesis falsifiable, (i.e. can evidence be found to show that it is not true?)

A hypothesis can be tested physically by conducting experiments, *analytically* by applying accepted scientific principles or by referring to *scientific research*. The experiments can be done in situ (see below for details) and in certified test areas/laboratories.

Whenever the investigator relies upon research as a means of hypothesis testing, references to the research must be acknowledged and cited.

The testing process needs to be continued until all reasonable hypotheses have been tested, and one is determined to be most/more consistent with the evidence and with the principles of science.

Any hypothesis formulated for causal factors (e.g., first fuel, ignition source, and ignition sequence), must be based on the analysis of facts. Those facts are derived from evidence, observations, reliable witnesses information, (calculations), experiments, and the laws of science. Speculative information must not be included in the analyses.



Below are some example questions to consider<sup>12</sup>:

- 1) Is there one point of origin or several? Has the fire started at position A or position B or at both position A and B?
- 2) Is the hypothesised ignition source viable for the first fuel ignited?
- 3) Is the required time for ignition consistent with the time line associated with the cause hypothesis and known facts of the incident?
- 4) What were the circumstances that brought the ignition source in contact with the first fuel ignited.
- 5) What, if any, were the faults required for ignition to occur?
- 6) Are the signs left by the fire what you would have expected given information provided to you and given your own hypotheses? For example, would the item of furniture have protected the floor or the wall?? Does the fire damage suggest that the furniture in question has burned from one specific direction?

### 12.1.3 Final hypothesis

When the hypothesis appears consistent with the evidence and any research (if available), it becomes a '*final hypothesis*' and can be presented as a conclusion or opinion of the investigator.

### 12.1.4 Conclusion

The point of origin/seat of fire can be described as the interpretation of the damage done by the fire. One of the tools used in the investigation of a point of origin is the ability to recognise, interpret, identify and analyse these fire patterns.

When investigating the fire patterns, you must be aware of those which could have been made by the possible offender. When investigating cases of suspected arson, it is sometimes possible to find patterns left by the offender in the point of origin and also establish their activities in or around the scene of the fire.

Note that, in post-flashover fires many of these patterns may not survive.

After the reconstruction, check the following things in the area where a witness says the fire started:

- Do the details given by the witness agree with your own observations and hypotheses?
- What is the damage like?
- Does it clearly show that the fire started there and didn't spread there from elsewhere?
- Is there any room for doubt? Can the fire have spread to this place? If so, at what stage of the fire?
- Could the fire spread coincide with the discovery of the fire?
- What possible objects of origin (i.e. electrical appliances) are present in the area?
- Have they been in use? Were they plugged in?
- Does the fire damage show that they can be eliminated?

If your opinions differ from those given by a witness, it is very important that the investigation records show that this area has been properly investigated, that all possible objects of origin have been examined, that they can be eliminated, and why. This must ultimately be mentioned in the report.

<sup>12</sup> More examples can be found in relevant documents i.e. NFPA 921.

### 13 PRESENTATION OF EVIDENCE

The way in which a report is written can vary from country to country. The list (table 1) below is recommended for use as a checklist for what a report should contain. The senior management and quality management departments for each institute are responsible for ensuring that a protocol for peer reviewing the fire investigation process and subsequent report is written and followed.

Table 1 Report structure

Introduction and basic information	Date and time Place Purpose of the investigation The condition of the scene when the fire investigation was carried out The fire investigator/specialist responsible
Working methods	Investigation by scientific methods Excavation Hypothesis testing
Background information	Information relevant to assessing the fire scene: from people from technical systems
Fire investigation at the scene (technical)	Limitations Descriptions of objects Descriptions of investigation results : Outside Inside Windows and other openings Injured people and/or fatalities List of contexts/evidence from the scene and the results of any tests carried out in situ
Assessment and conclusion	Conclusions from hypothesis testing regarding: The area/ point of origin The cause of the fire
Definitions and references (as appropriate)	Definitions of the most common and important terms used in fire investigation References to validated literature Building plans/drawings

### 14 HEALTH AND SAFETY

Preparation is key before attending any fire scene. At the very least, you must have the following basic equipment:

- Protective clothing (see appendix D)
- Video recording equipment and a camera
- Other equipment (tools, cordon tape, markers, pens, sampling containers/bags etc.)

It is advised that you prepare your own checklist of personal protective equipment (PPE) and other equipment so that you are fully prepared before attending a scene.

In addition to any other risk or safety assessments already in place, fire investigators must undertake their own risk and safety assessments at the scene both outside and inside, and must be aware that they are responsible for their own safety and those who are present with them. If necessary, specialist advice may be required.

Be aware that some risks, e.g. decreased integrity of the building construction, can occur long after the fire was extinguished.

During attendance, the risk assessment should be updated regularly, as required.

Be aware of the working conditions at all times and **do not take any risks.**

An investigation may have to be delayed until it is deemed that the structure is safe to enter. Actions to make the structure safe may involve supporting or demolishing walls, floors, and/or the roof, use of scaffolding, etc. Sufficient lighting must be available.

Any hazard or risk assessment must be dynamic and reassessed after any alteration or modification of the structure.

It is recommended that fire scene investigations are not carried out alone for improved safety.

In this phase of an incident, fire investigators must assess the actions of the first responders with respect to the security of the scene.

Strict surveillance and security measures must be put in place and maintained to protect the integrity of the scene before, during and, if appropriate, after the fire investigation.

#### 14.1 Secure the Scene

In order to ensure integrity of the scene, make sure that a sufficiently large area is cordoned off. Ensure that as few people as possible have access to the area inside the cordon. Consider using an inner and outer cordon, if that works best. Ensure that the outer cordon is sufficiently large as to encompass all areas containing possible evidence.

#### 14.2 Safety and Working Conditions

Obtain the existing hazard and risk assessment from the responder, if one was undertaken.

The fire investigator must undertake their own risk assessment at the scene, and must be aware that they are responsible for their own safety as well as the safety of those around them. The outside area must be assessed for risks and hazards. These include (but are not limited to) structural safety of the building (mechanical, electrical, roof, walls, the presence of sharps such as glass or other debris etc). If necessary, specialist advice must be sought.

An investigation may have to be delayed until it is deemed that the structure is safe to enter. Actions to make the structure safe may involve supporting or demolishing walls, floors, and/or the roof, use of scaffolding, etc. Sufficient lighting must be available. If a petrol/diesel-driven electricity generator is used, in order to minimise potential contamination, do not refill the generator with fuel at the scene, be careful where the generator is placed and always use disposable gloves (which MUST be left outside the scene).

Any hazard or risk assessment should be dynamic and repeated after any alteration or modification of the structure.

Other information about the contents and possible hazards within the scene must also be noted (eg. electrical, gases, asbestos, chemical hazards, other hazardous contents, including aerosols, and the potential danger of secondary explosions).

This information needs to be communicated to all personnel on site and to the specialist upon their arrival.

#### 14.3 Scene Security

Cordoning off with tape alone is not an efficient way to preserve a scene. It may be enough to keep the general public away, but it will not stop or prevent entry. For this to be effective a human presence at the cordon (police officer or fire fighter) is vital. This presence must ideally be maintained at the scene until the fire investigation is complete; however, if this is not possible, the absence of a 'scene guard' must be recorded.

Ideally, the person maintaining the cordon should start a scene log, recording the time of entry and exit of all persons to and from the scene. Information must include the identity and contact details of all individuals entering the scene, and may also include details of personal protective equipment (PPE). Be aware that you may need to record your own times of arrival and departure for reasons of health and safety and/or to establish a time line of events.

Bear in mind that the property owner or workers at the incident may later become suspects and their entry to and from the scene must also be closely monitored.

#### 14.4 Path of Entry

The route of any common approach path will vary depending on the type of incident, however the same method must be used to decide a route, before clearing and marking the path.

Any items that could be potential evidence must be photographed and noted in situ and removed or protected so as to clear the approach path to the area of interest (i.e. the fire damaged area).

This path must be clearly marked and used by all personnel to enter and exit that area.

With any fatal/serious injury fire or suspected arson fire, the common approach path must not be along the normal approach to the area of interest/seat of the fire. Be aware that a perpetrator may have used such a path to enter or leave the scene.

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## 16. CHANGES FROM THE PREVIOUS VERSION

Not applicable (first version).

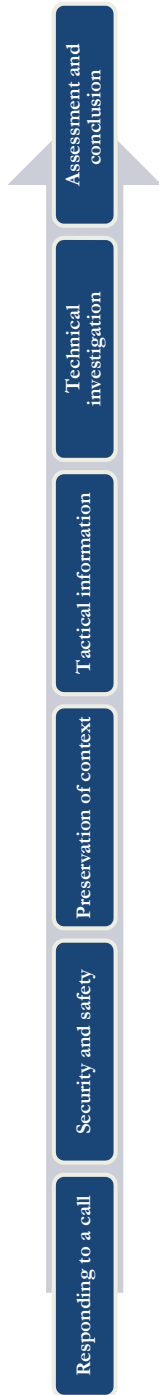
**17. TABLE OF APPENDICES**

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Appendix A INVESTIGATION PHASES



APPENDIX 1 INVESTIGATION PHASES



<p>En route – record</p> <p>At the scene – document</p> <p>General information for documentation</p> <p>Plan for preservation</p> <p>Communication and coordination</p>	<p>Secure the scene</p> <p>Safety and working conditions</p> <p>Adjustment of security</p> <p>Path of entry</p>	<p>Dialogue (exchanging all relevant info)</p> <p>Recording in situ i.e.:</p> <ul style="list-style-type: none"> <li>360 ° photo</li> <li>Drones</li> <li>Alternate light source</li> </ul> <p>Sampling, i.e.:</p> <ul style="list-style-type: none"> <li>Liquids</li> <li>Bottles and cans</li> <li>Technical systems</li> <li>Fatalities</li> <li>Documents</li> </ul>	<p>Background information from:</p> <ul style="list-style-type: none"> <li>People</li> <li>Technical systems</li> </ul>	<p>Interpretation of available information</p> <p>Investigation strategy</p> <p>First general overview</p> <p>Limits of the investigation</p> <p>Excavation</p>	<p>Hypothesis</p> <p>Develop</p> <p>Test</p> <p>Conclude</p> <p>Determination: Interpretation of the fire pattern</p> <p>Synchronization with background information</p> <p>Documentation of reconstruction</p> <p>Conclusion: Point of origin</p> <p>Cause of fire</p>
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	Involved
	Could be involved
	Not involved

## Appendix B TACTICAL INFORMATION

	Property owner/ First person at the scene/Witness/Neighbours <sup>13</sup>
The property	<p>Are there any particular hazards present within the premises (for example asbestos, building components, animals)?</p> <p>Ask for photographs and/or videos which show what the property looked like inside and outside prior to the fire.</p> <p>Ask the occupier/representative, to sketch a plan of the rooms/furniture and of the building.</p> <p>Was the property secure before the fire?</p> <p>Was there any CCTV (surveillance cameras) in the area or on other buildings?</p> <p>Were the premises and/or contents insured? If yes, when was the policy renewed?</p> <p>Were there any electrical appliances, heating appliances or any other potential sources of ignition in the area?</p> <p>Were there any fire/smoke alarms in the premises? If yes, where were they located and did they operate?</p> <p>Were there any ignitable materials or liquids, or materials, liable to spontaneous combustion, present?</p> <p>What was in the area where the fire was first observed?</p> <p>Who has access and/or keys to the property?</p> <p>Who has knowledge of the code/PIN for any security systems?</p> <p>Are there any photographs or films of the fire, or of the property before the fire?</p>
Actions and people before the fire	<p>Did any windows break before the fire brigade arrived? If so, when and in what order?</p> <p>Had any candles been used?</p> <p>Has any repair work, alterations, welding or any type of "hot work" been undertaken in the area? If yes, obtain details.</p> <p>Has anyone smoked in the area of origin, and if so, when was the last time this occurred?</p> <p>Have any unusual activities been noticed in the surrounding area?</p> <p>Have there been any previous fires at this address?</p> <p>Have there been any previous problems with any appliances?</p> <p>Have there been any previous problems with the building services/fixed installations (electricity, gas and water supplies)?</p> <p>If there was an intruder alarm, was it armed prior to the fire?</p> <p>Were any unusual sounds heard before the fire?</p> <p>Were the doors and windows closed when they left the area?</p> <p>Were there any strange smells?</p> <p>What were the actions of the last person in the property?</p> <p>When did that person leave the property?</p> <p>When did they discover the fire?</p> <p>Where were the occupants of the building when the fire broke out? What were they doing?</p> <p>Where were they when they discovered the fire? What was the available lighting?</p> <p>Which doors or windows were open when the fire was discovered?</p> <p>Who discovered the fire? What did they see?</p> <p>Had any windows broken before the fire was discovered?</p>
The fire	<p>How and why was the fire detected? Was it by the smoke, flames or heat?</p> <p>How did the fire develop?</p> <p>How did they escape from the building?</p> <p>How high were the flames?</p> <p>How intense was it?</p> <p>How long did it take from the discovery of the fire until the alarm was raised?</p> <p>How much smoke was given off?</p> <p>Was any attempt made to extinguish the fire?</p> <p>Was the fire at high or low level? What colour were the smoke and flames?</p>

<sup>13</sup> The listed questions are just examples. Other relevant questions may be asked depending on the specific fire investigation.



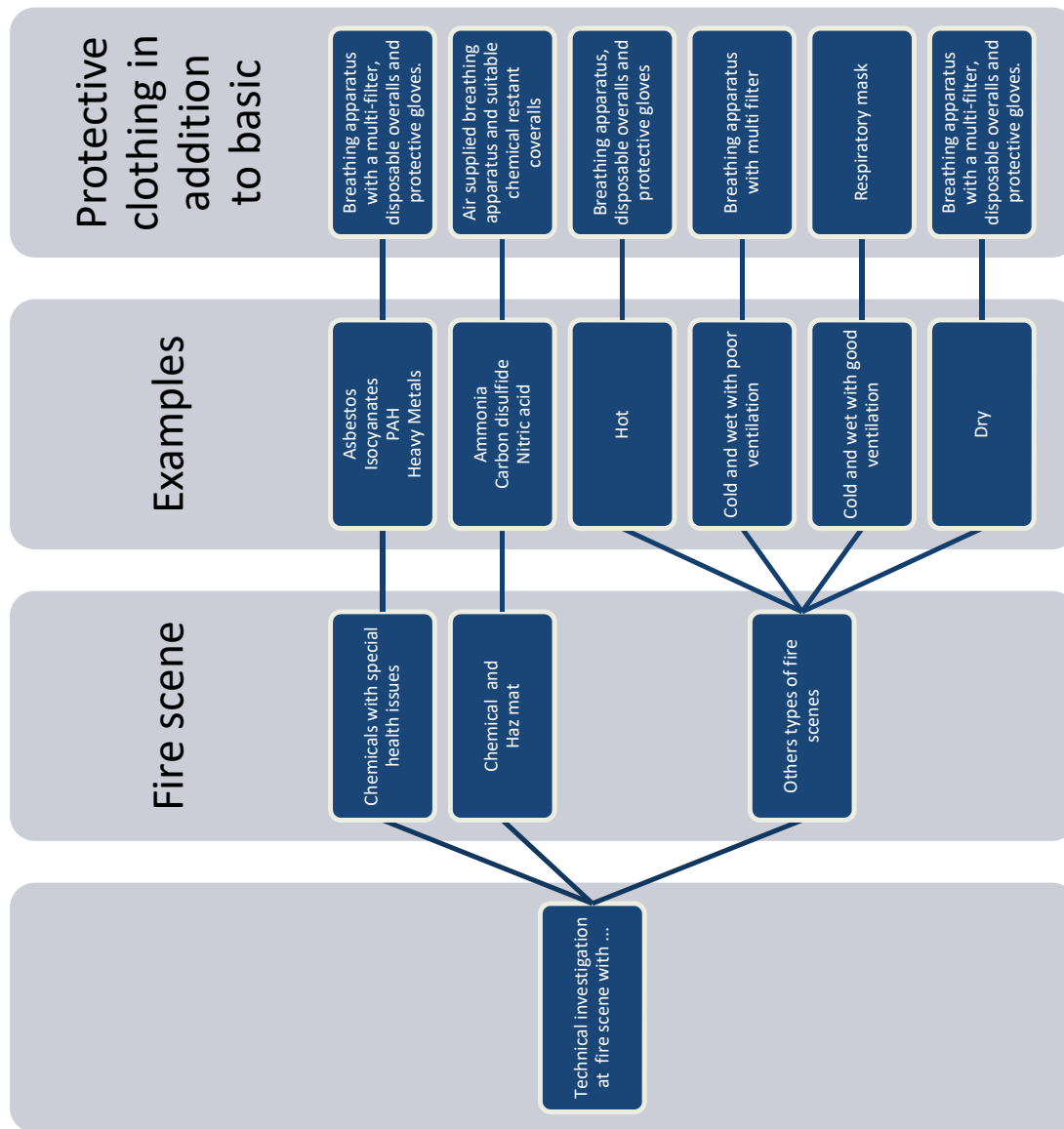
## Appendix C EXAMPLES OF FIRE CAUSES

In every case, regardless of how the motive / background to the fire is categorised (arson, accidental, sickness, stupidity etc.), a general interpretation of the fire damage must be made, in order to determine the cause. Ignition may be defined as that process by which a rapid exothermic reaction is initiated, which then propagates and causes the material involved to undergo change, producing temperatures greatly in excess of ambient. Below is a short list of examples and it is to be duly noted that the list is not complete:

Auto-ignition	A substance spontaneously ignites in normal atmosphere without an external source of ignition: Biological (i.e. hay) Chemical (i.e. pyrophoric substances)
Electrical	Heat conduction/convection from : Electrical equipment and appliances (i.e. shortcuts, bad connections, overload or insulation faults on wiring) Lighting equipment and heaters (i.e. overheated)
Embers	Ember is glowing hot and radiates a substantial amount of heat: Ashes (i.e. from a conventional fireplace) Sparks (i.e. airborne embers from a bonfire) Glowing fire debris Live charcoal (from i.e. a BBQ) Lit cigarette
Explosion	An explosion releases an extreme amount of energy, usually with the generation of high temperature: Natural (i.e. volcanic processes) Chemical (i.e. explosives, gases) Electrical and magnetic (i.e. high energy electrical arc which rapidly vaporizes metal and insulation material) Mechanical and vapour (i.e. BLEVE <sup>14</sup> )
Friction	The force resisting the relative motion of solid surfaces, fluid layers and material elements sliding against each other (i.e. faulty wheel bearings or brakes).
Natural phenomenon	A natural phenomenon is an observable event which is not man-made:  Biological (i.e. fermentation of sugar into acids, gases and/or alcohol <sup>15</sup> )  Chemical (i.e. fire from a rapid oxidation) Geological (i.e. volcanic activities) Meteorological (i.e. lightning)
Open flame	An open flame can come from for an example a lit: Lighter Matches Candle

14 Boiling Liquid Expanding Vapour Explosion  
15 Could also be an accelerator

## Appendix D PROTECTIVE CLOTHING



- Personal safety equipment – basic:
- a safety helmet
  - safety boots
  - protective ear equipment
  - protective goggles
  - gloves (industrial gloves and chemical-resistant rubber gloves).
  - work clothing
  - disposable overalls (dust-proof overalls)
  - light

## Appendix E DEFINITIONS

The following list of definitions are not complete, more can be found in i.e. *Dictionary of Forensic Science, Oxford*<sup>16</sup>

Accelerant	The flammable material that is used in an arson to accelerate the fire process. An accelerant can be a solid (i.e. paper, PUR), liquid (i.e. petrol) or gas (i.e. propane).
Arson	The act of deliberately setting a fire with criminal intent.
Auto ignition (Spontaneous)	A substance spontaneously ignites in normal atmosphere without an external source of ignition: Biological (i.e. hay) Chemical (i.e. pyrophoric substances)
Chimney effect	A rising stream of heat, smoke and gases that is confined in a shaft or similar vertical space (for example, stairways) or corners.
Combustion	The chemical reaction broadly defined as burning which occurs when a fuel and an oxidant is combined at elevated temperatures. Heat is important, both as a product of the reaction and to ensure that the reaction has enough energy to be self-sustaining.
Complete combustion	All organic material is burnt away and consumed in the combustion process.
Condensation	What happens when a substance goes from the gaseous phase to the liquid phase.
Conduction	Transfer (of heat, for example) by means of conductivity through solid materials. Metals are good heat conductors.
Convection	Transfer (of heat, for example) by means of a current (for example, a hot air flow from a wood-burning stove or hot flue gases).
Daubert criterion	Three critical United States Supreme court cases that have contributed to the precedents regarding the admissibility of scientific evidence and testimony in that country. First decision :It was the role of the judge to determine if scientific evidence is relevant and reliable. The two other decisions contributed to the expansion of expert witnesses to apply Daubert standards to all expert testimony, not just strictly scientific expert testimony.
Deflagration	Strictly defined, a region of combustion or flame front that is moving at subsonic speeds. Informally, rapid burning is often referred to as deflagration.
Detonation	A chemical reaction of explosive materials that spreads at supersonic speed and releases large volumes of energy and high temperatures. Thus, an explosion in an exploding substance (explosive) is a detonation.
Endothermic	A combustion process that cannot continue without the addition of heat.
Exothermic	A combustion process that releases heat and continues by itself without depending on an external heat source. (See also Endothermic).
Explosion	An explosion is a rapid expansion of gases caused by either a combustion or by the release of excess pressure. Can also be described as the sudden formation of (potential) energy for motive power with the production and release of gases under pressure, or the release of gas under pressure. This release of high pressure gases can move, alter or destroy nearby materials.

Fire	An self-sustaining combustion process during which heat, smoke, flames or embers are emitted.
Fire load	The total heat output that can potentially be released during the complete combustion of all flammable material in a room or an area. Measured in joules. (The volume of the flammable material present that can potentially catch fire).
Fire resistance	A construction's ability to withstand the effects of fire expressed in connection with standardised testing. Expressed in minutes.
Flame	A luminous combustion zone that results from the reaction between gases and which creates heat.
Flammability limit	The lower and upper flammability limits indicate the range, expressed as a volume percentage, in which a mixture of the substance (gas, liquid vapour or dust) and atmospheric air at a normal temperature can be ignited. The range between the two limits is also referred to as the flammable range or the explosive range.
Flashover	The moment when all flammable material in the room is involved in the fire. All flammable material in the room has reached ignition temperature and the fire is fully developed.
Flashpoint	The lowest temperature at which a flammable liquid releases combustible vapours.
Fusing point (or melting point)	The temperature at which a material goes from solid form to the liquid/fluid phase. (Expressed in degrees C).
Heat conduction	Heat that flows through a solid material.
Ignition source	The source of heat or flame that is used to ignite a material.
Ignition temperature	The temperature to which a material has to be heated using a standard method in order for it to burst into flame in atmospheric air.
In situ	On site or on the premises
Incendiary device	Devices that are used to ignite an accelerant in an arson fire. They can range from simple to sophisticated.
Incomplete combustion	A combustion process in which not all flammable materials are burnt completely (CO and soot is formed).
Inert gas	A non-flammable gas that is used, for example, as a means of extinguishing fire. Inert gas works by "reducing the oxygen content in the protected room from the normal 20.9% to 11.2% and thus extinguishing more or less all types of fire. Inert gas is used in automatic extinguishing systems and for protecting enclosed areas, for example computer rooms and ship tanks. Can also be used for welding, for example carbon dioxide (CO <sub>2</sub> ) or argon.
Non-Combustible material	A material that cannot be ignited/burn under established testing conditions. (ISO 1182).

Optimal mixture	The proportion of each component in a mixture of flammable gas and air which gives the quickest and cleanest combustion.
Oxygen	An odourless, colourless gaseous element. It is non-flammable but fuels a fire. (O <sub>2</sub> – ordinary air contains approximately 21% O <sub>2</sub> ).
Point of Origin	The place at which the fire started.
Pyrolysis	Chemical degradation of a material due to thermal stress.
Radiation	The transfer of heat by means of electromagnetic waves (infrared light, transmitted in straight lines at the speed of light).
Slow burning	Burning speed is between 1 and 10 mm a second.
Smoke	Small solid particles in gas, caused by combustion or pyrolysis.
Smouldering	A slow burning process without flames (characterised by an increase in temperature and smoke, but no light).
Stratigraphic excavation	Stratigraphy is a key concept to modern archaeological theory and practice. Modern excavation techniques are based on stratigraphic principles as applied in fire investigations: Original horizontality Lateral continuity
Sublimation	Distillation at low temperature. A material that goes directly from solid form to gas/vapour form (for example, wood and paper etc.).
Under ventilation	Development of a fire where the supply of air is less than what the fire needs.
Vapour	The gaseous state of a substance which, under normal pressure and temperature conditions, is usually a liquid.

## APPENDIX B1 - INVESTIGATING FIRE FATALITIES

### 1.1 INTRODUCTION

When human remains are found or suspected to be within a fire scene their recovery must be undertaken by practitioners who have the competence to do so. However, all fire scene investigators must have an awareness of how such remains should be preserved and protected during the fire scene investigation process.

### 1.2 HEALTH AND SAFETY

There are a number of specific risks associated with the location and recovery of human remains within a fire scene. These risks vary in type and severity depending on the degree of damage to the body. Full personal protective equipment (including masks and goggles) for biological hazards must be worn based on the hazards identified. Counseling must be available for anyone who comes in contact with human remains.

#### 1.2.1 Sharps

As a result of the fire, a body is exposed to both heat and impact damage for example due to falling debris and structural collapse. Loss of soft tissue due to heat can expose fractured bone which in turn pose a sharps risk to those handling the remains.

#### 1.2.2 Biological hazards

Soft tissue damage can expose internal organs and bodily fluids which can contain potentially harmful bacterial and virus', these in turn pose a risk to those handling the remains both by inhalation and by direct contact.

#### 1.2.3 Psychological risks

Observing and handling human remains carries the potential for psychological distress.

### 1.3 GENERAL INDICATORS OF THE PRESENCE OF HUMAN REMAINS

The physical condition of human remains will vary dependent upon the severity of the fire and/ or the length of time which the body has been exposed to the heat flux within the fire scene. Heat and fire fighting activities can cause extensive fragmentation and dispersion of the remains however the remains are still present within the scene to be recovered. The stages of damage listed below are not clearly defined but are part of a dynamic process that will vary on a scene by scene basis.

- Minimal heat damage,
- Pugilistic pose associated with some soft tissue damage
- Pugilistic pose associated with fragmentation of limb bones and exposure of the skull.
- Extensive loss of soft tissue, fragmentation of limb bones, exposure and fragmentation of skull and ribs, some loss of tissue and fragmentation of torso.
- Complete loss of soft tissue and fragmentation of bones, those left powder on touch.

### 1.4 SCENE EVALUATION

If human remains are suspected to be present in a scene at any stage of the scene examination, standard operating procedures for the recovery of human remains should

be initiated and re-evaluation of the risks and handling of the scene must be carried out. Consultation with the appropriate specialist/expert must be part of this process of re-evaluation, such specialists could include a forensic pathologist, forensic anthropologist etc.

In cases where the recovery of human remains is required the following procedures must be followed ;

1. The location of the body (including nearby debris on or surrounding the body and protected areas under or near the body) must be recorded and include a measured plan of the environment.
2. The position of the body must be recorded.
3. Photography of the teeth and fingerprinting should be considered prior to handling of the body depending on its condition.
4. Handling of the remains must be kept to a minimum.
5. Based on the condition of the body and the agreed scene examination strategy, samples (fingernail scrapings, biological evidence, trace evidence, clothing etc.) may be taken *in situ*. This is particularly the case if areas of the body have been protected from the effects of the fire for example by clothing or fallen debris.
6. Personal possessions and any clothing or wrapping associated with the body must be photographed and documented *in situ* prior to recovering, packaging and labelling.
7. Where applicable the body should be turned over within the scene and photographed. The area underneath the body should be recorded and carefully excavated.
8. For bodies that have become fragmented, the fragments may have spread as a result of fire suppression activities and all attempts should be made to maximise the recovery of these fragments in such cases consultation with forensic anthropologists or forensic pathologists is advisable to ensure maximum recovery. Discussing fire suppression activities with the first responders will help in this respect. The location of all fragments must be recorded.
9. For situations where bone is exposed and has become fragile through heat exposure, stabilising chemicals or wrapping materials (such as cling film) can be considered if their use prevents further fragmentation or deterioration. Chemicals must be used with extreme caution and control samples of any chemicals and wrapping materials should also be supplied.
10. Body fragments can adhere to other items of debris and this debris should be carefully checked prior to removal from the scene.
11. In scenes where human remains are in danger of further damage and the body cannot be recovered quickly, it is the role of the fire investigator to initiate contact with the appropriate specialists as soon as possible and act upon the advice of these specialists in relation to the protection of the remains.
12. Human remains must be placed in cold storage as soon as possible after recovery.

## APPENDIX C1 – CLANDESTINE MANUFACTURE OF CONTROLLED SUBSTANCES.

### 1.1 INTRODUCTION

A clandestine laboratory is any laboratory or facility that illegally manufactures controlled substances, or converts precursor chemicals into controlled substances. This includes the production of stimulants, depressants, hallucinogens and narcotics, (e.g. methamphetamine, amphetamine, heroin, cannabis), as well as an ever changing number of controlled analogs and designer substances collectively known as New Psychoactive Substances (e.g. substituted cathinones, synthetic cannabinoids). It also includes chemical processes which convert pre-precursor chemicals (e.g. APAAN) into precursor chemicals.

Clandestine laboratory premises can be encountered in almost any location usually houses, garages, industrial buildings, warehouses, motor vehicles and caravans. The chemical processes use equipment and recipes of varying degree of sophistication. Many of the chemicals found at a clandestine laboratory have a wide range of legal uses from which they have been diverted.

Cannabis has traditionally been grown outdoors but there has been an increasing tendency for indoor cultivation. This can be found in domestic or commercial premises and can be located in closets, basements etc. depending on the scale and sophistication of the production. Indoor cultivation is often hydroponic where plant nutrients and water are fed into the growing medium.

### 1.2 HEALTH AND SAFETY

It is critical for all responders to the scene to be able to identify the levels of risk as well as types of protection needed for the particular incident under investigation. Full personal protective equipment (including breathing apparatus) for chemical hazards must be worn based on the scale of the production process and the nature of the chemical or biological hazards identified. Based on the hazards identified, appropriate decontamination procedures must be deployed.

Clandestine laboratories pose specific and serious health threats due to;

#### 1.2.1 Chemicals

There are many hazardous highly flammable chemicals (e.g. large amounts of solvents), explosive and corrosive chemicals (e.g. strong acids, bases), as well as toxic and carcinogenic substances. These pose immediate and long term risks to human health and the environment. Dangers also arise where mixtures of chemical waste are present and chemical spills can further result in inhalation of toxic levels of solvents, acids, cyanide etc. Additional dangers arise from a lack of control measures, unlabeled or mislabeled chemicals and inappropriate ventilation within the 'laboratory' that can increase the risk to responders.

#### 1.2.2 Structural modifications

Premises are often modified in order to facilitate the laboratory function. This may cause increased risk to building integrity and reduced ventilation by removal or alteration of supporting structures. Poor ventilation can cause risk of inhalation of chemicals as well as high humidity levels which can result in elevated airborne levels of mould spores posing potential health hazards e.g. respiratory diseases.



Gas and electricity supplies may be altered causing an increased risk of fire, explosion and electrocution. Modification to water supplies may pose a risk due to reduction in water flow or contamination of water by chemicals.

### 1.2.3 Equipment

Home made and/or modified equipment can result in their catastrophic failure leading to an increased risk of explosion and fire.

The presence of gas cylinders cause an increased risk of explosion and fire.

Carbon dioxide generators are utilised in cannabis cultivation and pose a risk of suffocation.

### 1.2.4 Booby-traps

All responders should be aware of the possible presence of booby traps such as (but not limited to) electrified metal plates at door thresholds, wiring door and window handles to mains electricity supplies and the use of sharp objects strategically placed at entry points.

## 1.3 GENERAL INDICATORS OF CLANDESTINE MANUFACTURE OF CONTROLLED SUBSTANCES

Indicators which may alert fire investigators to the possible presence of a clandestine laboratory during the initial assessment may include the following:

- Unusual odors such as solvents, ammonia etc.
- Covered or painted over windows.
- Unusual or excessive security measures for the type of premises e.g. cameras, high fences, locked/chained gates, bars on windows, guard dogs, booby traps.
- Laboratory glassware /equipment.
- Chemicals, marked and unmarked chemical containers, unusual amounts of cold remedies.
- Unusual use or location of heating, cooling or pressurized equipment.
- Unusual ventilation equipment (pipes, fans etc.).
- Large amounts of full and/or empty chemical containers kept inside or in the vicinity of the premises.
- Observation by neighbours of odours, smoke, dumping of waste.
- Evidence of cooking rings and burnt utensils.
- Chemical and/or oil spillages and stains on surfaces.
- Unusual stained coffee filters.
- Discarded cling film and foil.
- Drug recipe books and notes (hand written and printed).
- Internet references for drug production.

### 1.3.1 Cannabis cultivation

Some specific equipment associated with the cultivation of cannabis include;

- Growing medium eg clay pebbles, perlite, coco shell, rockwool.
- Seeds.
- Germinating discs.
- Nutrients, fertilizer, vitamins, minerals and/or pesticides.
- pH meters.

- Electrical conductivity meters.
- Thermometers.
- Carbon dioxide cylinders/generators.
- Extractor fans.
- Ventilation ducting.
- Carbon filters.
- Light bulbs eg neon, LED, silver halide, high pressure sodium.
- Light reflectors.
- Electrical timers.
- Extensive wiring.
- Aluminium foil sheeting for lining walls and ceilings.
- Watering system eg drip feed system with associated piping, capillary mats, misters, water pump.
- Written instructions on cultivation process including watering/ lighting/ feeding.
- Various pots and trays.
- Plant and growing medium waste.

#### 1.4 SCENE EVALUATION

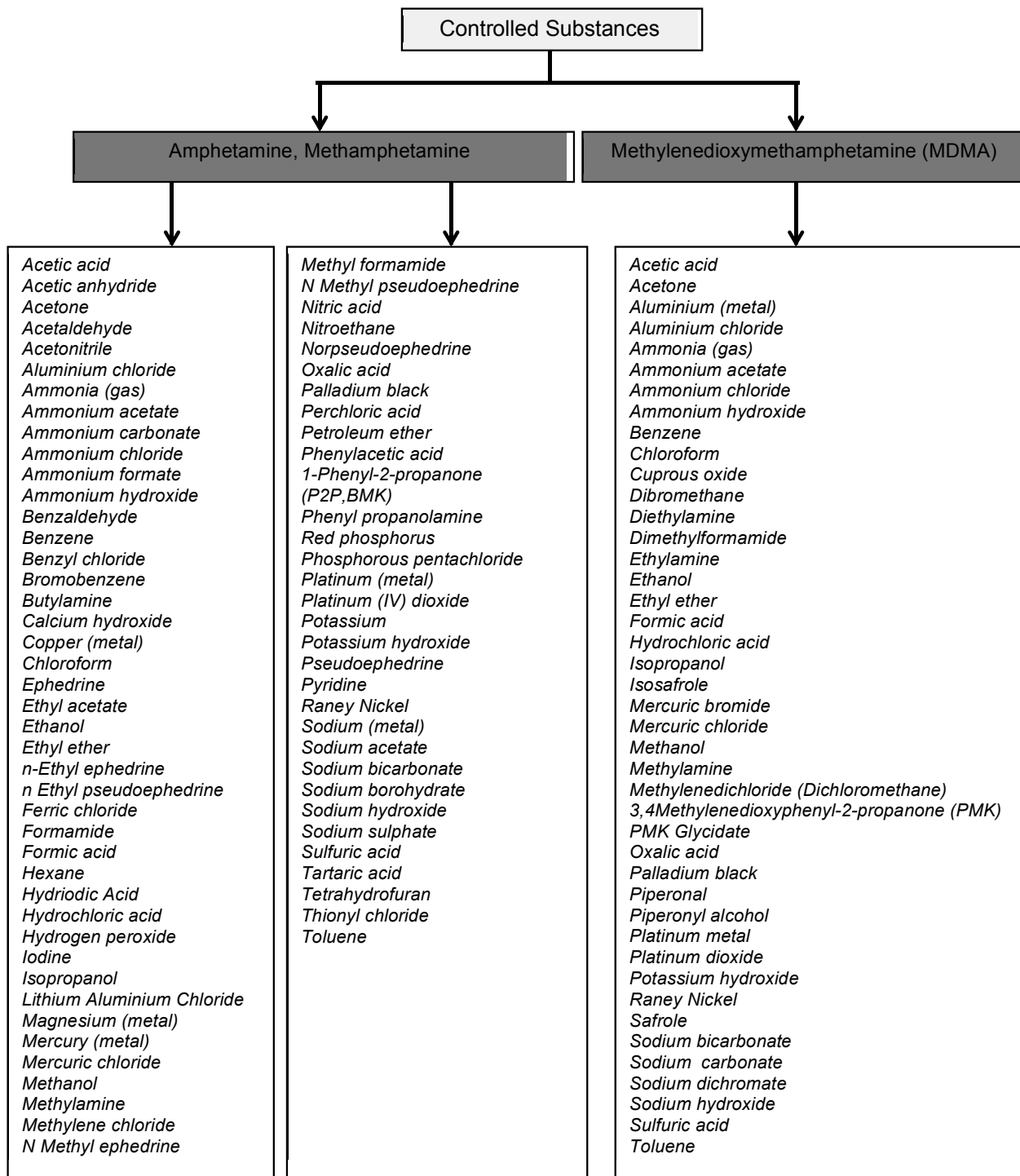
If a clandestine manufacturing process is suspected at any stage of the scene examination, standard operating procedures for the handling of hazardous materials must be initiated and re-evaluation of the risks and handling of the scene must be carried out. Consultation with the appropriate specialist/expert must be part of this process of re-evaluation.

In addition to the fire investigation a separate scene investigation may be carried out to investigate the chemical manufacturing process. This will involve appropriate specialists which may include, forensic chemists, safety officers, environmental officers and decontamination/ clean up personnel etc.

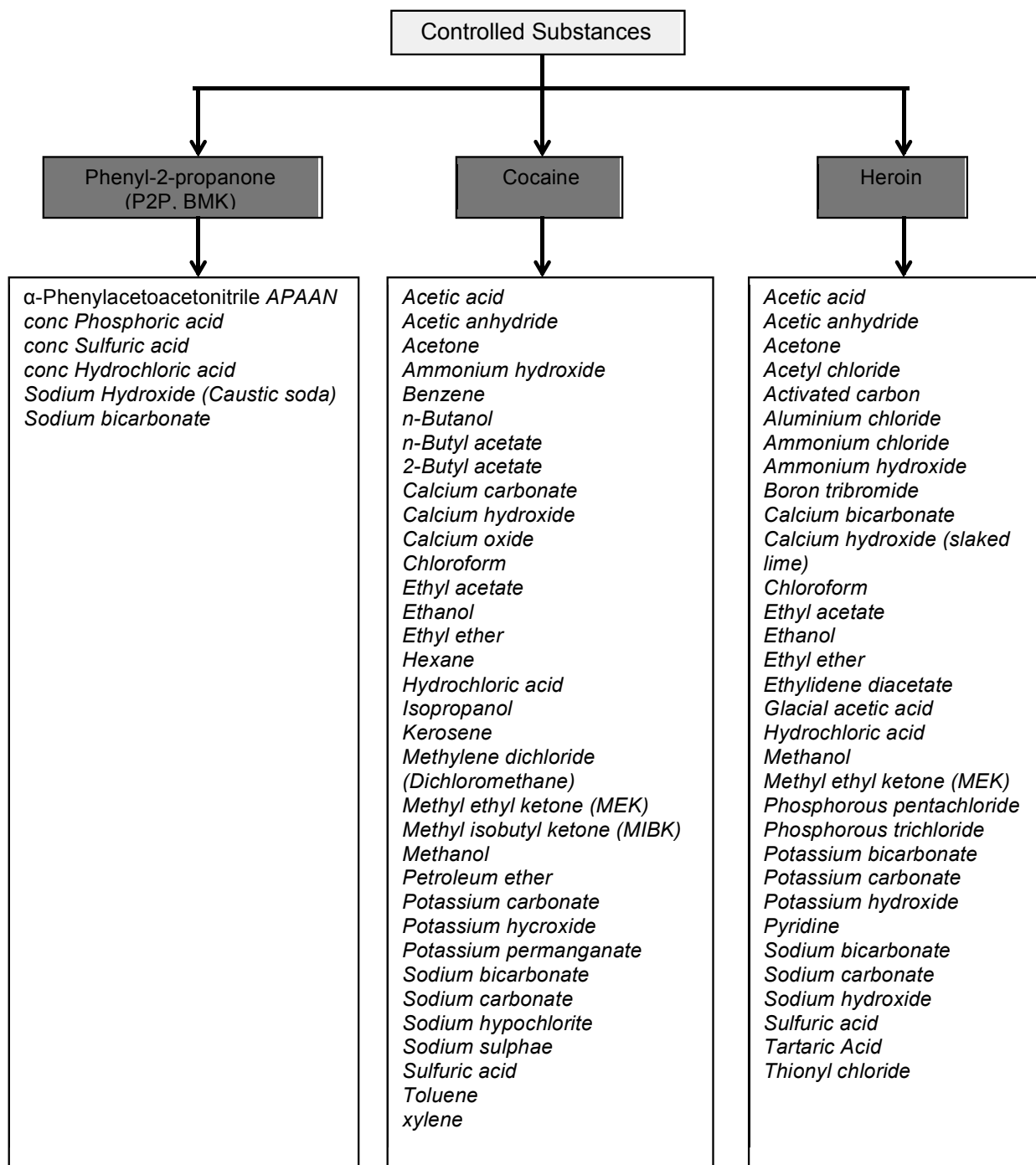
An overall strategy should be discussed and agreed to prior to any activities commencing in relation to both the fire scene investigation and the investigation of the chemical manufacturing process. This must include (but is not limited to);

- scene preservation including restriction of access to the scene.
- health and safety including the chemical or biological hazards present.
- evacuation of the immediate area or extension of a 'safe zone'.
- safe shut down of any chemical processes in operation.
- identification of the chemical process involved where possible.
- prioritisation of the scene examination in order to maximize the recovery of relevant evidence for both the fire scene investigation and the investigation of the clandestine laboratory.

## FLOW CHART A : CHEMICALS USED IN THE SYNTHESIS OF CONTROLLED DRUG SUBSTANCES.

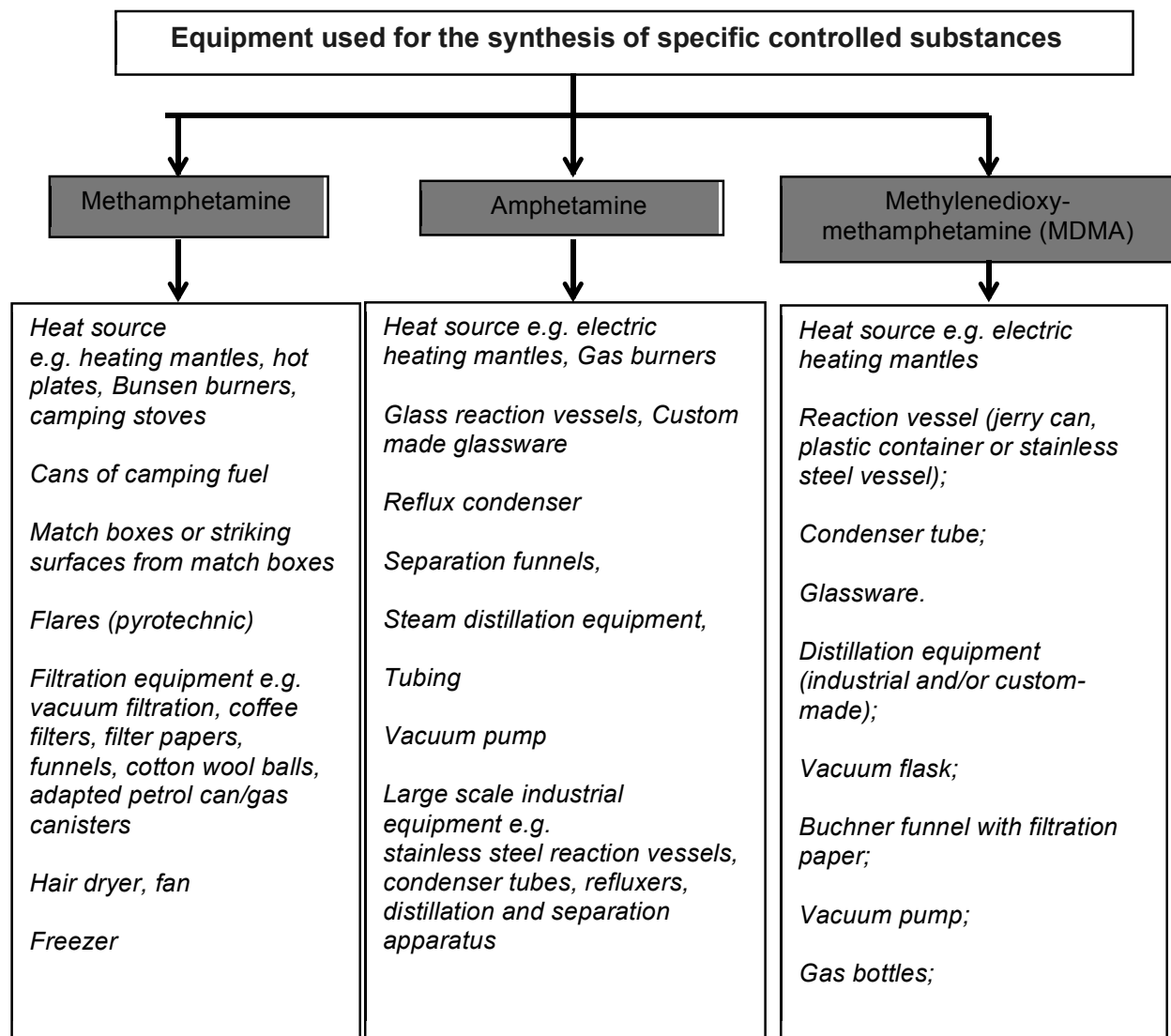


## FLOW CHART A (CONTINUED) : CHEMICALS USED IN THE SYNTHESIS OF CONTROLLED DRUG SUBSTANCES .



**FLOW CHART B : EQUIPMENT COMMONLY USED FOR THE SYNTHESIS OF CONTROLLED DRUG SUBSTANCES.**

**Common equipment :** Balances, thermometers, freezers, buckets, barrels, tubs; mixing devices; pH meter or paper; separation funnels, centrifuge, glass jars or modified soft drink bottles, packaging equipment, tableting press, heat sealing equipment, cling film, polythene bags, drying cupboard or drying rack.



## FLOW CHART C : HOUSEHOLD PRODUCTS COMMONLY USED FOR THE SYNTHESIS OF METHAMPHETAMINE.

Household products	Chemical
<p><b>Precursor source</b>  <i>Weight loss products, Cold medication e.g. Sudafed,            Plant material            Vasoconstrictor</i></p>	<p><b>Precursor chemicals</b>  <i>Ephedrine/Pseudoephedrine            Ephedra            Phenylpropanolamine</i></p>
<p><b>Source of Essential chemical</b>  <i>Aluminum foil            Photographic development solvent            Lithium batteries            Matchbooks and matchbook striker surface            Iodine tinctures            Etching solvent, wood preserver            Hair bleach            Food preservative            Precious metals, jewellery, dentistry            Table salt            Epsom salt, fertilizer</i></p>	<p><b>Essential chemicals</b>  <i>Aluminum foil            Methylamine            Lithium            Red phosphorous            Iodine            Mercuric chloride            Hydrogen peroxide            Phosphinic acid            Platinum            Sodium chloride            Magnesium sulfate</i></p>
<p><b>Source of Solvents</b>  <i>Mineral spirits            Charcoal lighter fluid            Camping fuel            Denatured alcohol            Nail varnish remover            Paint remover            Methylated spirit            Air conditioning refrigerant, crop fertilizer            Antifreeze            Dyes, lacquers ,varnish            Engine starter fluid            Gas line, antifreeze, brake cleaner fluid            Lye, drain cleaner, caustic soda            Paint thinner, brake cleaner            Concrete cleaner            Concrete cleaner, disinfectant            Battery acid            Dry cleaning fluid            Vinegar</i></p>	<p><b>Solvents</b>  <i>Mineral spirits            Charcoal lighter fluid            Camping fuel            Ethanol            Acetone            Dichloromethane            Methylated spirit            Anhydrous ammonia            Ethylene glycol, propylene glycol            Benzene            Ethyl ether            Methanol            Sodium hydroxide            Toluene            Hydrochloric acid            Hydriodic acid            Sulfuric acid            Trichloroethylene            Acetic acid</i></p>

## APPENDIX C2 – CLANDESTINE MANUFACTURE OF HOME MADE EXPLOSIVES

### 1.1 INTRODUCTION

Explosive materials include conventional high explosives, quantities of small arms propellant, fireworks, other pyrotechnic materials, incendiary mixtures and home made explosive mixtures. Explosives are sensitive to heat, shock, friction and electrostatic discharge; sensitivity will vary based on the type of explosive. However, all can explode violently if mishandled. Some home made explosives may be manufactured in a cold water bath or be stored in a refrigerator or packed in ice to ensure that they remain inert.

Home made explosives can be made from commonly available chemicals. They can be more or less sensitive than commercial explosives depending on the formulation, starting materials, purity and the methods of manufacture.

Many chemicals can be obtained from chemical companies in pure form or from readily available household or industrial products. Flowchart D provides some examples of the commonly encountered chemicals used in the manufacture of home made explosives, together with their physical appearance.

#### 1.1.1 Appearance

Some home made explosives may be found as crystalline solids that have settled to the bottom of a liquid filled container. Some may float on the top of a liquid. Other home made explosives may appear as non-crystalline solids. Residues of explosives may be left in mixing or storage containers; these can be extremely hazardous.

Colour and smell is not always a good indicator of the presence of explosives as this will vary depending on several factors, including starting products and purity.

### 1.2 HEALTH AND SAFETY

It is important to look at the circumstances of a scene in their entirety. These types of scenes are not always clean and tidy environments, and time should be taken to assess the scene carefully.

DO NOT HANDLE any items believed to be involved in the manufacture of home made explosives; contact an expert immediately.

### 1.3 GENERAL INDICATORS OF HOME MADE MANUFACTURE OF EXPLOSIVE SUBSTANCES

The manufacture of home made explosives does not require specialist scientific equipment include but are not limited to:

- food mixers,
- coffee grinders and blenders;
- beakers, glass jars, glass containers,
- buckets and bowls;
- saucepans
- conventional kitchen hob or electric hot plate;
- cold water bath or ice bath.

Specialist tools are also not required. Many tools used in household DIY are suitable and include but are not limited to:

- pliers,
- screwdrivers,
- soldering iron and solder,
- hammers,
- batteries,
- bulbs,
- wires,
- circuit boards,
- commercial electronic items such as switches, timers and clocks
- Home made detonators.
- Modified mobile phones.

#### **1.4. SCENE EVALUATION**

If the manufacture of home made explosives is suspected, procedures for the handling of hazardous materials must be initiated and re-evaluation of the risks and handling of the scene must be carried out. Consultation with the appropriate specialist in explosives ordnance disposal (EOD, Bomb disposal) must be part of this process of re-evaluation.

In addition to the fire investigation, a separate scene investigation may be carried out to investigate the home made explosive manufacturing process. This will involve appropriate specialists which may include explosive experts, safety officers and decontamination/clean up personnel etc.

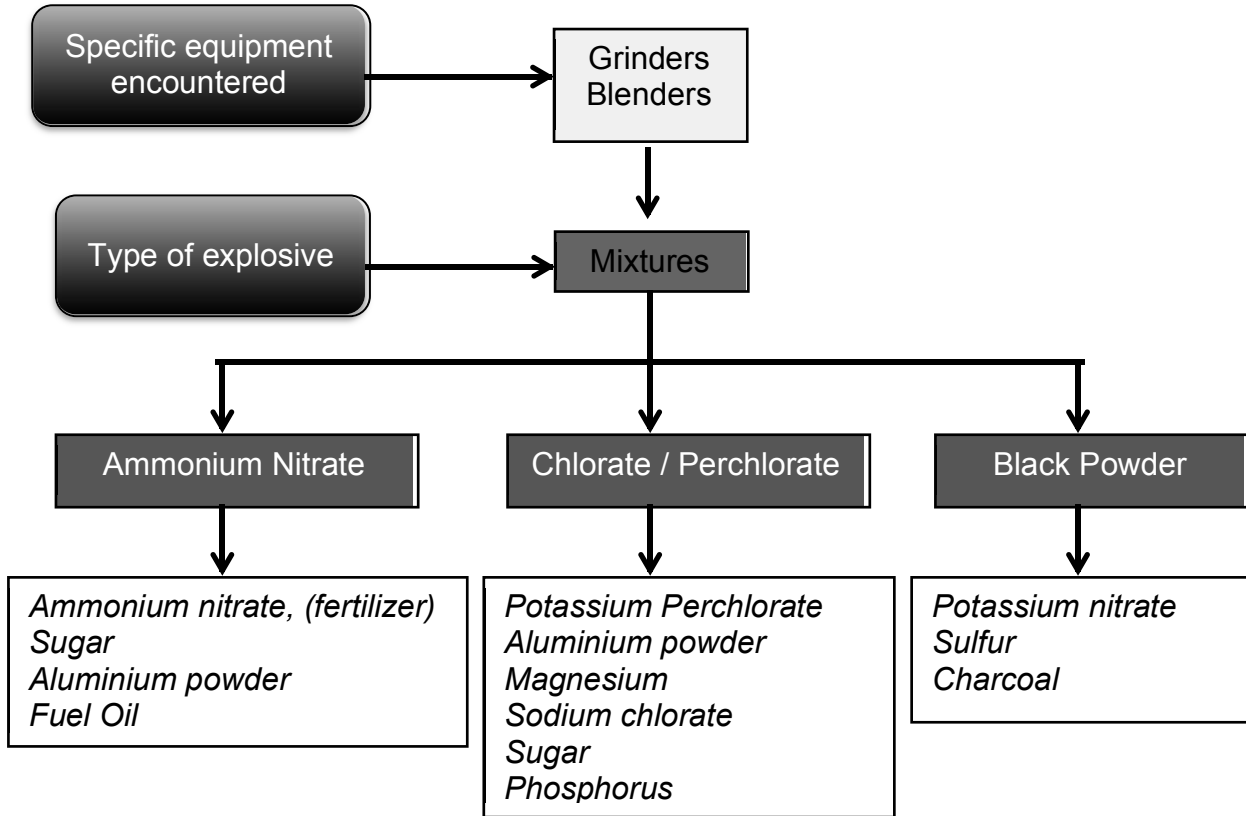
An overall multi agency strategy should be discussed and agreed prior to any activities commencing. The strategy should include both the fire scene investigation and the home made explosive manufacturing process. It should be borne in mind that further destruction may be required if the home made explosive material needs to be made safe by EOD or bomb disposal specialists.

The strategy must include (but is not limited to);

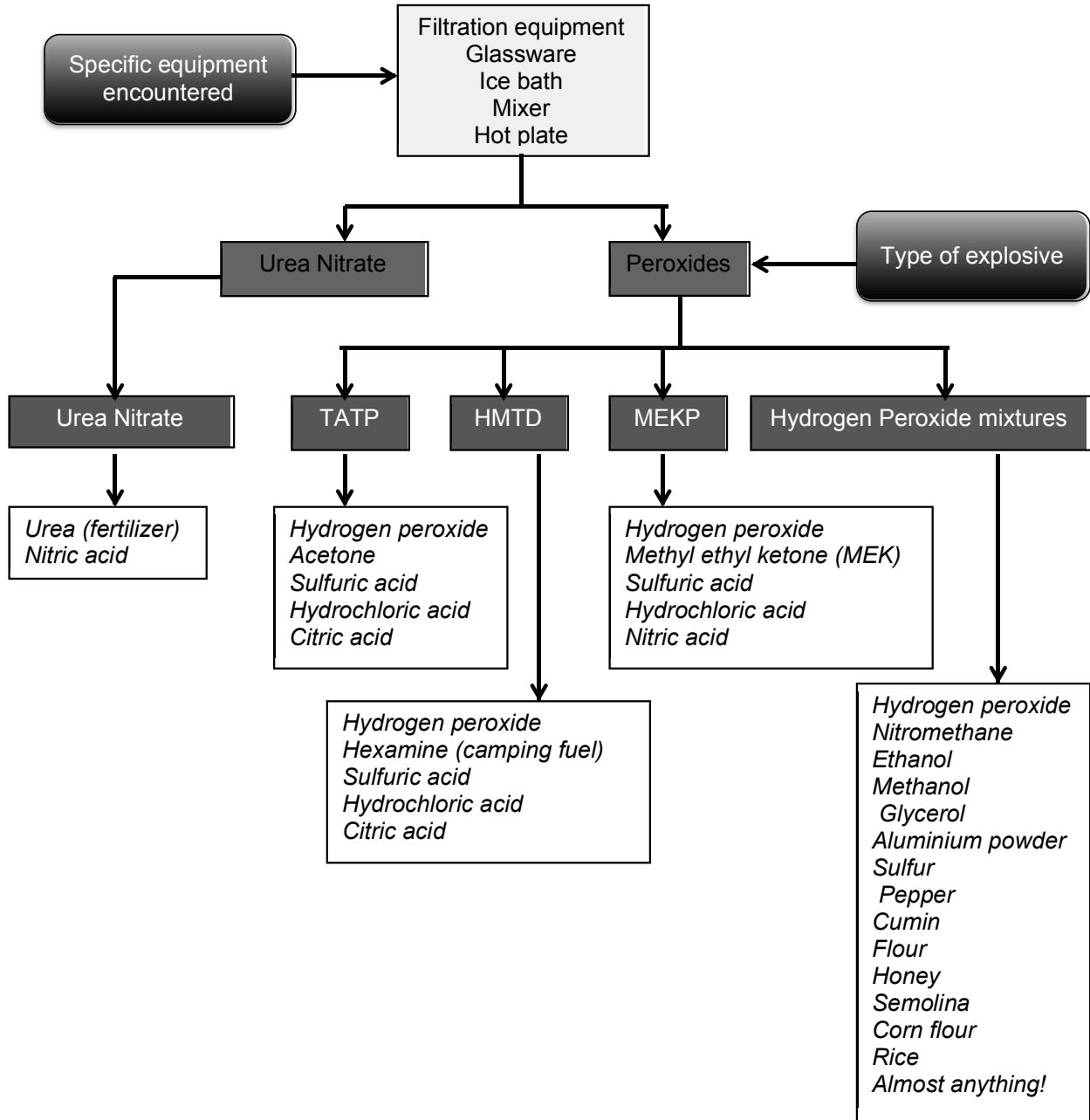
- evacuation plan of the immediate area.
- scene preservation including restriction of access to the scene, creation of different zones within the scene etc.
- health and safety including the chemical and explosive hazards present.
- identification of the home made explosive manufacturing process involved where possible.
- safe shut down of any chemical processes in operation.
- prioritisation of the scene examination in order to maximize the recovery of relevant evidence for both the fire scene investigation and the investigation of the preparation of the home made explosive material(s).



**FLOW CHART D1 : MATERIALS COMMONLY USED FOR THE SYNTHESIS OF  
HOMEMADE EXPLOSIVES**



**FLOW CHART D2 : MATERIALS COMMONLY USED FOR THE SYNTHESIS OF HOMEMADE EXPLOSIVES**







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