IFE Level 4 Certificate in Fire Science and Fire Safety (HL)

Unit 6: Fire Investigation

Unit Reference Number: T/505/5936

Introduction

This unit focuses on the specialist understanding and knowledge required by those who carry out fire and explosion investigations whether they work within the uniformed fire and rescue service or within the private sector. It covers the scientific principles that underpin the dynamics of fire as well as the process of investigation.

Learning Outcomes

Candidates who achieve this unit should be able to:

- apply fire science principles in carrying out fire investigations and arriving at conclusions
- explain the preparations and procedures to investigate an incident involving fire and/or explosion
- explain and apply the principles that underpin the collation and analysis of evidence
- analyse information to produce conclusions based on evidence and fire science

Unit Status

Optional

Content

1. Chemistry of Combustion and Fire Dynamics

Assessment Objective	Knowledge, Understanding and Skills
1.1 Explain the physical processes involved in a fire	• Heat, temperature and the states of matter • Heat transfer • Flame height • Upper layer temperature • Radiative feedback
1.2 Explain the characteristics of different types of fire and their impact on investigation	• Characteristics of a flaming fire • Characteristics of a smouldering fire • 'Flashover' and its impact on the investigation of a compartment fire
1.3 Understand the chemistry of fire	Definition of the following terms: • Stoichiometric mixture

	• Flammability limits • Flash point and fire point • Radiation induced flashover • Flames • Smouldering combustion • Spontaneous combustion • Spontaneous ignition temperature • Auto-ignition temperature
1.4 Describe the properties of common flammable materials and assess the implications in relation to fire	Flammable materials to include: • Methane, propane and butane • Acetylene • Hydrogen • Petroleum products • Paraffin • White spirit • Diesel oil • Ethanol (alcohol), methylated spirit, methanol (methyl alcohol) and isopropanol (2-propanol) • Plastic and chemicals that are used in plastic manufacturing industries • Rubbers (natural and synthetic) • Carbohydrates • Cellulose • Proteins • Fats • Wood
1.5 Assess, applying fire science, the factors that affect accuracy in determining the location of a seat of fire	Factors to include: • Size of fire • Flashover • Smouldering • Firefighting procedures • Fuel load • Backdraught • Collapse • Burn patterns • Human or animal interaction
1.6 Understand the physical signs that can illustrate the general locality of a seat of fire and relate those signs to fire dynamics (radiation, convection, conduction and heat plume)	• Low level burning • High level burning • Depth or severity of burning • Smoke spread • Patterning (heat/burn/smoke) • Glass fracture, melting, discolouration or staining • Heat effect on metals • Melting and degradation of plastics • Burning effects of timber

2. Ignition

Assessment Objective	Knowledge, Understanding and Skills

2.1 Explain the process of ignition and the way that the properties of materials involved affect ignition, incubation and fire growth	• Combustion processes:
	  ○ Spontaneous heating
	  ○ Spontaneous ignition
	  ○ Spontaneous combustion
	• Combustion of solids, liquids, gases, transient dust and vapour phases
	• How and why substances/fuels burn

2.2 Explain how static electricity can become a source of ignition	• Ways in which heat can be achieved in a circuit • Electrical causes of fire and the *effects* of fire in electrical equipment

2.3 Explain the types of explosions that may occur and the materials that can be involved in explosions	• Types of Explosion:
	  ○ Detonation
	  ○ Deflagration
	  ○ Mechanical
	• High Explosives
	• 'Condensed Phase Deflagration'
	• 'Dispersed explosion'
	• 'Pyrotechnics'
	• 'Ventilation induced flashover'
	• Importance of preservation of evidence of an explosion and the procedure for searching for the remains of a high explosive device

3. Investigating Fire Scenes

Note to candidates: fire scenes include buildings, transportation contexts and wildland

Assessment Objective	Knowledge, Understanding and Skills

3.1 Understand the effect that structures and voids have on a fire	• Structures to include:
	  ○ Buildings
	  ○ Road, rail, aviation and maritime transportation
	• Effects of ventilation
	• Effects of modern methods of construction on fires in moving vehicles

3.2 Assess the effects that the contents of a building/structure have on a fire	• Contents to include:
	  ○ Traditional furniture
	  ○ Modern furniture and furnishings
	  ○ Floor and wall coverings
	  ○ Transport loads
	• Concept of fire load density and orientation

3.3 Assess the effects that occupancy can have on a building/structure involved in fire	• Buildings/structures to include: ○ Houses and other domestic residences

	○ Factories ○ Chemical works ○ Hospitals and residential homes ○ Schools ○ Transportation • Human behaviour in fires
3.4 Outline the effects of firefighting on structure/contents involved in fire and assess the implications for fire investigation	• Water damage e.g. causing collapse • Movement or destruction of items by firefighting water • Dilution of liquids • Hotspots and areas of late extinguishment
3.5 Explain and assess the organisational aspects of fire investigation	• Scene priorities • Range of resources to be used and their application • Potential and actual contamination of a scene • Evidence preservation • Possible hazards which may pose a risk to the fire investigator at a fire scene including: ○ Collapse ○ Sharps ○ Trips and falls ○ Chemicals ○ Respiratory risks ○ Lone working • Dynamic Risk Assessment (DRA)
3.6 Describe and assess the aids, including their limitations, that are available to the fire investigator to detect hydrocarbons	• Human nose • Dog • Portable equipment • Specialist sampling equipment
3.7 Explain and assess the indirect methods of locating the seat of fire	Indirect methods including: • Observations of witnesses • Corroboration of witnesses • Reversal of fire fighting • Points of entry and exit • Position of bodies • Structural collapse • Knowledge of materials present
3.8 Explain and evaluate the methods used to carry out the investigation	• Reconstruction • Fact finding and testing • Excavation including: ○ Extraneous items and materials ○ Fire accelerants (liquid and dry) ○ Liquid burn patterns ○ Significant items and materials • Study of pre-fire events ○ History ○ Odours ○ Changes ○ Weather

	○ Disputes • Explain and apply the term “radius of error”

4. Collect, Record and Analyse Information and Evidence

Assessment Objective	Knowledge, Understanding and Skills
4.1 Explain the type of information that is required to develop a full and comprehensive report	• Cause and origin • Fire spread • Background • Findings • Conclusion • Recommendations
4.2 Outline the ways and methods used to collect information and assess the advantages and disadvantages of each method	• Observation • Research • Interview • Witnesses • IT examination (including CCTV, AFD and mobile phone data) • Use of private agents • Use of forensic accountants
4.3 Identify evidence at the scene of a fire and analyse its significance	• How glass can provide evidence to assist in the investigation of a fire • How smoke records can provide evidence to assist in the investigation of fire • How evidence can be gained from instrument marks, footwear impressions and tyre marks • Indicators which may suggest the presence of an ignitable liquid at a fire scene and what resources may be available to the investigator to confirm this • Potential ignition sources
4.4 Explain the use of trace evidence found at fire scenes including directional evidence	• Radiation effect • Blast • Travel via voids
4.5 Describe the recording of information relating to the positions of movable objects and fire seat location	• Drawings • Notes • Photographs • Witness marks • Reconstruction
4.6 Explain the process of effective interviewing of a witness and assess the evidence provided by different types of witness	• Define the terms “lay witness” and “expert witness” • Formal/informal approaches • Legal caution • Putting witnesses at ease • PEACE model
4.7 Describe the specific factors to be considered by the investigator when	• Photo Log – no deletions (accepted protocols if available)

taking photographs at a fire scene to ensure clear and readable images which may be presented as evidence in a court of law	• Accurate date/time • Personal photographic ability • Zoom in/out for location of points of interest • Logical sequence of images • No finger pointing • Use tape measure or standard template square
4.8 Identify where fires may be due to arson and present evidence	• Explain the reasons for suspecting arson as a cause of fire from the general circumstances • Explain the reasons for suspecting arson at or after the investigation of the scene of fire • Discuss the types of persons who set fires and explain the classification of them into certain groups
4.9 Explain how to evaluate information to form and test hypotheses	• Compilation methods • How to interpret results • Identification of inconsistencies • How to qualify conclusions • How actual fire safety measures and practices, or lack of same, contributed to the incident
4.10 Assess the methods and equipment for handing and storing evidence to preserve continuity, avoid damage and cross contamination	• Importance of maintaining continuity records • Methods of provision for secure storage and transportation

5. Fatal Fires

Assessment Objective	**Knowledge, Understanding and Skills**
5.1 Explain the fundamental features of an investigation when a person dies as a result of fire	• Evidence that needs to be collected to establish the location of death and when and how the deceased died • Factors which would lead an investigator to recognise a death in fire as a murder or suicide
5.2 Explain the factors to be considered when dealing with fatalities	• Ways in which the deceased may be identified • Points to consider when removing bodies at fire scenes • Effect of fire on bodies and factors affecting damage • Basic medical terminology that may be encountered during an investigation and subsequent post mortem • Recovery of evidence and liaison with appropriate personnel • How to avoid causing unnecessary stress and treating deceased with due regard

6. Testing

Assessment Objective	Knowledge, Understanding and Skills
6.1 Explain the taking and examination of fire debris samples	• The chain of continuity for law • Avoidance of contamination
6.2 Explain the principles of laboratory analysis of material and samples collected at the scene of fire	• Incendiary devices • Containers • Clocks and watches • Hair and clothing • Paint • Other articles and evidence that may be found at a fire scene • Fuels and fire accelerants – hydrocarbons • Fuels and fire accelerants – non-hydrocarbons • Toxic combustion products