

Unit 36: Forensic Fire Investigation

Unit code:	F/502/5581
QCF Level 3:	BTEC National
Credit value:	10
Guided learning hours:	60

● Aim and purpose

The aim of this unit is to enable the learner to develop an understanding of the chemistry of combustion, and the stages and disciplines involved in reconstructing and documenting events to determine the causes of fire.

● Unit introduction

Fire investigation is a specialist branch of forensic science. The analysis of a fire scene not only requires the investigator to determine the origin of the fire but also the cause and how the fire developed. It is one of the more challenging areas of forensic science due to the multi-disciplinary nature of the investigator's job. Fire investigators need to understand the science behind the behaviour of fire but, since fires can be caused by, or involve, everyday items, they also need to understand many other disciplines, such as construction, electricity, gas and even human behaviour. Fire investigators must also recognise their limitations and, when needed, call on experts to assist.

This unit explores the ways in which investigators can examine the charred remains of a fire and trace back, through the damage, to the point of origin, uncovering the evidence of what caused the incident and reconstructing events.

An understanding of the chemistry of combustion and extinction is essential for any fire investigator. In this unit learners will study how materials can ignite, burn, and be extinguished and the probable route of a fire spreading through a building. Learners will also study the relationship between building construction and design, and fire spread and prevention.

Fire investigators do not work alone. Learners will also have the opportunity examine the relationship of the fire investigator with different agencies and will build an understanding of how they work together to extinguish a fire, treat casualties, make the site safe, and preserve and examine the evidence.

The investigator's role doesn't end with the successful determination of the cause of a fire as they can be called to court as expert witnesses. Learners will be expected to document their investigation and produce reports suitable for presentation in a court of law.

● Learning outcomes

On completion of this unit a learner should:

- 1 Know the chemistry of combustion and extinction
- 2 Know how safety aspects of building construction and design relate to fire prevention
- 3 Be able to investigate a fire scene
- 4 Know the role played by other agencies.

Unit content

1 Know the chemistry of combustion and extinction

Sources of ignition: primary and secondary sources

Combustion: fire tetrahedron; flame; pyrolysis; heat of combustion; flash point; fire point; auto-ignition temperature; limits of flammability; heat release rate (HRR); toxic fumes; glowing and smouldering combustion; self heating; self ignition; fuel controlled combustion; ventilation controlled combustion

Extinction: smothering, starving, cooling; types of extinguisher

Heat transfer: conduction; convection; radiation

2 Know how safety aspects of building construction and design relate to fire prevention

Aspects of construction and design: types of structure, eg fire doors, fire walls, venting, compartments; occupancy; fire loading and calculating fire loading; fire safety systems, eg smoke and heat alarms, sprinkler systems; building regulations (Approved Document B Fire safety – Volume 1 Dwellings; Approved Document B – Volume 2 Buildings other than dwellings)

3 Be able to investigate a fire scene

Fire scene: scientific method approach; safety; preservation; observation; recording findings (contemporaneous notes); plan drawing; photographs; excavation; collection, packaging and preservation of samples; reconstruction; compartment and non compartment fires

Fire behaviour: patterns ('U', 'V', truncated and inverted cones, hour glass); method of generation and spread (point of origin, plumes, ventilation, hot gas layer, flame over, flashover, full room involvement/post flashover); suppression; location of patterns

Witness evidence: eye-witnesses, eg occupiers, fire crews, neighbours, passers-by; interviews; transcripts of interviews; transcripts of messages/phone calls to emergency services

Documentation: fire reports, eg Incident recording system (IRS), FDR1, FDR2; fire safety documents, eg fire safety risk assessment; diagrams, eg floor plans, room and contents, contents reconstruction, damage patterns, eg explode view to include ceiling, floor and walls, and isochar patterns; presentation in court

4 Understand the role played by other agencies

Other agencies: police; scene of crime officer; specialist dog units; forensic scientist; pathologist; gas adviser; electricity adviser; insurance loss adjuster; Health and Safety Executive; solicitor

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P1 describe the chemistry of combustion and extinction	M1 investigate the chemistry of combustion and extinction	D1 assess the major causal factors involved in fire and its spread
P2 outline safety aspects of building design and construction related to fire prevention [IE 1, 2]	M2 explain safety aspects of building design and construction	D2 evaluate the safety aspects of a given building design in relation to building regulations
P3 carry out an investigation on a simulated fire scene using appropriate techniques [TW 1, 2, 3]	M3 explain how evidence from a fire investigation is collected and used	D3 evaluate the evidence from a simulated fire investigation, drawing scientifically derived conclusions
P4 describe the roles of agencies that could be involved in a fire investigation. [IE 1, 2]	M4 explain the roles and interactions of the agencies involved in a fire investigation.	D4 evaluate the operation and liaison of the agencies involved in a fire investigation.

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers	RL – reflective learners TW – team workers	SM – self-managers EP – effective participators

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. These include practicals, lectures, discussion, seminars, site visits, guest speakers, internet research and use of library resources. The aim should be to stimulate and educate the learners so they will be in a position to understand the main concepts in fire investigation and the roles played by different agencies at a fire scene.

Health and safety issues relating to laboratory work in the centre must be emphasised and the health and safety issues encountered at a fire scene discussed. Risk assessments, the application of COSHH and other regulations that apply to laboratories must be adhered to.

Learning outcome 1 covers sources of ignition and the chemistry of combustion and extinction. This learning outcome should involve formal lectures, input from specialist speakers and learner research, accompanied by experimental work carried out in the laboratory. It is important that both primary and secondary sources are covered.

Learning outcome 2 covers aspects of building construction and design and how they relate to fire prevention and investigation. This should mainly involve formal lectures and learner research.

Learning outcome 3 covers how a fire is investigated and learners are required to prepare a formal report of the investigation. The general principles of fire behaviour should be discussed along with the ways in which an investigator can collect information at a fire scene, the different forms of evidence that can be found and how this evidence may be used in the investigation process. Documentation of fire scenes, the collection, packaging and preservation of evidence, the chain of continuity and report writing must also be explained. This should mainly involve formal lectures and learner research. Learners should conduct a simulated fire investigation and produce a report based on their findings. Learners may find it difficult to attend the scene of a real fire due to health and safety issues, which is why a simulated approach should be used. Local fire departments and investigators could be approached to obtain resources such as copies of photographs and/or videos for this investigation. Input from specialist speakers would also be useful. Small-scale recreations using doll's house furniture can be helpful.

Learning outcome 4 covers the role that other agencies play in a fire investigation. This should mainly involve formal lectures and learner research. Case studies and specialist speakers would be particularly useful.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction to <i>Unit content</i> and structure of assignments.
Sources of ignition: Series of lectures followed by practical investigation of ignition.
Chemistry of combustion and extinction: Series of lectures followed by practical investigation of combustion of various materials and methods of extinction.
Heat transfer: Series of lectures, practical investigation of heat transfer.
Assignment 1 – Chemistry of Combustion and Extinction (P1, M1, D1)
Report on the chemistry of combustion and extinction.
Aspects of construction and design: Series of lectures, guest speakers from the trade if possible, practical examination of the design features of the school/college.
Building regulations: Learner-centred research.
Assignment 2 – Safety First (P2, M2, D2)
Presentation on safety aspects of building design and construction.
Fire scene: Series of lectures, guest speakers from the fire brigade if possible, practical activities to include recording the scene; photographs, plan drawing and notes and also evidence collection, packaging and analysis.
Fire behaviour: Series of lectures on method of generation and spread. Practical investigation of plumes (open and confined).
Fire patterns: Series of lectures, guest speakers from the fire brigade if possible, learners to identify patterns from images.
Witnesses: Lectures, transcription activities, role-play activities.
Documentation: Completion of fire reports and fire safety risk assessments, construction of annotated exploded view diagrams of scene. Role play: expert witness.
Assignment 3 – Fire Investigation (P3, M3, D3)
Carrying out a simulated fire investigation and producing a report to include a plan drawing of the building.
Agencies involved in fire investigation: Analysis of case studies, learners to identify agencies involved in the process.
Assignment 4 – Role of Other Agencies (P4, M4, D4)
Case study.
Review of unit and programme of assignments.

Assessment

All the pass grade criteria must be met in order for a learner to achieve this unit.

For P1, learners must describe the chemistry of combustion and extinction. They should make reference to the components of the fire tetrahedron and sources of ignition. For M1, learners must investigate the chemistry of combustion and extinction by performing experiments in the laboratory. For D1, learners need knowledge of the chemistry of combustion and extinction to assess how fire spreads and the best way to prevent fires. In doing so learners must demonstrate thorough knowledge and understanding of the chemistry of combustion and fire engineering terminology.

For P2, learners must outline the safety aspects of building design and construction that relate to fire prevention and/or investigation. For M2, learners must explain how the aspects of building design and construction outlined for P2 impinge on safety.

The purpose of fire safety design in a building is to allow people to escape before being overcome by the effects of fire. Fire safety can be achieved by using fire engineering which is based on the principles of fire science, human behaviour and risk management. Fire safety design features include emergency exits, systems for detecting fires, alarms to warn people of fire, sprinkler systems to extinguish fires, materials used in the construction of a building to slow fire growth, and construction to limit fire spread from one area to another. A number of issues must be considered when incorporating fire safety design in a building, including fire ignition growth and spread, the location of people in the building and their state, how people will become aware of a fire and what they might do, how quickly people can get out, how a fire might develop, how smoke will be generated and could spread, how the smoke and fire might affect people and how the building materials will respond to a fire. For D2, learners must evaluate safety aspects of a given building design and construction in relation to building regulations.

For P3, learners must conduct a simulated fire investigation, ensuring that information is gathered in a systematic way, paying attention to all relevant details. A detailed scene examination would include descriptions of the ceilings, walls, floors, doors, windows and staircases within a building as well as a thorough description of the exterior of the building. Smoke, fire, heat patterns and other post-fire indicators should be described along with any identified points of origin and ignition sources (smouldering/flame). Sketches and plans should include a key with directional information, measurements and scales. Positions of doors, windows, fixtures, appliances, furniture and all relevant items should be recorded. For M3, learners must consider the types of evidence that may be collected from a fire scene. They must explain how the evidence is collected and its use and purpose in ascertaining the cause and spread of the fire. For D3, learners must evaluate the evidence collected from a simulated fire scene, and describe how it could be used as part of the investigation.

For P4, learners must discuss the various agencies involved in a fire investigation. For M4, learners must explain the role of each agency and the part they play in investigating fire.

The role of the fire service is to fight fires and to protect people and property from fires. A fire investigation usually involves investigators from a number of other agencies who all have specific roles including determination of the origin and cause of the fire, collection of evidence for a criminal investigation, assessment of the effectiveness of fire safety measures and estimation of loss. A team approach is essential and the legitimate interests of each agency need to be considered. For D4, learners must evaluate the role of each agency and the potential value of their contributions to the success of a fire investigation.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, M1, D1	Chemistry of Combustion and Extinction	As a trainee fire investigator you need knowledge of the chemistry of combustion and extinction to assess how fire spreads and the best way to prevent fires. Report on your investigation.	Report.
P2, M2, D2	Safety First	As a fire investigator you have been asked to present details to a team of architects on fire safety features that need to be considered when building/refurbishing educational premises.	Presentation.
P3, M3, D3	Fire Investigation	As a fire investigator you are required to carry out an investigation of a simulated fire and produce a report.	Report.
P4, M4, D4	Role of Other Agencies	Working within the fire service you have been asked to produce a portfolio for training purposes on the roles of other agencies that the fire investigator will liaise with during an investigation.	Portfolio.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Applied Science sector suite. This unit has particular links with the units shown below in the BTEC Applied science suite of qualifications:

Level 3
Forensic Evidence Collection and Analysis
Forensic Photography
Criminal Investigation Practice

Essential resources

Learners need access to simulated fire scenes, a forensic science laboratory, a learning resource centre equipped with fire investigation books, periodicals, journals, ICT equipment, scanners, printers, CD ROMs, and other associated software.

Employer engagement and vocational contexts

Centres should develop links with local fire stations. Centres that deliver public service courses normally already have these links and may even employ fire service personnel as specialist speakers.

Gardiner Associates and Forensic Pathways both provide interagency fire investigation training to police and fire authorities.

Indicative reading for learners

Textbooks

Almirall J R and Furton K G – *Analysis of Arson Evidence (Forensic Science Techniques)* (CRC Press, 2004) ISBN 9780849378850

DeHaan J D – *Kirk's Fire Investigation, 6th Edition* (Prentice Hall, 2006) ISBN 9780131719224

DeHaan J D and Icove D J – *Forensic Fire Scene Reconstruction, 2nd Edition* (Prentice Hall, 2008) ISBN 9780132228572

Faith N – *Blaze: The Forensics of Fire* (St Martin's Press, 2000) ISBN 9780312261283

Noon R K – *Forensic Engineering Investigation* (CRC Press, 2000) ISBN 9780849309113

Quintiere J G – *Principles of Fire Behaviour* (Delmar, 1997) ISBN 9780827377325

Redsicker D R – *Practical Fire and Arson Investigation* (CRC Press, 2007) ISBN 9780849321337

Websites

www.arson-codes.com	Corporate Investigative Services provides fire analysis consultation services
www.communities.gov.uk	Communities and Local Government for a copy of an FDR1 form
www.fidogs.co.uk	The Association of Fire Investigation Dog Handlers
www.firesafe.org.uk	Fire Safety Advice Centre
www.fireservicecollege.ac.uk	The Fire Service College
www.fmglobal.com	FM Global is an insurance company: Pocket Guide to Arson and Fire Investigation
www.gardinerassociates.com	Gardiner Associates is a provider of interagency fire investigation training to police and fire authorities
www.ife.org.uk	Institution of Fire Engineers
www.interfire.org	Provides resources for fire services, fire insurers, law enforcement etc
www.nfpa.org	National Fire Protection Association
www.thefpa.co.uk	The Fire Protection Association is the UK's national fire safety organisation

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	[IE1,2] researching fire safety regulations for building construction and design; researching other agencies involved in fire investigation
Team workers	[TW1,2,3] investigating simulated fire scene.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	[IE2,3] researching chemistry of combustion
Creative thinkers	[CT1,2] designing leaflet for sources of ignition
Effective participators	[EP2,3,4,5] giving a presentation on fire safety features that need to be considered when building/refurbishing educational premises.

● Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	<p>researching fire safety regulations for building construction and design</p> <p>producing a presentation, using appropriate software, on fire safety regulations for building construction and design</p> <p>producing scale drawing for fire investigation report</p> <p>researching other agencies involved in fire investigation</p>
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	creating and finding illustrative materials for a leaflet and adapting them for use
ICT – Develop, present and communicate information	
<p>Enter, develop and format information independently to suit its meaning and purpose including:</p> <ul style="list-style-type: none"> • text and tables • images • numbers • records 	<p>producing a leaflet/poster on sources of ignition</p> <p>producing a presentation, using appropriate software, on fire safety regulations for building construction and design</p> <p>producing scale drawing for fire investigation report</p> <p>producing a portfolio of roles of other agencies involved in fire investigation</p>
Bring together information to suit content and purpose	
Present information in ways that are fit for purpose and audience	
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	delivering a presentation on fire safety regulations for building construction and design
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching fire safety regulations for building construction and design
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	<p>writing report on investigation of chemistry of combustion and extinction</p> <p>writing portfolio on roles of other agencies involved in fire investigation.</p>