IFE Level 3 Award in Fire Engineering Science

Qualification Specification

Qualification Number: 610/5534/7

About the Institution of Fire Engineers (IFE)

The IFE is the professional institution for those working in the fire sector.

The IFE is a registered charity working for societal benefit. Founded in 1918, the IFE's mission is to promote, encourage and improve the science, practice and professionalism of fire engineering with the overall aim of protecting and saving lives. Members of the IFE share a commitment to ensuring that the fire profession remains relevant and valued, protecting people, property and the environment from fire.

The IFE Awarding Organisation
The IFE's awarding organisation is non-profitmaking.

The aim of the of the awarding organisation is to encourage those who work in the sector to engage with, and develop, the critical understanding needed to operate effectively and safely and to best professional standards so that they can protect and save lives. In doing this, the awarding organisation contributes to three of the IFE's (six) over-arching strategic priorities i.e.:

- *Facilitate awareness of fire issues and developments through the communication of ideas, knowledge and information.*
- *Foster professionalism by establishing and maintaining pathways and recognised standards of fire professionalism and competency.*
- *Increase knowledge in the science, practice and professionalism of fire engineering.*

All of the IFE's qualifications are designed for those working in the fire sector and to meet the above priorities. Qualifications and their associated assessments (examinations and practical activities/assignments) provided by the IFE are designed, assessed and quality assured by experts with extensive experience of working within the fire sector.

Contact Details
Email: exams@ife.org.uk

IFE House, 64-66 Cygnet Court, Timothy's Bridge Road, Stratford-upon-Avon, CV37 9NW

Tel: +44 (0)1789 261463, Option 2.

IFE Level 3 Award in Fire Engineering Science

Introduction
The IFE Level 3 Award in Fire Engineering Science has been developed by the Institution of Fire Engineers (IFE), representatives of Fire and Rescue Services and other fire professionals. The content and structure of the qualification has been established to reflect best professional practice.

Aims of the Qualification
This qualification has been designed to enable individuals to demonstrate a wide range of critical knowledge and understanding relevant to fire science, managing fire/rescue situations and determining measures for protection against fire.

Target Audience
The qualification will meet the needs of:

- those employed in fire and rescue service roles across the world, particularly those who are either already in Crew Manager roles or those who wish to develop and demonstrate knowledge and understanding relevant to the role of Crew Manager in preparation for promotion to this role;
- those operating in specialist fire and rescue contexts, such as aviation or fire prevention/fire safety roles, who need to develop and apply a wide range of knowledge and understanding in their role;
- other fire professionals and those within related industries of the Built Environment who wish to demonstrate their knowledge and understanding of fire-related subjects;

Qualification Content
The content of the Award is set out in the information presented below. The relevant sections below provide information on the range of topics that must be studied to achieve the Award including the way in which candidates need to show their understanding (Assessment Criteria) and the scope/range/contents in which they can be tested (Knowledge and Understanding).

Candidates are advised to prepare for each examination by covering all topics in the content so that they are able to provide comprehensive responses.

Assessment
The assessment takes the form of a 120-minute examination. The examination is closed book and provides a summative assessment of the full range of learning specified in the unit content. There are 100 marks available in the examination.

Examinations are provided in English only.

Examinations are designed to ensure that all sections of the content are tested in each examination and to provide candidates with the opportunity to demonstrate their knowledge and understanding across the content specified in the unit.

Certification

Achievement

In order to achieve the Award, candidates must obtain at least 70 marks out of the available 100 in the relevant examination.

Achievement is not graded. Successful candidates are issued an Award which recognises that candidates have passed the examination.

Certificate Achievement

In order to achieve the IFE Level 3 Certificate in Fire Science, Operations, Fire Safety and Management, candidates must achieve a Pass in all four mandatory Award examinations. The qualification certificate is not graded. Successful candidates will be awarded a Pass Certificate.

Candidates do not need to achieve a Pass in all four awards at the same examination session.

Candidates must achieve all four awards within five years to achieve the Level 3 Certificate. The five-year period starts from 1 January of the year in which they take and pass their first examination. Candidates who take examinations in March 2023 and October 2023 will be able to combine these with passes from examinations that they sat in 2022, 2021, 2020 and 2019.

The IFE will automatically issue a full Level 3 Certificate in Fire Science, Operations, Fire Safety and Management certificate at the point where candidates have achieved passes in all four of the unit required.

Candidates may re-sit unit examinations as often as necessary in order to achieve a Pass.

Entry Requirements

There are no formal entry requirements. As the examination is provided in English only, candidates will need to have a comprehensive understanding of the English language in order to access the examination questions

Candidates are advised that mathematical skills will be required in order to complete the IFE Level 3 Award in Fire Engineering Science examination.

Qualification Level

This qualification has been designed to enable candidates to demonstrate that they have attained knowledge and understanding at Level 3.

Other types of qualifications that are set at Level 3 include A level, AS level, international Baccalaureate diploma, level 3 diploma, and level 3 NVQ.

The qualifications regulator, Ofqual, has provided the following descriptors to illustrate the knowledge and understanding expected from those who hold qualifications at Level 3.

Level 3 Knowledge descriptor

The holder (of the qualification):

- has factual, procedural and theoretical knowledge and understanding of a subject or field of work to complete tasks and address problems that while well-defined, may be complex and non-routine.
- can interpret and evaluate relevant information and ideas.
- is aware of the nature of the area of study or work.
- is aware of different perspectives or approaches within the area of study or work

Candidates are advised to bear these descriptors in mind in preparing for examinations and when presenting responses during examinations.

Progression

Candidates who are successful in achieving the IFE Level 3 Award in Fire Engineering Science, can progress to the remaining awards to achieve the full IFE Level 3 Certificate in Fire Science, Operations, Fire Safety and Management. They will then have developed knowledge and understanding that will prepare them to undertake further study.

Qualification Learning Time

The length of time needed to complete this qualification will vary depending upon the starting point (i.e., previous knowledge and experience) for each individual.

Research suggests that most candidates should spend around 60 hours preparing for each Award although some candidates may wish to allocate a higher proportion of their preparation time to one or more Awards depending on their pre-existing knowledge.

Total qualification time for this Award is 62 hours comprising:

- 60 hours of learning e.g., self-study/course training. Study may be self-study (please see the section on recommended reading below) and may include relevant employer training programmes.
- 2 hours of assessment.

Most candidates prepare for IFE examinations via self-study or by drawing on training provided by their employer that covers aspects of the syllabus. Candidates are advised to cross-map their study/training against the content of the unit to ensure that all parts of the unit have been covered. Recommended reading materials are listed below.

Recommended Reading

Candidates should be aware that this reading list is advisory rather than definitive.

Candidates should use the content of the units as their guide in deciding what reading materials they need to help them prepare for the examination – please see Content section below. The IFE recommends that all candidates should read widely in order to extend the depth and breadth of their knowledge and understanding.

Candidates preparing for the examinations are advised to refer to the list below:

- Elementary Fire Engineering Handbook (IFE 50),Version issued 2017, available via IFE online shop or Google Books.
- IFE Resources https://ife.org.uk/Home/Events-and-resources/Articles

Candidates may also refer to the sample examination and examiner reports (short answer questions sections) on previous examinations which are available on the IFE's website - Past papers and exam reports (ife.org.uk).

Award 1: Fire Engineering Science

Introduction
This Award provides candidates with the opportunity to develop and demonstrate their understanding of fire engineering science. The content has been designed to reflect the technical knowledge that fire professionals need in order to understand the behaviour of fire including the chemistry of fire and the science that underpins firefighting techniques and protecting against fire.

Learning Outcomes
Candidates who achieve this Award should be able to:

- carry out mathematical calculations accurately
- understand and apply the chemistry of fire
- understand and apply the principles of hydraulics
- understand and apply the principles of electricity

Content

1. Mathematics

Assessment Criteria	Knowledge and Understanding
1.1 Demonstrate an understanding of mathematical terms and solve problems	• The four processes - addition, subtraction, multiplication and division in respect of fractions, decimals, percentages, ratios, proportions and statistics • Transposition of formulae
1.2 Demonstrate an understanding of basic geometry	• Two dimensional shapes - square, rectangle, quadrilateral, parallelogram, rhombus, trapezium, triangle, circle • Three dimensional objects - cube, cuboid, pyramid, prism, cylinder, cone, sphere
1.3 Undertake calculations in respect of geometrical shapes and objects	• Area and perimeter of a regular and irregular shapes • Volume and capacity of rectangular and circular tanks • Volume and capacity of hose and pipeline
1.4 Understand elementary trigonometry and undertake calculations	• Pythagoras' theorem • The terms - opposite, adjacent, hypotenuse • Angles, including right, acute, obtuse, straight, reflex

2. Mechanics

Assessment Criteria	Knowledge and Understanding
2.1 Define and describe the physical properties of matter and apply understanding in carrying out calculations and comparisons	• Physical state of matter – solid, liquid, gas, plasma • Mass • Density • Relative density (specific gravity) • Vapour density • Liquids of different density • Gases of different density • Melting, boiling and evaporation • Solubility and miscibility • Viscosity • Conductivity • Hardness
2.2 Understand mechanical terms and applications and apply understanding in carrying out calculations	• Newton's Laws of Motion • Motion, including gravity, speed, velocity and acceleration • Momentum and Force, including Torque • Energy • Work, Power and Mechanical Energy, including Potential Energy and Kinetic Energy • Friction and stopping distances • Simple machines e.g., lever and pulley systems • Mechanical Advantage, Velocity Ratio and Efficiency

3. Heat and Temperature

Assessment Criteria	Knowledge and Understanding
3.1 Define and explain basic terms and their relationships	• Heat • Temperature • Relationship between heat and temperature

3.2 Demonstrate an understanding of how temperature is measured	• Methods of measuring temperature including:
	  ○ Liquid thermometers
	  ○ The air or gas thermometer
	  ○ Using solids to measure temperature
	  ○ Thermocouples
	  ○ Electrical resistance
	  ○ Thermistors
	  ○ Comparison by brightness
	  ○ Infra red
	• Thermometric scales:
	  ○ The Celsius or Centigrade scale
	  ○ The Fahrenheit scale
	  ○ The Kelvin or Absolute scale

3.3 Define the units of heat	• Joule • Calorie

3.4 Define and explain the terms used in the context of heat transfer	• Specific heat • Change of state • Latent heat • Latent heat of vaporisation • The effect of change of pressure on the boiling point and latent heat • Latent heat of fusion • Cooling by evaporation
3.5 Describe and explain processes of heat transmission	• Conduction • Convection • Radiation

3.6 Describe and explain the principles of thermal expansion	• Solids
	  ○ The coefficient of linear expansion
	  ○ Nickel-iron alloy (Invar)
	  ○ Expansion in metal structures
	  ○ Thermostats
	  ○ The coefficient of superficial and cubical expansion of solids
	• Liquids
	  ○ Cubical expansion
	  ○ The effect of expansion on density
	• Gases (Liquefaction)
	  ○ Critical temperature and pressure
	  ○ Liquefied gases in cylinders
	• Sublimation

3.7 Define the Gas Laws and undertake calculations involving them	• Boyle's Law • Charles's Law • Law of Pressures • The General Gas Law

4. Hydraulics

Assessment Criteria	**Knowledge and Understanding**
4.1 Describe the properties of water and explain its reaction to pressure and energy.	• Properties of water • Principal characteristics of pressure • Relationship between pressure and head for water • Loss of pressure due to friction • Energy changes in water streams • Water power and efficiency • Jet reaction • Water hammer • Undertake calculations involving water power, efficiency and jet reaction
4.2 Describe the effect of atmospheric pressure on suction lift and the practical limitations and potential problems that can occur on the fireground	• Atmospheric pressure • Suction lift

4.3 Describe how water flows through hose, pipelines and nozzles and undertake the relevant calculations	• The conditions required to enable water to flow in hose or pipelines • Quantity of water flowing • Velocity of water • Discharge through nozzles

5. Chemistry

Assessment Criteria	**Knowledge and Understanding**
5.1 Define and use basic chemical terms and explain structures and reactions in different contexts.	• Atom (protons, neutrons and electrons) • Molecules • Elements • Compounds • Mixture • Radicals • Atomic mass • Molecular mass • Valency • Reactivity • Metal • Non-metal • Organic chemistry
5.2 Explain the structure and composition of simple chemical formulae and equations	• Use symbols to write formulae • Interpret formulae

5.3 Describe and explain the chemistry of combustion	• The components of the fire tetrahedron
	• Exothermic reactions
	• Types of flames and practical examples:
	  ○ Premixed
	  ○ Diffusion
	• Laminar and turbulent flow
	• Flash point
	• Fire point
	• Flammable limit range
	• Stages of fire development
	• Ignition:
	  ○ Spontaneous ignition temperature/auto ignition temperature (AIT)
	  ○ Self-heating and spontaneous combustion
	• Difference between flaming and smouldering combustion
	• Toxic products of combustion
	• Classes of fire:
	  ○ Ordinary combustibles - paper, plastic, wood, fabric, etc.
	  ○ Flammable liquids - fuel, oil, kerosene

	○ Electrical equipment/Fires involving energised electrical equipment ○ Flammable metals - magnesium, aluminium, etc. Cooking related e.g., grease, lard, etc.
5.4 Explain and apply the principles of chemistry to the extinction of fire	• Starvation • Smothering • Cooling
5.5 Explain the chemistry and applications of the primary fire extinguishing media and methods	• Water • Foam • Vaporising liquids • Carbon dioxide and inert gases • Dry chemical powders • Blanketing • Beating out

6. Electricity

Assessment Criteria	**Knowledge and Understanding**
6.1 Define and use electrical terms, symbols and units and undertake calculations involving them	• Amperes • Volts (Electromotive Force - EMF) • Ohms • Joule • Watts • Power
6.2 Define, understand and use Ohm's Law	• Principles of Ohm's Law • Ohm's Law calculations
6.3 Describe the types of electrical supply and current flow in a circuit	• Direct Current (dc) and Alternating Current (ac) • Simple circuitry ○ Series ○ Parallel • Resistance in a circuit
6.4 Describe the purpose of electrical transformers	• Step up • Step down
6.5 Explain the nature and dangers of static electricity	• Causes of static electricity • Attraction and repulsion • Examples of dangerous conditions
6.6 Explain the purpose and significance of conductors and insulators	• Good and poor conductors • Insulators for different purposes • Types of insulating materials

6.7 Explain the purpose and operation of protective devices to electrical circuits.	• Short circuits • Earthing devices • Fuses • Circuit Breakers ○ Miniature Circuit Breakers (MCB) • Residual Current Circuit Breakers (RCCB)
6.8 Identify potentially dangerous electrical loading conditions and explain the measures that can be taken to prevent them.	• Electrical causes of fire ○ Prevention of electrical causes of fire