



Department
for Education

Construction: Building Services Engineering

**T Level outline content: final version for
consultation**

October 2018

Contents

Introduction	3
Outline content for T Levels:	
Construction core content	7
Occupational specialist content:	15
- Electrotechnical Engineering	
- Protection Systems Engineering	
- Ventilation	
- Gas Engineering	
- Plumbing	
- Heating Engineering	
- Air Conditioning Engineering	
- Refrigeration Engineering	
Integrating Maths, English & Digital skills	117

Introduction

T Levels are new, two-year, technical study programmes, designed with employers to give young people the skills that industry needs. T Levels will provide a mixture of:

- technical knowledge and skills specific to their chosen industry or occupation
- an industry placement of at least 45 days in their chosen industry or occupation
- relevant maths, English and digital skills.

T Levels will become one of three major options for students to study at level 3, alongside apprenticeships for those who wish to study and train for a specific occupation 'on the job', and A levels for students who wish to continue academic education.

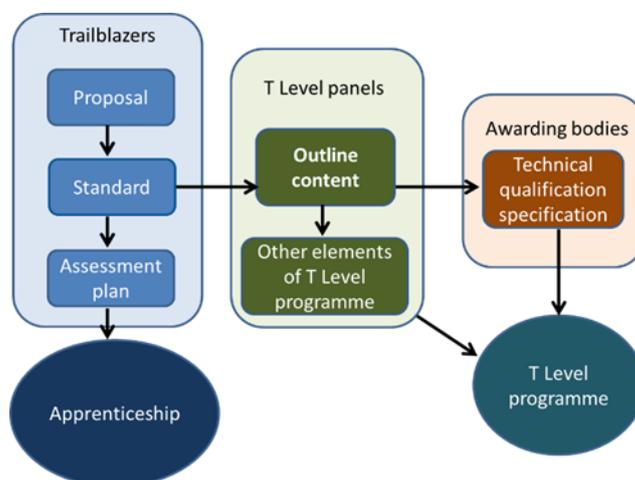
When they complete a T Level study programme, students will be able to choose between moving into a skilled occupation or further study, for example, a higher or degree level apprenticeship, or higher level technical study, including higher education.

Technical education has been categorised into fifteen different technical routes, according to occupational specialism. T Levels will be available across eleven of those routes, with occupations in the remaining four routes accessible through an apprenticeship only. Most routes have been split into a number of pathways; the T Level will broadly sit at pathway level. The occupations within scope for each T Level are set out in the Institute for Apprenticeships' occupational maps.

Outline content

This outline content has been produced by [T Level panels](#) of employers, professional bodies and providers, and is based on the same standards as those used for apprenticeships. The outline content will form the basis of the specifications for T Level Technical Qualifications, which will be developed by awarding organisations for approval by the Institute for Apprenticeships. One awarding organisation will be appointed to develop and deliver each Technical Qualification following a procurement process.

The diagram below demonstrates how the same standard created by employer-led Trailblazer groups is used for both apprenticeships, and as the basis for this outline content. It also shows that this outline content will be used by awarding organisations to develop the full Technical Qualification (TQ) specification.

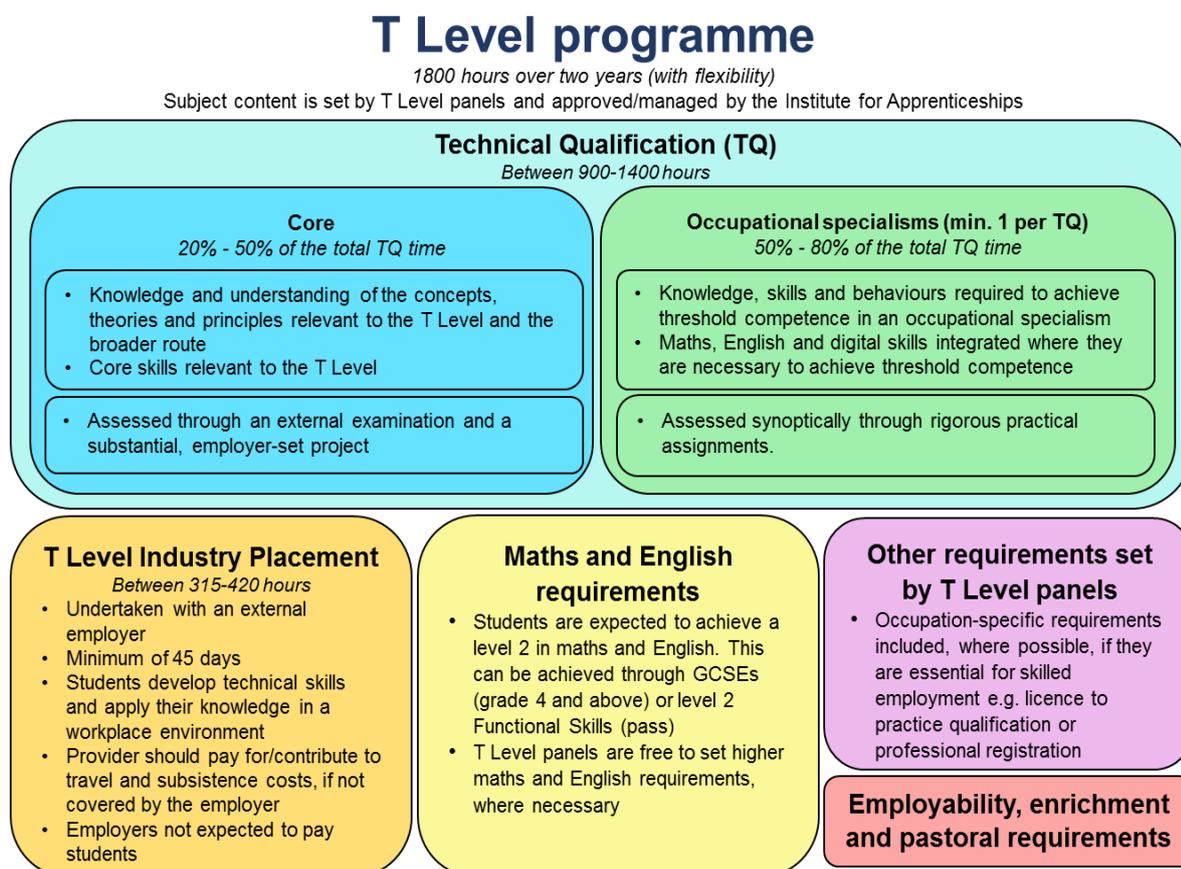


Colleges and other education and training providers will decide how to structure the T Level courses they offer, based on the qualification specifications. This will enable them to deliver the study programme's mandatory components in the most effective way for students.

T Level study programmes will include the following mandatory elements:

- a 'core' set of underpinning knowledge, concepts and skills, tailored for their chosen industry and occupation: 'core content'
- specialist content covering occupational or industry-specific skills: 'occupational specialist content'
- an industry placement with an employer, which will last for a minimum of 45 working days.

The diagram below demonstrates the different elements of a T Level programme. This outline content relates solely to the Technical Qualification part of a T Level programme.



Purpose Statement

Qualification Purpose

The purpose of the level 3 Technical Qualification is to ensure students have the knowledge and skills needed to progress into skilled employment or higher level technical training relevant to the T Level.¹

To achieve this, each level 3 Technical Qualification must:

- provide reliable evidence of students' attainment in relation to:
 - the core knowledge and skills relevant to the route and occupational specialisms covered by the qualification
 - the knowledge and skills required for at least one occupational specialism relevant to the qualification.
- be up-to-date, providing the knowledge and skills needed for the occupations to have continued currency among employers and others.
- ensure that maths, English and digital skills are developed and applied where they are essential to achieve occupationally relevant outcomes.
- ensure that the minimum pass grade standard for occupational specialisms attests to threshold competence, meets employer expectations, and is as close to full occupational competence as possible.
- allow the accurate identification of students' level of attainment and the effective differentiation of their performance.
- provide a clear and coherent basis for development of suitably demanding high-quality level 3 courses, which enable students to realise their potential.
- provide students with the opportunity to manage and improve their own performance.
- support fair access to attainment for all students who take the qualification, including those with special educational needs and disabilities (SEND).

¹ The Institute for Apprenticeships may only approve the qualification "if satisfied that by obtaining the qualification a person demonstrates that he or she has attained as many of the outcomes set out in the standards as may reasonably be expected to be attained by undertaking a course of education" (Technical and Further Education Act 2017).

Technical Qualification Design

T Level programmes will differ in length to reflect the requirements of different occupations, but are expected to last 1800 hours over two years (on average).

To accommodate legitimate differences in content across T Levels, we propose that the total time for the Technical Qualification:

- will fall within a defined range of between 900 and 1400 hours
- is no less than 50% of the time for the T level programme as a whole and
- is no more than 75% of the total time for the programme as a whole.

Component	Content	Assessment	Grading	Planned Hours
Core Students complete one component which covers all the core content	Knowledge and understanding of contexts, concepts, theories and principles relevant to the T Level Ability to apply core knowledge and skills, through a project, to meet employer-set requirements	Assessed through an externally set test and an employer-set project	Six point scale plus ungraded (U) A* – E and U	Between 20% and 50% of the qualification time
Occupational specialisms Students must complete at least one, or more depending on the minimum requirements specific to the qualification	The knowledge and skills needed to achieve threshold competence	Synoptic assessment of performance outcomes, to determine whether a student meets the minimum requirements for threshold competence	Three point scale plus ungraded (U) Distinction, Merit, Pass and Ungraded	Between 50% and 80% of qualification time

Construction: Building Services Engineering

Awarding organisations will need to ensure that students have an up-to-date knowledge of the legal and regulatory obligations relating to employment in the occupations relevant to the T Level, and understand the practical implication of these on their work.

Maths, English and Digital skills are set out in the final section of this document. Awarding organisations should integrate these within the qualification so that they are applied in occupationally relevant contexts. Other core skills and behaviours important for employability are already integrated within the content and must be clearly specified in the qualification specification.

Core content

The core content relates to the whole route, and the pathway that the Technical Qualification covers. This breadth of will help to ensure students are able to apply their skills in a variety of contexts and for a variety of different purposes. The content will vary depending on the requirements of the route and the pathway or occupations covered by the scope of the Technical Qualification.

The core knowledge and understanding is assessed through an examination and core skills through a practical employer-set project.

The core knowledge and understanding focuses on the students' knowledge and understanding of contexts, concepts, theories and principles relevant to the T Level. This could include, where appropriate, assessment of knowledge and understanding relevant to the route and the pathway.

The employer-set project provides the opportunity to develop and apply a minimum range of core skills important for employability. Awarding organisations can integrate knowledge in the employer-set project, to contextualise core skills.

The allocation of content to each type of assessment will need to be approved by the Institute for Apprenticeships.

Construction core knowledge and understanding

Element	Content
Health and safety	<ul style="list-style-type: none"> • Legislation, e.g. HASAWA, COSHH, Working at Height, Construction Design and Management regulations (CDM) including an overview of roles, responsibilities and enforcement. • Liability including public liability and employers liability. • Approved codes of practice, including Managing Health and Safety in Construction. • Implications of poor health and safety performance, including ethical, legal, environmental and financial. • Development of safe systems of work, including company management systems, risk assessments, method statements and permits to work. • Safety conscious behaviours, e.g. following safe systems of work, reporting potential hazards and implications of poor housekeeping.
Science	<p>Scientific principles, their applications, interaction between them to meet the purpose of the built environment and how their performance in the building is measured including,</p> <ul style="list-style-type: none"> • Materials science, including material properties, chemical composition, degradation, failure and effects of environmental conditions. • Mechanical science, including the relationship between force, work, energy and power. • Electricity, including sources of power, generation, transformation, distribution and the relationship between voltage, current, resistance, electrical power, energy, efficiency and work done. • Structural science, including forces, loads, materials, and structural members. • Heat, including heat transfer, air temperature, air density humidity, condensation air movement, heat loss, thermal conductivity and resistance.

	<ul style="list-style-type: none"> • Light, including refraction, difference in artificial and natural light, glare, directed and reflected light, flow of light energy and daylight factor. • Acoustics, including frequencies, reverberation, decibels, comfort levels and privacy. • Earth science, including physical geography, hydrology, geology, earth forces, natural phenomenon (e.g. earthquakes) and weather.
Design	<ul style="list-style-type: none"> • Benefits of good design including within budget, of good design to product performance e.g on budget, over specified, difficult to assemble/build. • Design principles, e.g. buildability and integration of services. • Role of different disciplines (e.g. contractor, architect) involved in design. • Design process from conception to completion. Human factors, e.g. inclusivity, heat, acoustics, lighting and air quality. • Understanding of the whole building, including life cycle assessment.
Construction & the built environment industry	<ul style="list-style-type: none"> • Structure of the construction industry. • How the construction industry serves the economy as a whole. • Integration of the supply chain through partnering and collaborative practices. • How projects are procured within the construction sector e.g. tenders and supply chain. • Roles and responsibilities of the construction professions e.g. surveyor, carpenter, heating engineer. • The role of CPD in developing the knowledge and skills of those working in the sector and those that may provide it eg through professional bodies, accreditation, certification bodies. • Building information modelling, including Digital Plan of Works (DPoW), Employer's Information

	<p>Requirements (EIR), Common Data Environment (CDE), information exchange and the effect on project delivery.</p> <ul style="list-style-type: none"> • How current examples of PESTLE factors may impact the industry. e.g. post Grenfell, tax changes for self-employed, augmented reality.
Sustainability	<ul style="list-style-type: none"> • Importance of sustainability when planning and delivering a construction project e.g. environmental protection. • Types of sustainable solutions, e.g. social, environmental, economic and human. • Obligations under environmental legislation, e.g. Clean Air Act and Water Act. • Environmental policies and initiatives and how they impact on design and construction. • Environmental performance measures e.g. water use, radioactive waste. • Principles of heritage and conservation, e.g. listed buildings, traditional buildings and maintenance of existing stock. • Lean construction including reduce, repurpose and recycle. • Waste management including types of materials that require specific actions (e.g. asbestos) and the measures in place by construction organisations. • Energy production and energy use (including embodied energy).
Measurement	<ul style="list-style-type: none"> • The benefits of accurate and appropriate measurement on built environment performance e.g. accurate reporting. • Types of measurement, including standard units of measurement and mensuration techniques. • Measurement standards, guidance and practice including measurement rules.
Building Technology	<ul style="list-style-type: none"> • Construction methods, including traditional and modern methods, e.g. on and off-site construction and robotics.

	<ul style="list-style-type: none"> • Forms of construction, built environment and civil engineering structures, sub-structures, superstructures, foundations and external works. • Building regulations and their purpose in construction including renovation. • Building standards and their purpose in renovation and construction including ISO, British and industry. • Manufacturers' instructions and their purpose in renovation and construction. • Internet of things, e.g. data capture in a completed building, utilising data for manufacture and delivery and machine to machine learning.
Information and data	<ul style="list-style-type: none"> • Key elements of data, including accuracy, generalisation, interoperability, level of detail and metadata. • Purpose of information standards, regulation, and guidance and practice. • Sources of information, e.g. product data and manufacturer's specifications. • Data management and confidentiality, including data protection legislation and typical organisational procedures.
Relationship Management	<ul style="list-style-type: none"> • Types of stakeholders, e.g. client, team and end user. • Roles, expectations and interrelationships of different stakeholders throughout the construction project delivery e.g. at design stage, through construction, to handover and in use. • The importance of a collaborative approach to project delivery and reporting, and how this is applied in practice. • Customer service principles, e.g. product knowledge, time and communication. • The importance of team work to team and project performance. • Team dynamics, including what is expected of a team member, what qualities are needed and how these qualities are demonstrated.

	<ul style="list-style-type: none"> • Equality, diversity and representation including related legislation. • Negotiation techniques e.g. win-win. • Conflict management techniques e.g. mediation. • Methods (e.g. verbal, non-verbal) and styles (e.g. formal, informal) of communication and suitability for different situations that may arise throughout a construction project. • Employment rights and responsibilities of the employer and employee e.g. health and safety. • Ethics and ethical behaviour e.g. honesty, fairness. • How sources of information, including social networking contribute to knowledge sharing.
Digital Technology	<ul style="list-style-type: none"> • Internet of things, e.g. crowd sourcing digital data to assist just in time asset management, information interdependencies. • Digital engineering techniques e.g. simulation, animation. • Opportunities for the use of technology used in other industries and contexts and adapting for use in construction and the built environment.
Commercial/Business	<ul style="list-style-type: none"> • Business structures, e.g. community interest companies and SMEs. • Business objectives, e.g. financial and social. • Business values, e.g. care for life, ethical and transparent, commit to customer and better together. • Principles and examples of corporate social responsibility, e.g. community design, local recruitment. • Principles of entrepreneurship and innovation e.g. vision, research, finance. • How businesses measure success, e.g. benchmarking, KPIs and target setting. • Principles of project management e.g. clear goals and objectives, defined roles, milestones.

- | | |
|--|---|
| | <ul style="list-style-type: none">• Quality management and techniques used in business. |
|--|---|

Employer-set project

The employer-set project ensures students have the opportunity to combine core knowledge and skills to develop a substantial piece of work in response to an employer-set brief.

To ensure consistency in project scope and demand, awarding organisations will develop assessment objectives which require students to:

- plan their approach to meeting the brief
- apply core knowledge and skills as appropriate
- select relevant techniques and resources to meet the brief
- use maths, English and digital skills as appropriate
- realise a project outcome and review how well the outcome meets the brief.

The awarding organisation will work with a relevant employer or employers to devise a set brief that:

- ensures a motivating starting point for students' projects, for example, a real-world problem to solve
- ensures students can generate evidence that covers the assessment objectives
- is manageable for providers to deliver
- is officially approved by the awarding organisation and employer.

For building services engineering in achieving the assessment objectives and meeting the brief students must demonstrate the following core skills:

- communication, e.g. providing information and advice to customers and / or wider stakeholders on the potential risks of a change to an industrial system, or making a presentation to a stakeholder on the implications of change
- work with others, e.g. to develop content to bid for a construction project
- applying a logical approach to solving problems, identifying issues and proposing solutions, e.g. through setting criteria for successful implementation of a system, using cost / benefit analysis of the introduction of new procedures or equipment
- primary research, e.g. obtaining measurements related to a design and / or customer requirements.

Occupational Specialist Content

Specialist content is structured into different occupational specialisms, which correspond to the apprenticeship standards listed on the occupational map covered by the T Level. Occupational specialisms ensure students develop the knowledge, skills and behaviours necessary to achieve 'threshold competence' in the occupational specialism.

Achievement of threshold competence signals that a student is well-placed to develop full occupational competence, with further support and development, once in work (including an apprenticeship). The knowledge and skills listed are required to achieve one or more 'performance outcomes'. These indicate what the student will be able to do as a result of learning and applying the specified knowledge and skills.

In essence, each performance outcome describes, at a high level, what the student 'can do' to have achieved threshold competence in an occupational specialism.

Core skills and behaviours are specified in occupational specialism(s) only where they are essential to achieving the given performance outcome. Although the behaviours maybe assessed implicitly through application of skills, they must be clearly specified in the qualification specification to support effective application of those skills.

Occupational Specialist Content

Occupational Specialism: Electrotechnical engineering

Performance Outcome 1: Install electrotechnical systems

Knowledge Specific to Performance Outcome	Skills
<p>Installation</p> <ul style="list-style-type: none"> • How to install cable installation and wiring system supports. • How to Terminate cables, e.g. armoured cable glands, coax, control wiring and data cabling. • Ways to terminate and connect conductors, e.g. screwed, crimped and push fit connections. <p>Health and safety</p> <ul style="list-style-type: none"> • Safe working practices specific to electrical work, e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. • How to inspect the work environment to ensure it is safe including sensory inspection. <p>Tools and equipment</p> <ul style="list-style-type: none"> • Tools and equipment used for installation (e.g. general hand tools and specific tools for termination of cables etc) and their purpose. • Importance of maintenance and maintenance techniques, including storage. • Operation and handling requirements, e.g. how to use a screwdriver correctly etc. <p>Electrical Installations</p>	<ul style="list-style-type: none"> • Assess risk associated with tasks e.g. is any specialist equipment needed etc. • Identify information required to complete tasks, including manufacturers installations instructions. • Collect and collate information e.g. drawings and plans etc. • Review information to ensure its accuracy and validity, including suitability of equipment being installed. • Select tools, equipment and materials to complete task e.g. cable type, hand tools etc. • Inspect the suitability of resources for use, including tools, materials and equipment. • Mark out the position of electrical equipment e.g. accessories location. • Analyse situations to identify potential causes for delays and errors e.g. the work site not being ready, incorrect drawings, insufficient materials etc. • Use tools and equipment to carry out tasks e.g. to connect equipment, to install wiring and containment systems etc. • Handle materials e.g. metal and plastic containment systems and cable types etc. • Connect electrical equipment to the installed wiring systems e.g. luminaires, accessories etc. • Install cable containment systems e.g. conduit, trunking, basket and tray etc.

- Fundamental Principles of BS7671 e.g. Part 1 etc.
- Special Locations listed in BS7671 e.g. locations containing a bath or shower etc.
- Special Installations listed in BS7671 e.g. Electric Vehicle Charging Installations etc.
- How to select and install wiring systems, e.g. armoured, insulated and sheathed cable types etc.
- Earthing arrangements e.g. TN systems and TT Systems etc.
- How to identify the electrical supply, including AC, DC, single and poly-phase circuits up to 1000V AC and 1500V DC.
- Protection for safety e.g. protection against electric shock, thermal effects, overcurrent etc.
- How to erect an electrical installation e.g. selection and erection of equipment etc.
- Building Regulations specific to electrical work, e.g. Part P – Electrical Safety in England and Wales etc.
- Cable types and sizes, accessories and equipment used in older electrical installations.

Information and data

- Drawings, conventions, symbols and terminology needed to aid interpretation.
- Types of documentation produced and their purpose.

- Install cabling e.g. single core cables, armoured cables, insulated and sheathed flat cables etc.
- Terminate cables e.g. armoured, insulated and sheathed flat cables etc.
- Connect conductors e.g. terminate into relevant terminals using appropriate tools etc.
- Update digital building information management system software.

Performance Outcome 2: Commission electrotechnical systems

Knowledge Specific to Performance Outcome	Skills
<p>Commissioning</p> <ul style="list-style-type: none"> • How to undertake inspections for initial verification of electrotechnical systems. • How to undertake testing for electrotechnical systems e.g. continuity of conductors, insulation resistance, polarity, earth fault loop impedance etc. • How to adjust equipment as required by installation standards to ensure correct function e.g. adjust settings of sensors where required etc. <p>Health and safety</p> <ul style="list-style-type: none"> • Safe working practices specific to electrical work, e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. • How to inspect the work environment to ensure it is safe including sensory inspection. <p>Tools and equipment</p> <ul style="list-style-type: none"> • Tools and equipment used for installation (e.g. general hand tools and specific tools for termination of cables etc) and their purpose. • Importance of maintenance and maintenance techniques, including storage. • Operation and handling requirements, e.g. how to use a screwdriver correctly etc. <p>Electrical Installations</p> <ul style="list-style-type: none"> • Fundamental Principles of BS7671 e.g. Part 1 etc. 	<ul style="list-style-type: none"> • Inspect electrotechnical systems e.g. visual inspection etc. • Test electrotechnical systems e.g. continuity of conductors, insulation resistance, polarity, earth fault loop impedance. • Analyse and interpret information and data e.g. from testing electrotechnical systems etc. • Complete commissioning documentation e.g. Electrical Installation Certificate etc.

- Special Locations listed in BS7671 e.g. locations containing a bath or shower etc.
- Special Installations listed in BS7671 e.g. Electric Vehicle Charging Installations etc.
- How to select and install wiring systems, e.g. armoured, insulated and sheathed cable types etc.
- Earthing arrangements e.g. TN systems and TT Systems etc.
- How to identify the electrical supply, including AC, DC, single and poly-phase circuits up to 1000V AC and 1500V DC.
- Protection for safety e.g. protection against electric shock, thermal effects, overcurrent etc.
- How to erect an electrical installation e.g. selection and erection of equipment etc.
- Building Regulations specific to electrical work, e.g. Part P – Electrical Safety in England and Wales etc.
- Cable types and sizes, accessories and equipment used in older electrical installations.

Information and data

- Drawings, conventions, symbols and terminology needed to aid interpretation.
- Types of documentation produced and their purpose.

Performance Outcome 3: Maintain electrotechnical systems

Knowledge Specific to Performance Outcome	Skills
<p>Principles of maintenance</p> <ul style="list-style-type: none"> Planned maintenance, e.g. servicing schedules of equipment. Reactive maintenance, e.g. equipment breakdown such as a faulty switch. Fault finding techniques, e.g. testing and questioning. Different requirements for each building types, e.g. hospitals, chemical plants, paint stores. <p>Health and safety</p> <ul style="list-style-type: none"> Safe working practices specific to electrical work, e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. How to inspect the work environment to ensure it is safe including sensory inspection. <p>Tools and equipment</p> <ul style="list-style-type: none"> Tools and equipment used for installation (e.g. general hand tools and specific tools for termination of cables etc) and their purpose. Importance of maintenance and maintenance techniques, including storage. Operation and handling requirements, e.g. how to use a screwdriver correctly etc. <p>Electrical Installations</p> <ul style="list-style-type: none"> Fundamental Principles of BS7671 e.g. Part 1 etc. Special Locations listed in BS7671 e.g. locations containing a bath or shower etc. 	<ul style="list-style-type: none"> Communicate orally health and safety risks to stakeholders e.g. explain unsafe situations and the risks associated with them etc. Sequence activities required to complete task including planning to isolate electrical supplies and informing relevant people. Allocate time and resources to complete the task including materials required for the task. Collect system data e.g. data from any integrated monitoring systems etc. Record system data e.g. on work records or equipment maintenance sheets etc. Analyse data from work activity e.g. system generated diagnostic reports. Provide technical advice and guidance (e.g. safety advice, energy efficiency etc.) to technical and non-technical stakeholders. Test electrical equipment to ensure it is safe to work on e.g. stored charge etc. Analyse information to identify potential faults e.g. feedback from system users etc. Think creatively to propose solutions for installation faults, e.g. insulation resistance readings deteriorating over time, contingency plans for equipment that is no longer manufactured etc. Replace components of electro-technical systems, e.g. lamps and tubes, broken accessories etc.

- Special Installations listed in BS7671 e.g. Electric Vehicle Charging Installations etc.
- How to select and install wiring systems, e.g. armoured, insulated and sheathed cable types etc.
- Earthing arrangements e.g. TN systems and TT Systems etc.
- How to identify the electrical supply, including AC, DC, single and poly-phase circuits up to 1000V AC and 1500V DC.
- Protection for safety e.g. protection against electric shock, thermal effects, overcurrent etc.
- How to erect an electrical installation e.g. selection and erection of equipment etc.
- Building Regulations specific to electrical work, e.g. Part P – Electrical Safety in England and Wales etc.
- Cable types and sizes, accessories and equipment used in older electrical installations.

Information and data

- Drawings, conventions, symbols and terminology needed to aid interpretation.
- Types of documentation produced and their purpose.

Performance Outcome 4: Decommission electrotechnical systems

Knowledge Specific to Performance Outcome	Skills
<p>Decommission</p> <ul style="list-style-type: none"> • How to make systems safe to decommission. • How to identify potential issues before decommissioning a system. <p>Health and safety</p> <ul style="list-style-type: none"> • Safe working practices specific to electrical work, e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. • How to inspect the work environment to ensure it is safe including sensory inspection. <p>Tools and equipment</p> <ul style="list-style-type: none"> • Tools and equipment used for installation (e.g. general hand tools and specific tools for termination of cables etc) and their purpose. • Importance of maintenance and maintenance techniques, including storage. • Operation and handling requirements, e.g. how to use a screwdriver correctly etc. <p>Electrical Installations</p> <ul style="list-style-type: none"> • Fundamental Principles of BS7671 e.g. Part 1 etc. • Special Locations listed in BS7671 e.g. locations containing a bath or shower etc. • Special Installations listed in BS7671 e.g. Electric Vehicle Charging Installations etc. • How to select and install wiring systems, e.g. armoured, insulated and sheathed cable types etc. 	<ul style="list-style-type: none"> • Make systems safe to work on including safe isolation and discharging stored charge. • Communicate with relevant stakeholders to ensure required information is available to undertake the task using electronic communication. • Remove electrotechnical systems, e.g. remove redundant wiring systems and equipment etc.

- Earthing arrangements e.g. TN systems and TT Systems etc.
- How to identify the electrical supply, including AC, DC, single and poly-phase circuits up to 1000V AC and 1500V DC.
- Protection for safety e.g. protection against electric shock, thermal effects, overcurrent etc.
- How to erect an electrical installation e.g. selection and erection of equipment etc.
- Building Regulations specific to electrical work, e.g. Part P – Electrical Safety in England and Wales etc.
- Cable types and sizes, accessories and equipment used in older electrical installations.

Information and data

- Drawings, conventions, symbols and terminology needed to aid interpretation.
- Types of documentation produced and their purpose.

Occupational Specialism: Protective Systems Engineering

Performance Outcome 1: Install Protection Systems

Knowledge Specific to Performance Outcome	Skills
<p>Installation of electrical and electronic systems and components</p> <ul style="list-style-type: none"> • How to install cable installation and wiring system supports • How to terminate cables, e.g. armoured cable glands, coax, control wiring and data cabling etc. • Ways to terminate and connect conductors, e.g. screwed, crimped and push fit connections etc. <p>Health and safety</p> <ul style="list-style-type: none"> • Safe working practices specific to work on protection systems, e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. • How to inspect the work environment to ensure it is safe including sensory inspection. • Waste management requirements, including which materials may contain hazardous substances. <p>Tools and equipment</p> <ul style="list-style-type: none"> • Tools and equipment used when working with protection systems (e.g. general hand tools and specific tools for termination of cables), their purpose and suitability for different task etc. • How to ensure tools and equipment are fit for purpose e.g. calibration checks, cleanliness checks. • Importance of maintenance and maintenance techniques. 	<ul style="list-style-type: none"> • Assess risk associated with tasks e.g. is any specialist equipment needed etc. • Identify information required to complete tasks, including manufacturers installations instructions. • Collect and collate information e.g. drawings and plans etc. • Review information to ensure its accuracy and validity, including suitability of equipment being installed. • Select tools, equipment and materials to complete task e.g. cable type, hand tools etc. • Inspect the suitability of resources for use, including tools, materials and equipment. • Mark out the position of equipment e.g. detection and monitoring equipment location etc. • Analyse formal and informal information to identify potential causes for delays and errors e.g. the work site not being ready, incorrect drawings, insufficient materials etc. • Use tools and equipment to carry out tasks e.g. to connect equipment, to install wiring and containment systems etc. • Handle materials e.g. metal and plastic containment systems and cable types etc. • Connect equipment to the installed wiring systems e.g. call points, detectors etc. • Install cable containment systems e.g. conduit, trunking, basket and tray etc. • Install cabling e.g. armoured cables, insulated and sheathed flat cables etc.

- Operation and handling requirements, e.g. how to use a screwdriver correctly etc.

British Standards and Building Regulations

- The requirements of relevant BS in relation to protection systems, e.g. BS5839, BS5266, BS7671 etc.
- The requirements of the relevant Building Regulations and Standards.

Protection system types and purpose

- Fire Detection Systems fire and smoke patterns in and around buildings in relation to Fire Detection Systems.
- Security Systems, including access control and video surveillance.
- Emergency Lighting Systems.

Systems

- Characteristics, types and purpose of different types of components and their suitability for different types of protection systems including those operating at different voltage levels.
- How components operate within a system and integrate to enable the system to operate effectively including different types of wireless systems available.
- Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available.

Digital Knowledge

- Data storage and data security e.g. prevention of cyber-attacks, malware and Trojans etc.

- Terminate cables e.g. armoured, insulated, coax and data cables etc.
- Connect conductors e.g. terminate into relevant terminals using appropriate tools etc.

- Programming and set up of digital systems using various ICT resources e.g. computer, mobile technology etc.

Information and data

- Drawings, conventions, symbols and terminology needed to aid interpretation.
- Types of documentation produced and their purpose.

Performance Outcome 2: Commission Protection Systems

Knowledge Specific to Performance Outcome	Skills
<p>Commissioning</p> <ul style="list-style-type: none"> • How to undertake inspections for initial verification of protection systems e.g. visual inspection. • How to undertake testing for protection systems e.g. continuity of conductors and functional testing. <p>Health and safety</p> <ul style="list-style-type: none"> • Safe working practices specific to work on protection systems, e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. • How to inspect the work environment to ensure it is safe including sensory inspection. • Waste management requirements, including which materials may contain hazardous substances. <p>Tools and equipment</p> <ul style="list-style-type: none"> • Tools and equipment used when working with protection systems (e.g. general hand tools and specific tools for termination of cables), their purpose and suitability for different task etc. • How to ensure tools and equipment are fit for purpose e.g. calibration checks, cleanliness checks. • Importance of maintenance and maintenance techniques • Operation and handling requirements, e.g. how to use a screwdriver correctly etc. <p>British Standards and Building Regulations</p>	<ul style="list-style-type: none"> • Inspect protection systems e.g. visual inspection etc. • Test protection systems e.g. continuity of conductors, functional operation etc. • Analyse and interpret information and data from ICT applications e.g. computer, digital transmission over IP, email, mobile communication technology etc. • Complete the documentation for the task, e.g. Commissioning Certificate etc. • Use oral and non-verbal communication skills to demonstrate system operation. • Adjust protection systems equipment as required by installation standards e.g. adjust settings of sensors where required etc. • Update digital building information management system software.

- The requirements of relevant BS in relation to protection systems, e.g. BS5839, BS5266, BS7671 etc.
- The requirements of the relevant Building Regulations and Standards.

Protection system types and purpose

- Fire Detection Systems fire and smoke patterns in and around buildings in relation to Fire Detection Systems.
- Security Systems, including access control and video surveillance.
- Emergency Lighting Systems.

Systems

- Characteristics, types and purpose of different types of components and their suitability for different types of protection systems including those operating at different voltage levels.
- How components operate within a system and integrate to enable the system to operate effectively including different types of wireless systems available.
- Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available.

Digital Knowledge

- Data storage and data security e.g. prevention of cyber-attacks, malware and Trojans etc.
- Programming and set up of digital systems using various ICT resources e.g. computer, mobile technology etc.

Information and data

- | | |
|---|--|
| <ul style="list-style-type: none">• Drawings, conventions, symbols and terminology needed to aid interpretation.• Types of documentation produced and their purpose. | |
|---|--|

Performance Outcome 3: Maintain Protection Systems

Knowledge Specific to Performance Outcome	Skills
<p>Principles of maintenance</p> <ul style="list-style-type: none"> • Planned maintenance, e.g. servicing schedules of equipment • Reactive maintenance, e.g. equipment breakdown such as a faulty detector. • Fault finding techniques, e.g. testing and questioning • Different requirements for each building types, e.g. hospitals, chemical plants, paint stores. • Older systems and installations e.g. 230V fire systems, mechanical sounders, cable types no longer used but maybe still installed. <p>Health and safety</p> <ul style="list-style-type: none"> • Safe working practices specific to work on protection systems, e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. • How to inspect the work environment to ensure it is safe including sensory inspection. • Waste management requirements, including which materials may contain hazardous substances. <p>Tools and equipment</p> <ul style="list-style-type: none"> • Tools and equipment used when working with protection systems (e.g. general hand tools and specific tools for termination of cables), their purpose and suitability for different task etc. • How to ensure tools and equipment are fit for purpose e.g. calibration checks, cleanliness checks. 	<ul style="list-style-type: none"> • Communicate orally health and safety risks to stakeholders e.g. explain unsafe situations and the risks associated with them etc. • Sequence activities required to complete task including planning to isolate electrical supplies and informing relevant people where required. • Allocate time and resources to complete the task including materials required for the task. • Collect system data from ICT applications e.g. computer, digital transmission over IP, email, mobile communication technology etc. • Record system data e.g. on work records or equipment maintenance sheets etc. • Communicate written technical advice and guidance to technical and non-technical stakeholders e.g. safety advice, to stakeholders etc. • Test equipment to ensure it is safe to work on e.g. stored charge etc. • Analyse information to identify potential faults e.g. feedback from system users etc. • Think creatively to propose solutions for installation faults, e.g. insulation resistance readings deteriorating over time, contingency plans for equipment that is no longer manufactured etc. • Replace components of protection systems, e.g. sensors, detectors and monitoring equipment etc.

- Importance of maintenance and maintenance techniques.
- Operation and handling requirements, e.g. how to use a screwdriver correctly etc.

British Standards and Building Regulations

- The requirements of relevant BS in relation to protection systems, e.g. BS5839, BS5266, BS7671 etc.
- The requirements of the relevant Building Regulations and Standards.

Protection system types and purpose

- Fire Detection Systems fire and smoke patterns in and around buildings in relation to Fire Detection Systems.
- Security Systems, including access control and video surveillance.
- Emergency Lighting Systems.

Systems

- Characteristics, types and purpose of different types of components and their suitability for different types of protection systems including those operating at different voltage levels.
- How components operate within a system and integrate to enable the system to operate effectively including different types of wireless systems available.
- Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available.

Digital Knowledge

- Data storage and data security e.g. prevention of cyber-attacks, malware and Trojans etc.

- Programming and set up of digital systems using various ICT resources e.g. computer, mobile technology etc.

Information and data

- Drawings, conventions, symbols and terminology needed to aid interpretation.
- Types of documentation produced and their purpose.

Performance Outcome 4: Decommission Protection Systems

Knowledge Specific to Performance Outcome	Skills
<p>Decommission</p> <ul style="list-style-type: none"> • How to make systems safe to decommission. • How to identify potential issues before decommissioning a system. <p>Health and safety</p> <ul style="list-style-type: none"> • Safe working practices specific to work on protection systems, e.g. safe isolation and Personal Protective Equipment (PPE) required when undertaking electrical testing etc. • How to inspect the work environment to ensure it is safe including sensory inspection. • Waste management requirements, including which materials may contain hazardous substances. <p>Tools and equipment</p> <ul style="list-style-type: none"> • Tools and equipment used when working with protection systems (e.g. general hand tools and specific tools for termination of cables), their purpose and suitability for different task etc. • How to ensure tools and equipment are fit for purpose e.g. calibration checks, cleanliness checks. • Importance of maintenance and maintenance techniques • Operation and handling requirements, e.g. how to use a screwdriver correctly etc. <p>British Standards and Building Regulations</p> <ul style="list-style-type: none"> • The requirements of relevant BS in relation to protection systems, e.g. BS5839, BS5266, BS7671 etc. 	<ul style="list-style-type: none"> • Make systems safe to work on including safe isolation and discharging stored charge. • Communicate with stakeholders to ensure required information is available to undertake the task using electronic communication. • Remove protection systems, e.g. remove redundant equipment and wiring systems etc.

- The requirements of the relevant Building Regulations and Standards.

Protection system types and purpose

- Fire Detection Systems fire and smoke patterns in and around buildings in relation to Fire Detection Systems.
- Security Systems, including access control and video surveillance.
- Emergency Lighting Systems.

Systems

- Characteristics, types and purpose of different types of components and their suitability for different types of protection systems including those operating at different voltage levels.
- How components operate within a system and integrate to enable the system to operate effectively including different types of wireless systems available.
- Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available.

Digital Knowledge

- Data storage and data security e.g. prevention of cyber-attacks, malware and Trojans etc.
- Programming and set up of digital systems using various ICT resources e.g. computer, mobile technology etc.

Information and data

- Drawings, conventions, symbols and terminology needed to aid interpretation.
- Types of documentation produced and their purpose.

Occupational Specialism: Ventilation

Performance Outcome 1: Install ventilation systems

Knowledge Specific to Performance Outcome	Skills
<p>Health and safety</p> <ul style="list-style-type: none"> • Key requirements of legislation and Approved Codes of Practice (ACOPs) including Legionnaires Disease: The control of legionella bacteria in water systems, Control of Asbestos Regulations. • Implications of poor health and safety performance specific to ventilation engineering including Indoor Air Quality (IAQ), dust, contaminants, odours. • Typical hazards and safe systems of work specific to ventilation engineering e.g. Risk Assessment and Method Statement (RAMS) etc. • Safe isolation techniques. <p>Ventilation systems</p> <ul style="list-style-type: none"> • Types of systems (e.g. general supply and extract ventilation, kitchen extraction ventilation and Local Exhaust Ventilation etc.) their purposes, similarities and differences in operation. • Mechanical components (e.g. fans, anti-vibration mounts etc.), their characteristics, function within the system and implications to the system of component failure. • Electrotechnical components (e.g. inverters, actuators etc.) their characteristics, function within the system and implications to the system of component failure. • Types of control system Building Management System (BMS) or standalone), their purposes, components, similarities and differences. 	<ul style="list-style-type: none"> • Interpret a risk assessment e.g. apply controls where required etc. • Interpret information provided e.g. specification, drawing, local site considerations etc. • Calculate installation requirements e.g. positive and negative static pressure, air velocity, structural load bearing and support tolerances etc. • Measure ductwork requirements e.g. location of fixings, lengths etc. • Mark out required measurements eg on building fabric, on ductwork. • Prepare work areas for installation activities. • Position, fix, insert and secure ventilation ductwork (including ceiling, floor mounted, riser) to modular air handling system components. • Apply internal ventilation ductwork coatings and linings • Test for air leakages and make corrections. • Update digital building information management system software.

- The importance of system cleanliness and cleaning cleanliness standards and requirements and how to achieve these.

Tools, equipment and materials

- Tools and equipment (e.g. portable access equipment, drills, hand tools etc.) and their purpose.
- Importance of maintenance and maintenance techniques, including calibration requirements and storage.
- Operation and handling requirements, including protection of ductwork from fabrication location to site delivery address (Pre-Delivery and Installation (PDI) levels).

Ductwork science

- Types of ductwork and in-line system components and their suitability for different systems.
- Types of linings, coatings and identification labels and their suitability for different systems.
- Types of ductwork materials, their properties (e.g. fire ratings, thickness gauges etc.) and their suitability for different systems.
- Types of thermal insulation materials, their properties including relevant standards and their suitability for different systems.
- Types of support, fittings and fixings and their suitability for different systems.

Environmental

- Environmental technologies that could be utilised along with a new or existing installation including control systems, patterns of usage, effective use of materials, alternative products, improved designs.

Information and data

- The contents and importance of the Asbestos register and legionella control log book.
- Ventilation layout drawings, legends and scale measurements.
- Building regulations related to the type of building and ventilation system.
- Indoor air quality requirements for different situations
- Types of documentation produced, their content and purpose e.g. commissioning certificates, manufacturer's data sheets, asset lists etc.

Measurement

How to measure and record:

- Metric, rectangular and circular ductwork dimensions in millimetres.
- Velocity, flowrates, pressure, humidity, IAQ.

Performance Outcome 2: Commission ventilation systems

Knowledge Specific to Performance Outcome	Skills
<p>Commissioning</p> <ul style="list-style-type: none"> • Positive and negative pressure classification and system balancing. • Types of tests, their purpose and techniques to be applied including system balance and set to work, airflows, volume, pressure, BMS point to point and functional tests, post clean vacuum testing. <p>Health and safety</p> <ul style="list-style-type: none"> • Key requirements of legislation and Approved Codes of Practice (ACOPs) including Legionnaires Disease: The control of legionella bacteria in water systems, Control of Asbestos Regulations. • Implications of poor health and safety performance specific to ventilation engineering including Indoor Air Quality (IAQ), dust, contaminants, odours. • Typical hazards and safe systems of work specific to ventilation engineering e.g. Risk Assessment and Method Statement (RAMS) etc. • Safe isolation techniques. <p>Ventilation systems</p> <ul style="list-style-type: none"> • Types of systems (e.g. general supply and extract ventilation, kitchen extraction ventilation and Local Exhaust Ventilation etc.) their purposes, similarities and differences in operation. • Mechanical components (e.g. fans, anti-vibration mounts etc.), their characteristics, function within the system and implications to the system of component failure. 	<ul style="list-style-type: none"> • Produce a method statement including risk assessment (RAMS). • Assess suitability of information provided e.g. for sufficiency, accuracy etc. • Interpret collected data e.g. determine data parameters, whether system meets design parameters etc. • Test system including load testing, air leakage, particulate testing, system balancing. • Record test results. • Annotate system profile and layout drawings reflecting system adaptations. • Update building information systems. • Produce handover documentation e.g. asset list, air testing results, fan details etc.

- Electrotechnical components (e.g. inverters, actuators etc.) their characteristics, function within the system and implications to the system of component failure.
- Types of control system Building Management System (BMS) or standalone), their purposes, components, similarities and differences.
- The importance of system cleanliness and cleaning cleanliness standards and requirements and how to achieve these.

Tools, equipment and materials

- Tools and equipment (e.g. portable access equipment, drills, hand tools etc.) and their purpose.
- Importance of maintenance and maintenance techniques, including calibration requirements and storage.
- Operation and handling requirements, including protection of ductwork from fabrication location to site delivery address (Pre-Delivery and Installation (PDI) levels).

Ductwork science

- Types of ductwork and in-line system components and their suitability for different systems.
- Types of linings, coatings and identification labels and their suitability for different systems.
- Types of ductwork materials, their properties (e.g. fire ratings, thickness gauges etc.) and their suitability for different systems.
- Types of thermal insulation materials, their properties including relevant standards and their suitability for different systems.
- Types of support, fittings and fixings and their suitability for different systems.

Environmental

- Environmental technologies that could be utilised along with a new or existing installation including control systems, patterns of usage, effective use of materials, alternative products, improved designs.

Information and data

- The contents and importance of the Asbestos register and legionella control log book.
- Ventilation layout drawings, legends and scale measurements.
- Building regulations related to the type of building and ventilation system.
- Indoor air quality requirements for different situations
- Types of documentation produced, their content and purpose e.g. commissioning certificates, manufacturer's data sheets, asset lists etc.

Measurement

How to measure and record:

- Metric, rectangular and circular ductwork dimensions in millimetres.
- Velocity, flowrates, pressure, humidity, IAQ.

Performance Outcome 3: Maintain ventilation systems

Knowledge Specific to Performance Outcome	Skills
<p>Maintenance</p> <ul style="list-style-type: none"> • Purpose of maintenance activities and implications for failure to maintain assets. • Contents of a maintenance plan (e.g. materials and spares, time needed). • Types of maintenance (e.g. planned, total preventative (TPM), breakdown, reactive, condition-based) and their benefits and limitations. • Cutting techniques and how they are applied including resources needed. • Mechanical joining techniques and how they are applied including resources needed. • Assembly and disassembly techniques and how they are applied. • Fault finding techniques, how they are applied and suitability for different situations. • Regulations and procedures for waste management of decontaminated ductwork and associated components. <p>Health and safety</p> <ul style="list-style-type: none"> • Key requirements of legislation and Approved Codes of Practice (ACOPs) including Legionnaires Disease: The control of legionella bacteria in water systems, Control of Asbestos Regulations. • Implications of poor health and safety performance specific to ventilation engineering including Indoor Air Quality (IAQ), dust, contaminants, odours. 	<ul style="list-style-type: none"> • Sequence and prioritise tasks. • Identify information requirements e.g. from a maintenance plan etc. • Gather required information e.g. manufacturers' specifications, handover materials, site registers etc. • Calculate maintenance downtime. • Convert imperial measurements to metric. • Calculate resource and equipment requirements. • Discuss with client the effectiveness and efficient status of the installation using open questioning and listening. • Clean system including pre-clean and post clean testing • Handle materials to maintain their integrity and that of the system including the use of aggressive chemicals. • Identify root cause of faults. • Apply fault finding techniques to rectify system operation. • Measure ductwork dimensions e.g. for transformation section etc. • Cut ductwork e.g. using shears, portable electrical equipment such as nibblers etc. • Join ductwork using mechanical techniques. • Disassemble parts of a system. Reinstall components within a system.

- Typical hazards and safe systems of work specific to ventilation engineering e.g. Risk Assessment and Method Statement (RAMS) etc.
- Safe isolation techniques.

Ventilation systems

- Types of systems (e.g. general supply and extract ventilation, kitchen extraction ventilation and Local Exhaust Ventilation etc.) their purposes, similarities and differences in operation.
- Mechanical components (e.g. fans, anti-vibration mounts etc.), their characteristics, function within the system and implications to the system of component failure.
- Electrotechnical components (e.g. inverters, actuators etc.) their characteristics, function within the system and implications to the system of component failure.
- Types of control system Building Management System (BMS) or standalone), their purposes, components, similarities and differences.
- The importance of system cleanliness and cleaning cleanliness standards and requirements and how to achieve these.

Tools, equipment and materials

- Tools and equipment (e.g. portable access equipment, drills, hand tools etc.) and their purpose.
- Importance of maintenance and maintenance techniques, including calibration requirements and storage.
- Operation and handling requirements, including protection of ductwork from fabrication location to site delivery address (Pre-Delivery and Installation (PDI) levels).

Ductwork science

- Types of ductwork and in-line system components and their suitability for different systems.
- Types of linings, coatings and identification labels and their suitability for different systems.
- Types of ductwork materials, their properties (e.g. fire ratings, thickness gauges etc.) and their suitability for different systems.
- Types of thermal insulation materials, their properties including relevant standards and their suitability for different systems.
- Types of support, fittings and fixings and their suitability for different systems.

Environmental

- Environmental technologies that could be utilised along with a new or existing installation including control systems, patterns of usage, effective use of materials, alternative products, improved designs.

Information and data

- The contents and importance of the Asbestos register and legionella control log book.
- Ventilation layout drawings, legends and scale measurements.
- Building regulations related to the type of building and ventilation system.
- Indoor air quality requirements for different situations
- Types of documentation produced, their content and purpose e.g. commissioning certificates, manufacturer's data sheets, asset lists etc.

Measurement

How to measure and record:

- | | |
|--|--|
| <ul style="list-style-type: none">• Metric, rectangular and circular ductwork dimensions in millimetres.• Velocity, flowrates, pressure, humidity, IAQ. | |
|--|--|

Occupational Specialism: Gas engineering

Performance Outcome 1: Install gas systems

Knowledge Specific to Performance Outcome	Skills
<p>Installation</p> <ul style="list-style-type: none"> • Bending techniques e.g. machine, scissor, hand etc. • Connection techniques e.g. threading, soldering etc. • Potential impact of installation activities on customer essential services and how these can be minimised e.g. isolation of services, preparation of temporary services etc. <p>Health and safety</p> <ul style="list-style-type: none"> • Typical hazards and risks associated with working with gas systems including gas, asbestos, fire, dust, burns, lone working. • Safe working practices associated with working with gas systems including use of personal protective equipment (PPE). • Implications of health and safety legislation (including Provision and Use of Work Equipment Regulations (PUWER) and additional guidance (including lone working) to employers and those working with gas systems. • Emergency procedures, including gas escapes, report of fumes and for unsafe situations. • Electrical awareness and be knowledge to carry out safe isolation and essential electrical safety checks. <p>Legislation and industry guidance Implications of legislation and additional guidance to employers and those working with gas systems including:</p>	<ul style="list-style-type: none"> • Interpret information from a risk assessment. • Use tools in accordance with good working practice. • Install pipework relevant to the type of gas being conveyed • Install clips/brackets to various substrates. • Install flues/chimneys to facilitate a range of gas appliances and equipment e.g. LPG closed flue to commercial warm air units etc. • Install ventilators to facilitate the correct combustible air requirements for appliances installed in a variety of locations/buildings e.g. LPG to commercial catering etc. • Install appliances. • Install components into appliances. • Install controls into systems. • Install thermal installation materials. • Install seals appropriate to the gas appliance. • Check gas components are in accordance with design parameters. • Check gas components are registered Gas Council (GC). • Analyse information to identify requirements for gas installation e.g. flueing requirements. • Communicate system requirements to allied trades e.g. electrical requirements etc. • Establish safe working environment to conduct gas installation.

- Gas Safety (Installation and Use) Regulations.
- Control of Asbestos Regulations.

Gas systems

- Characteristics, types and purpose of different types of components and their suitability for different types of systems including Liquid Petroleum Gas (LPG) and Natural Gas, domestic and commercial.
- How components operate within a system and integrate to enable the system to operate effectively e.g. pressures etc.
- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location e.g. gas council number etc.
- Types of control systems required for heating systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by heating systems including limitations, operating parameters, legal requirements.
- Waste and waste products including types of systems, attributes (e.g. Magnetite, corrosion smells, bacteria etc.), hazards to user, interaction with other parties.
- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage etc.
- Safety devices applicable to Gas systems, their characteristics and operation.
- Gas and the combustion process including combustion analysis, carbon monoxide (CO), types of burners and interaction with other devices e.g. ventilators and Mechanical Heat Ventilation Recovery (MHVR) etc.

- Ensure no ingress of foreign objects within gas system and components.
- Update relevant line diagrams/installation plans.
- Complete a method statement for installation identifying any potential delays.
- Adapt on-site specific gas system installation changes e.g. LPG to natural gas etc.
- Gather relevant gas system component part information.
- Update digital building information management system software.

- Types of flues in relation to gas and the combustion process, their correct operation, safe operation and suitability for different types of system.
- Types of ventilation in relation to gas and the combustion process and their suitability for different requirements.

Science

Scientific principles and concepts as applied to gas engineering including:

- Sources of energy and heat transfer.
- Gas laws including Charles's law, Boyle's law, combined gas laws.
- Electrical systems and properties, including current, magnetic flux, frequency, resistance, voltage, Ohm's law, power.
- Mechanical properties, systems and units, including latent heat, capillary action, velocity, ductility, malleability, force, pressure, flow rates, dynamic pressure, humidity, atmospheric pressure, conduction, convection, heat transfer, heat losses, stack effects.
- Strength, including tensile, compressive, shear.
- Thermodynamics, including laws, material science, phase transition.
- Properties of materials, including acoustics, corrosion, pH, permeability, castability, brittleness, creep, durability, elasticity, flexibility, fatigue limit, hardness, resilience, size, toughness, viscosity, boiling point, flammability, flash point, melting point, thermal conductivity, vapour pressure.

- Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.

Information and data

- Gas engineering drawing symbols and markings.
- Building regulations related to the type of building and heating system.
- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Pipework technology

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.
- Flow rates and their relationship to pipework and system design.
- How to apply different techniques for forming and bending pipework.

Sustainability

- Energy efficiency measures and emerging technology measures that could be utilised along with a new or existing gas installation including insulation materials, control systems, environmental technologies, patterns of usage, alternative products, improved designs.

Tools and equipment

- Types of tools, equipment and materials used for access, measuring when working on gas systems, their characteristics, properties, purpose and suitability for tasks.

- Operation and handling requirements of tools, equipment and materials.
- Importance of maintenance and how to maintain equipment e.g. storage, greasing, sharpening etc.

Appliances

- Types of gas appliances and their system requirements.

Building technology

- Types of building fabric and implications for installation and maintenance of gas systems.
- Types of fixtures and suitability for different building fabrics.
- Techniques for penetrating building fabric and their suitability for different situations.

Performance Outcome 2: Commission gas systems

Knowledge Specific to Performance Outcome	Skills
<p>Commissioning</p> <ul style="list-style-type: none"> • Inspection techniques and how they are applied in commissioning systems e.g. visual measurement etc. • Factors to inspect during commissioning (e.g. flow rate, temperature etc.) and how expected standards are defined. • Testing of installation e.g. tightness, flue flow and spillage etc. • Documentation required for commissioning and verification of commissioning e.g. service sheet, commissioning record etc. • Technical information required for use by different stakeholders. • Safe storage and supply of fuel source. <p>Health and safety</p> <ul style="list-style-type: none"> • Typical hazards and risks associated with working with gas systems including gas, asbestos, fire, dust, burns, lone working. • Safe working practices associated with working with gas systems including use of personal protective equipment (PPE). • Implications of health and safety legislation (including Provision and Use of Work Equipment Regulations (PUWER) and additional guidance (including lone working) to employers and those working with gas systems. • Emergency procedures, including gas escapes, report of fumes and for unsafe situations. 	<ul style="list-style-type: none"> • Assess risks associated with completing the activities. • Test all gas rates and pressures are within against regulatory requirements. • Ensure any tools/equipment are calibrated correctly. • Calculate correct purge in accordance with gas installation. • Purge system correctly. • Visually inspect installation is compliant with Gas Safety and Use Regulations 1998. • Complete gas system handover documentation to end user e.g. manufactures commissioning log etc. • Demonstrate safe operation of gas appliance and controls to the end user. • Visually check gas system installation conforms to original design requirements. • Set gas system parameters to commission in accordance with manufactures instructions and Gas Safety and Use Regulations 1998. • Record commissioning results. • Analyse commissioning results to determine correct gas installation in accordance with original design.

- Electrical awareness and be knowledge to carry out safe isolation and essential electrical safety checks.

Legislation and industry guidance

Implications of legislation and additional guidance to employers and those working with gas systems including:

- Gas Safety (Installation and Use) Regulations.
- Control of Asbestos Regulations.

Gas systems

- Characteristics, types and purpose of different types of components and their suitability for different types of systems including Liquid Petroleum Gas (LPG) and Natural Gas, domestic and commercial.
- How components operate within a system and integrate to enable the system to operate effectively e.g. pressures etc.
- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location e.g. gas council number etc.
- Types of control systems required for heating systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by heating systems including limitations, operating parameters, legal requirements.
- Waste and waste products including types of systems, attributes (e.g. Magnetite, corrosion smells, bacteria etc.), hazards to user, interaction with other parties.
- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage etc.
- Safety devices applicable to Gas systems, their characteristics and operation.

- Gas and the combustion process including combustion analysis, carbon monoxide (CO), types of burners and interaction with other devices e.g. ventilators and Mechanical Heat Ventilation Recovery (MHVR) etc.
- Types of flues in relation to gas and the combustion process, their correct operation, safe operation and suitability for different types of system.
- Types of ventilation in relation to gas and the combustion process and their suitability for different requirements.

Science

Scientific principles and concepts as applied to gas engineering including:

- Sources of energy and heat transfer.
- Gas laws including Charles's law, Boyle's law, combined gas laws.
- Electrical systems and properties, including current, magnetic flux, frequency, resistance, voltage, Ohm's law, power.
- Mechanical properties, systems and units, including latent heat, capillary action, velocity, ductility, malleability, force, pressure, flow rates, dynamic pressure, humidity, atmospheric pressure, conduction, convection, heat transfer, heat losses, stack effects.
- Strength, including tensile, compressive, shear.
- Thermodynamics, including laws, material science, phase transition.
- Properties of materials, including acoustics, corrosion, pH, permeability, castability, brittleness, creep, durability, elasticity, flexibility, fatigue limit, hardness, resilience, size,

toughness, viscosity, boiling point, flammability, flash point, melting point, thermal conductivity, vapour pressure.

- Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.

Information and data

- Gas engineering drawing symbols and markings.
- Building regulations related to the type of building and heating system.
- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Pipework technology

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.
- Flow rates and their relationship to pipework and system design.
- How to apply different techniques for forming and bending pipework.

Sustainability

- Energy efficiency measures and emerging technology measures that could be utilised along with a new or existing gas installation including insulation materials, control systems, environmental technologies, patterns of usage, alternative products, improved designs.

Tools and equipment

- Types of tools, equipment and materials used for access, measuring when working on gas systems, their characteristics, properties, purpose and suitability for tasks.
- Operation and handling requirements of tools, equipment and materials.
- Importance of maintenance and how to maintain equipment e.g. storage, greasing, sharpening etc.

Appliances

- Types of gas appliances and their system requirements.

Building technology

- Types of building fabric and implications for installation and maintenance of gas systems.
- Types of fixtures and suitability for different building fabrics.
- Techniques for penetrating building fabric and their suitability for different situations.

Performance Outcome 3: Maintain gas systems

Knowledge Specific to Performance Outcome	Skills
<p>System maintenance</p> <ul style="list-style-type: none"> • Different types of maintenance, their characteristics, requirements and suitability for different situations including proactive and reactive. • Types of resources required to carry out maintenance activities and where they are obtained. • Typical times required to complete maintenance tasks and common faults within systems. • Fault finding techniques, their suitability for different situations and how they are applied in practice. • How to clean components without compromising system and associated tools, equipment and materials. • Documentation required for maintenance and verification of maintenance activities e.g. manufactures instruction, maintenance checklists etc. • Types of actions required when faults cannot be rectified and implications to customer and business including time and costs. <p>Health and safety</p> <ul style="list-style-type: none"> • Typical hazards and risks associated with working with gas systems including gas, asbestos, fire, dust, burns, lone working. • Safe working practices associated with working with gas systems including use of personal protective equipment (PPE). 	<ul style="list-style-type: none"> • Question end user to identify any gas installation and use concerns. • Identify the correct replacement parts relevant to the appliance from a selection of similar parts e.g. correct multifunctional valve etc. • Calculate maintenance downtime. • Safe handling of all gas components when conducting maintenance e.g. smart meters etc. • Identify potential gas installation system errors. • Test system in accordance with end user requirements. • Remove and replace faulty gas system components. • Repair faulty gas system components e.g. a thermocouple within a multifunctional valve etc.

- Implications of health and safety legislation (including Provision and Use of Work Equipment Regulations (PUWER) and additional guidance (including lone working) to employers and those working with gas systems.
- Emergency procedures, including gas escapes, report of fumes and for unsafe situations.
- Electrical awareness and be knowledge to carry out safe isolation and essential electrical safety checks.

Legislation and industry guidance

Implications of legislation and additional guidance to employers and those working with gas systems including:

- Gas Safety (Installation and Use) Regulations.
- Control of Asbestos Regulations.

Gas systems

- Characteristics, types and purpose of different types of components and their suitability for different types of systems including Liquid Petroleum Gas (LPG) and Natural Gas, domestic and commercial.
- How components operate within a system and integrate to enable the system to operate effectively e.g. pressures etc.
- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location e.g. gas council number etc.
- Types of control systems required for heating systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by heating systems including limitations, operating parameters, legal requirements.

- Waste and waste products including types of systems, attributes (e.g. Magnetite, corrosion smells, bacteria etc.), hazards to user, interaction with other parties.
- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage etc.
- Safety devices applicable to Gas systems, their characteristics and operation.
- Gas and the combustion process including combustion analysis, carbon monoxide (CO), types of burners and interaction with other devices e.g. ventilators and Mechanical Heat Ventilation Recovery (MHVR) etc.
- Types of flues in relation to gas and the combustion process, their correct operation, safe operation and suitability for different types of system.
- Types of ventilation in relation to gas and the combustion process and their suitability for different requirements.

Science

Scientific principles and concepts as applied to gas engineering including:

- Sources of energy and heat transfer.
- Gas laws including Charles's law, Boyle's law, combined gas laws.
- Electrical systems and properties, including current, magnetic flux, frequency, resistance, voltage, Ohm's law, power.
- Mechanical properties, systems and units, including latent heat, capillary action, velocity, ductility, malleability, force, pressure, flow rates, dynamic pressure, humidity,

atmospheric pressure, conduction, convection, heat transfer, heat losses, stack effects.

- Strength, including tensile, compressive, shear.
- Thermodynamics, including laws, material science, phase transition.
- Properties of materials, including acoustics, corrosion, pH, permeability, castability, brittleness, creep, durability, elasticity, flexibility, fatigue limit, hardness, resilience, size, toughness, viscosity, boiling point, flammability, flash point, melting point, thermal conductivity, vapour pressure.
- Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.

Information and data

- Gas engineering drawing symbols and markings.
- Building regulations related to the type of building and heating system.
- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Pipework technology

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.
- Flow rates and their relationship to pipework and system design.
- How to apply different techniques for forming and bending pipework.

Sustainability

- Energy efficiency measures and emerging technology measures that could be utilised along with a new or existing gas installation including insulation materials, control systems, environmental technologies, patterns of usage, alternative products, improved designs.

Tools and equipment

- Types of tools, equipment and materials used for access, measuring when working on gas systems, their characteristics, properties, purpose and suitability for tasks.
- Operation and handling requirements of tools, equipment and materials.
- Importance of maintenance and how to maintain equipment e.g. storage, greasing, sharpening etc.

Appliances

- Types of gas appliances and their system requirements.

Building technology

- Types of building fabric and implications for installation and maintenance of gas systems.
- Types of fixtures and suitability for different building fabrics.
- Techniques for penetrating building fabric and their suitability for different situations.

Performance Outcome 4: Decommission gas systems

Knowledge Specific to Performance Outcome	Skills
<p>Decommissioning</p> <ul style="list-style-type: none"> • Procedures involved in decommissioning. • Waste management procedures e.g. transport of licenced waste, materials that can be recycled. • How to safely remove different types of waste from the working area including asbestos lagging, old flues. • Documentation required for decommissioning and verification of decommissioning activities, their content and purpose. • Requirements for recording, labelling and reporting decommissioned systems including warning notices and labels to prevent use of decommissioned appliances. <p>Health and safety</p> <ul style="list-style-type: none"> • Typical hazards and risks associated with working with gas systems including gas, asbestos, fire, dust, burns, lone working. • Safe working practices associated with working with gas systems including use of personal protective equipment (PPE). • Implications of health and safety legislation (including Provision and Use of Work Equipment Regulations (PUWER) and additional guidance (including lone working) to employers and those working with gas systems. • Emergency procedures, including gas escapes, report of fumes and for unsafe situations. 	<ul style="list-style-type: none"> • Enable control mechanism from a risk assessment prior to working. • Establishing consumer needs when decommissioning any gas installation e.g. maintaining temporary heating system etc. • Safely isolate the gas system prior to decommissioning e.g. Emergency Control valve (ECV) and Electrical etc. • Extract gas equipment and components from installation with appropriate handling techniques. • Reinstall appropriate service post decommissioning e.g. re-pressurise heating system following a replacement part etc. • Maintain safe working area. • Return clean installation to end user. • Safe disposal of waste products when decommissioning gas system.

- Electrical awareness and be knowledge to carry out safe isolation and essential electrical safety checks.

Legislation and industry guidance

Implications of legislation and additional guidance to employers and those working with gas systems including:

- Gas Safety (Installation and Use) Regulations.
- Control of Asbestos Regulations.

Gas systems

- Characteristics, types and purpose of different types of components and their suitability for different types of systems including Liquid Petroleum Gas (LPG) and Natural Gas, domestic and commercial.
- How components operate within a system and integrate to enable the system to operate effectively e.g. pressures etc.
- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location e.g. gas council number etc.
- Types of control systems required for heating systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by heating systems including limitations, operating parameters, legal requirements.
- Waste and waste products including types of systems, attributes (e.g. Magnetite, corrosion smells, bacteria etc.), hazards to user, interaction with other parties.
- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage etc.
- Safety devices applicable to Gas systems, their characteristics and operation.

- Gas and the combustion process including combustion analysis, carbon monoxide (CO), types of burners and interaction with other devices e.g. ventilators and Mechanical Heat Ventilation Recovery (MHVR) etc.
- Types of flues in relation to gas and the combustion process, their correct operation, safe operation and suitability for different types of system.
- Types of ventilation in relation to gas and the combustion process and their suitability for different requirements.

Science

Scientific principles and concepts as applied to gas engineering including:

- Sources of energy and heat transfer.
- Gas laws including Charles's law, Boyle's law, combined gas laws.
- Electrical systems and properties, including current, magnetic flux, frequency, resistance, voltage, Ohm's law, power.
- Mechanical properties, systems and units, including latent heat, capillary action, velocity, ductility, malleability, force, pressure, flow rates, dynamic pressure, humidity, atmospheric pressure, conduction, convection, heat transfer, heat losses, stack effects.
- Strength, including tensile, compressive, shear.
- Thermodynamics, including laws, material science, phase transition.
- Properties of materials, including acoustics, corrosion, pH, permeability, castability, brittleness, creep, durability, elasticity, flexibility, fatigue limit, hardness, resilience, size,

toughness, viscosity, boiling point, flammability, flash point, melting point, thermal conductivity, vapour pressure.

- Combustion, including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.

Information and data

- Gas engineering drawing symbols and markings.
- Building regulations related to the type of building and heating system.
- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Pipework technology

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.
- Flow rates and their relationship to pipework and system design.
- How to apply different techniques for forming and bending pipework.

Sustainability

- Energy efficiency measures and emerging technology measures that could be utilised along with a new or existing gas installation including insulation materials, control systems, environmental technologies, patterns of usage, alternative products, improved designs.

Tools and equipment

- Types of tools, equipment and materials used for access, measuring when working on gas systems, their characteristics, properties, purpose and suitability for tasks.
- Operation and handling requirements of tools, equipment and materials.
- Importance of maintenance and how to maintain equipment e.g. storage, greasing, sharpening etc.

Appliances

- Types of gas appliances and their system requirements.

Building technology

- Types of building fabric and implications for installation and maintenance of gas systems.
- Types of fixtures and suitability for different building fabrics.
- Techniques for penetrating building fabric and their suitability for different situations.

Occupational Specialism: Plumbing

Performance Outcome 1: Install plumbing systems

Knowledge Specific to Performance Outcome	Skills
<p>Installation</p> <ul style="list-style-type: none"> • Bending techniques e.g. machine, scissor, hand etc. • Connection techniques e.g. threading, soldering etc. • Potential impact of installation activities on customer essential services and how these can be minimised e.g. isolation of services, preparation of temporary services etc. <p>Health and safety</p> <ul style="list-style-type: none"> • Key requirements of Codes of Practice (CoP) including Water Bylaws, Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards e.g. BS6700, Legionnaires disease: the control of legionella bacteria in water systems, Control of Asbestos Regulations. • Implications of legislation (including Control of Noise at Work Regulations, Control of Vibrations at Work Regulations, Provision and Use of Work Equipment Regulations (PUWER)), to employers, those working with plumbing systems and how the tasks are undertaken. • Typical hazards and risks associated with plumbing systems and the controls that need to be in place. <p>Tools and equipment</p> <ul style="list-style-type: none"> • Tools and equipment used for installation (e.g. benders, soldering equipment etc.) and their purpose. 	<ul style="list-style-type: none"> • Interpret risk assessments. • Select tools, equipment and materials e.g. pipe slice, soldering equipment, plastic pipe etc. • Measure site requirements and materials. • Mark out requirements e.g. joist notching's, depths, pipe lengths etc. • Use tools including hand and power tools. • Bend pipes including 90° and offset angles. • Cut pipes including leaving chamfered edge. • Connect materials. • Fix pipework to structures. • Position and secure components in plumbing system • Interpret information provided including drawings, specifications, local site considerations. • Update digital building information management system software.

- Importance of maintenance and maintenance techniques, including storage.
- Operation and handling requirements for tools and equipment.

Plumbing systems

- Components used in plumbing systems (e.g. valves, syphons etc.), their characteristics, function within the system and how they work together to support the operation of the system.
- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location.
- Types of control systems required for plumbing systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by plumbing systems including limitations, operating parameters, waste outputs, fluid categories.
- Waste and waste products types of systems, attributes (e.g. smells, bacteria etc.), hazards to user, interaction with other parties including the undertaker, treatment.
- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage.

Science

Scientific principles, their applications, interaction between them to meet the purpose of the system and how their performance in the system is measured including:

- Types of water, properties and chemical states, sources and storage, water quality (including pH) and treatments, behaviour under different temperatures.
- Relationship between flow and pressure including Boyle's and Charles' Law.
- Relationship between mass/volume and specific heat capacity.
- Types of insulation materials, their properties including relevant standards and their suitability for different systems.
- Electrolyte qualities of materials and the period table, relationship to flow rates.

Pipework

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment required.
- Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics.

Building technology

- Types of building fabric and implications for installation and maintenance of systems.
- Techniques for penetrating building fabric and their suitability for different situations.

Information and data

- Plumbing drawing symbols and markings.
- Building regulations related to the type of building and plumbing system.

- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Measurement

- Metric and imperial dimensions of height, weight and length
- International System of Units (SI), including base units for mass, electrical current, temperature.
- Derived SI units, including those associated with area, volume, weight, energy, pressure and force.

Performance Outcome 2: Commission plumbing systems

Knowledge Specific to Performance Outcome	Skills
<p>Commissioning</p> <ul style="list-style-type: none"> • Inspection techniques and how they are applied in commissioning systems e.g. visual measurement etc. • Factors to inspect during commissioning (e.g. flow rate, temperature etc.) and how expected standards are defined. • Testing techniques (e.g. pressure test, safety valve operations etc.) and their application. • Documentation required for commissioning and verification of commissioning e.g. service sheet, commissioning record etc. • Technical information required for use by different stakeholders. <p>Health and safety</p> <ul style="list-style-type: none"> • Key requirements of Codes of Practice (CoP) including Water Bylaws, Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards e.g. BS6700, Legionnaires disease: the control of legionella bacteria in water systems, Control of Asbestos Regulations. • Implications of legislation (including Control of Noise at Work Regulations, Control of Vibrations at Work Regulations, Provision and Use of Work Equipment Regulations (PUWER)), to employers, those working with plumbing systems and how the tasks are undertaken. • Typical hazards and risks associated with plumbing systems and the controls that need to be in place. 	<ul style="list-style-type: none"> • Assess risks associated with completing activities. • Interpret information and data including from visual and other sources e.g. manufacturers' instructions, drawings, BS and EN standards etc. • Inspect the installation of components. • Ensure accuracy and compliance with intended outcomes e.g. flow rate, temperature etc. • Test system e.g. pressure test, safety valve operations etc. • Record data e.g. flow rate, temperature etc. • Complete required documentation e.g. service sheet, commissioning record etc. • Present technical information orally for different stakeholders.

Tools and equipment

- Tools and equipment used for installation (e.g. benders, soldering equipment etc.) and their purpose.
- Importance of maintenance and maintenance techniques, including storage.
- Operation and handling requirements for tools and equipment.

Plumbing systems

- Components used in plumbing systems (e.g. valves, syphons etc.), their characteristics, function within the system and how they work together to support the operation of the system.
- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location.
- Types of control systems required for plumbing systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by plumbing systems including limitations, operating parameters, waste outputs, fluid categories.
- Waste and waste products types of systems, attributes (e.g. smells, bacteria etc.), hazards to user, interaction with other parties including the undertaker, treatment.
- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage.

Science

Scientific principles, their applications, interaction between them to meet the purpose of the system and how their performance in the system is measured including:

- Types of water, properties and chemical states, sources and storage, water quality (including pH) and treatments, behaviour under different temperatures.
- Relationship between flow and pressure including Boyle's and Charles' Law.
- Relationship between mass/volume and specific heat capacity.
- Types of insulation materials, their properties including relevant standards and their suitability for different systems.
- Electrolyte qualities of materials and the period table, relationship to flow rates.

Pipework

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment required.
- Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics.

Building technology

- Types of building fabric and implications for installation and maintenance of systems.
- Techniques for penetrating building fabric and their suitability for different situations.

Information and data

- Plumbing drawing symbols and markings.

- Building regulations related to the type of building and plumbing system.
- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Measurement

- Metric and imperial dimensions of height, weight and length
- International System of Units (SI), including base units for mass, electrical current, temperature.
- Derived SI units, including those associated with area, volume, weight, energy, pressure and force.

Performance Outcome 3: Maintain plumbing systems

Knowledge Specific to Performance Outcome	Skills
<p>Maintenance</p> <ul style="list-style-type: none"> • Types of maintenance (e.g. proactive, reactive etc.) and their suitability for different situations. • Maintenance plans, their content and typical tasks. • Typical times required to complete maintenance tasks • Resources required to complete maintenance tasks e.g. system specifications, previous maintenance records, manufactures instructions etc. • Fault finding techniques and their application. • Typical faults in plumbing systems and how they are caused • Documentation required for maintenance and verification of maintenance activities e.g. manufactures instruction, maintenance checklists etc. • Types of actions required when faults cannot be rectified and implications to customer and business including time and costs. <p>Health and safety</p> <ul style="list-style-type: none"> • Key requirements of Codes of Practice (CoP) including Water Bylaws, Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards e.g. BS6700, Legionnaires disease: the control of legionella bacteria in water systems, Control of Asbestos Regulations. • Implications of legislation (including Control of Noise at Work Regulations, Control of Vibrations at Work Regulations, Provision and Use of Work Equipment 	<ul style="list-style-type: none"> • Identify information requirements from a brief e.g. expected system flow rates, water pressures, water temperatures. vessel pressures etc. • Explore user requirements using open questioning and listening. • Estimate and calculate time and resources. • Analyse situations to identify potential causes for delays and errors. • Inspect the suitability of materials, tools and equipment e.g. adjustable spanners, copper pipe etc. • Analyse situations to identify potential faults. • Repair components in systems e.g. tap washer and cartridges etc. • Disassemble parts of a system. • Replace components within a system.

Regulations (PUWER)), to employers, those working with plumbing systems and how the tasks are undertaken.

- Typical hazards and risks associated with plumbing systems and the controls that need to be in place.

Tools and equipment

- Tools and equipment used for installation (e.g. benders, soldering equipment etc.) and their purpose.
- Importance of maintenance and maintenance techniques, including storage.
- Operation and handling requirements for tools and equipment.

Plumbing systems

- Components used in plumbing systems (e.g. valves, syphons etc.), their characteristics, function within the system and how they work together to support the operation of the system.
- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location.
- Types of control systems required for plumbing systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by plumbing systems including limitations, operating parameters, waste outputs, fluid categories.
- Waste and waste products types of systems, attributes (e.g. smells, bacteria etc.), hazards to user, interaction with other parties including the undertaker, treatment.

- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage.

Science

Scientific principles, their applications, interaction between them to meet the purpose of the system and how their performance in the system is measured including:

- Types of water, properties and chemical states, sources and storage, water quality (including pH) and treatments, behaviour under different temperatures.
- Relationship between flow and pressure including Boyle's and Charles' Law.
- Relationship between mass/volume and specific heat capacity.
- Types of insulation materials, their properties including relevant standards and their suitability for different systems.
- Electrolyte qualities of materials and the period table, relationship to flow rates.

Pipework

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment required.
- Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics.

Building technology

- Types of building fabric and implications for installation and maintenance of systems.
- Techniques for penetrating building fabric and their suitability for different situations.

Information and data

- Plumbing drawing symbols and markings.
- Building regulations related to the type of building and plumbing system.
- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Measurement

- Metric and imperial dimensions of height, weight and length
- International System of Units (SI), including base units for mass, electrical current, temperature.
- Derived SI units, including those associated with area, volume, weight, energy, pressure and force.

Performance Outcome 4: Decommission plumbing systems

Knowledge Specific to Performance Outcome	Skills
<p>Decommissioning</p> <ul style="list-style-type: none"> • Procedures involved in decommissioning. • Waste management procedures e.g. transport of licenced waste, materials that can be recycled etc. • How to safely remove different types of waste from the working area including asbestos lagging, contaminated water. • Documentation required for decommissioning and verification of decommissioning activities, their content and purpose. • Requirements for recording, labelling and reporting decommissioned systems including warning notices and labels to prevent use of decommissioned appliances. <p>Health and safety</p> <ul style="list-style-type: none"> • Key requirements of Codes of Practice (CoP) including Water Bylaws, Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards e.g. BS6700, Legionnaires disease: the control of legionella bacteria in water systems, Control of Asbestos Regulations. • Implications of legislation (including Control of Noise at Work Regulations, Control of Vibrations at Work Regulations, Provision and Use of Work Equipment Regulations (PUWER)), to employers, those working with plumbing systems and how the tasks are undertaken. • Typical hazards and risks associated with plumbing systems and the controls that need to be in place. 	<ul style="list-style-type: none"> • Safely isolate electrical and other services. • Handle materials to protect their integrity and safety e.g. copper pipe, plastics etc. • Extract components from a system. • Reconfigure system. • Categorise waste e.g. for recycling, disposal etc. • Make good the building fabric.

Tools and equipment

- Tools and equipment used for installation (e.g. benders, soldering equipment etc.) and their purpose.
- Importance of maintenance and maintenance techniques, including storage.
- Operation and handling requirements for tools and equipment.

Plumbing systems

- Components used in plumbing systems (e.g. valves, syphons etc.), their characteristics, function within the system and how they work together to support the operation of the system.
- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location.
- Types of control systems required for plumbing systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by plumbing systems including limitations, operating parameters, waste outputs, fluid categories.
- Waste and waste products types of systems, attributes (e.g. smells, bacteria etc.), hazards to user, interaction with other parties including the undertaker, treatment.
- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage.

Science

Scientific principles, their applications, interaction between them to meet the purpose of the system and how their performance in the system is measured including:

- Types of water, properties and chemical states, sources and storage, water quality (including pH) and treatments, behaviour under different temperatures.
- Relationship between flow and pressure including Boyle's and Charles' Law.
- Relationship between mass/volume and specific heat capacity.
- Types of insulation materials, their properties including relevant standards and their suitability for different systems.
- Electrolyte qualities of materials and the period table, relationship to flow rates.

Pipework

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment required.
- Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics.

Building technology

- Types of building fabric and implications for installation and maintenance of systems.
- Techniques for penetrating building fabric and their suitability for different situations.

Information and data

- Plumbing drawing symbols and markings.
- Building regulations related to the type of building and plumbing system.
- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Measurement

- Metric and imperial dimensions of height, weight and length
- International System of Units (SI), including base units for mass, electrical current, temperature.
- Derived SI units, including those associated with area, volume, weight, energy, pressure and force.

Occupational Specialism: Heating engineering

Performance Outcome 1: Install heating systems

Knowledge Specific to Performance Outcome	Skills
<p>Installation</p> <ul style="list-style-type: none"> • Bending techniques e.g. machine, scissor, hand etc. • Connection techniques e.g. threading, soldering etc. • Potential impact of installation activities on customer essential services and how these can be minimised e.g. isolation of services, preparation of temporary services etc <p>Health and safety</p> <ul style="list-style-type: none"> • Key requirements of Codes of Practice (CoP) including Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards e.g. BS 5449. • Implications of legislation (including Control of Noise at Work Regulations, Control of Vibrations at Work Regulations, Provision and Use of Work Equipment Regulations (PUWER), Control of Asbestos Regulations RPH) to employers, those working with heating systems and how the tasks are undertaken. • Typical hazards and risks associated with heating systems (e.g. burns, dust etc.) and the controls that need to be in place. <p>Heating systems</p> <ul style="list-style-type: none"> • Components used in heating systems (e.g. thermostats, valves etc.), their characteristics, function within the system 	<ul style="list-style-type: none"> • Install pipework relevant to the type of system. • Install clips/brackets to different types of building fabric. • Install flues/chimneys. • Install ventilators. • Install appliances. • Install heat emitting devices. • Install components into appliances. • Install controls into a range of systems. • Install thermal installation materials. • Install seals for heat emitting devices. • Check heating products are in accordance with design parameters. • Install control systems for the system. • Prepare a safe working environment to conduct heating system installation. • Update line diagrams/installation plans. • Use hand and power tools when penetrating a range of building fabrics. • Update digital building information management system software.

and how they work together to support the operation of the system.

- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location.
- Types of control systems required for heating systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by heating systems including limitations, operating parameters, legal requirements.
- Waste and waste products, types of systems, attributes (e.g. magnetite, corrosion etc.), hazards to user, interaction with other parties including the consumers.
- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage etc.
- Safety devices applicable to heating systems, their characteristics and operation.

Science

Applications of scientific principles and concepts to heating engineering including:

- Sources of energy and heat transfer.
- Gas laws including Charles's law, Boyle's law.
- Electrical systems and properties including current, magnetic flux, frequency, resistance, voltage, Ohm's law, power.
- Mechanical properties, systems and units including latent heat, capillary action, velocity, ductility, malleability, force, pressure, flow rates, dynamic pressure, humidity,

atmospheric pressure, conduction, convection, heat transfer, heat losses, stack effects.

- Strength including tensile, compressive, shear.
- Thermodynamics including laws, material science, phase transition.
- Properties of materials including acoustics, corrosion, pH, permeability, castability, brittleness, creep, durability, elasticity, flexibility, fatigue limit, hardness, resilience, size, toughness, viscosity, boiling point, flammability, flash point, melting point, thermal conductivity, vapour pressure.
- Combustion including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.
- Heating Systems and the combustion process including:
 - Combustion analysis
 - Carbon monoxide (CO)
 - Types of burners
 - Interaction with other devices e.g. ventilators and MVHR etc.
- Flues in relation to gas and the combustion process the following:
 - Various Types
 - Correct Operation
 - Safe Operation
 - Sizes.
- Ventilation in relation to gas and the combustion process the following:
 - Requirements
 - Types
 - Methods.

Legislation and industry guidance

- Implications of legislation and additional guidance to employers and those working with heating systems including:
 - Gas Safety (Installation and Use) Regulations
 - Building Regulations
 - Water Regulations
 - CIBSE Domestic Heating Design Guide
 - Building Standards
 - Gas Industry Unsafe Situations Procedure
 - Environmental legislation.

Information and data

- Heating drawing symbols and markings.
- Building regulations related to the type of building and heating system.
- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Pipework technology

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.
- Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics.

Sustainability

- Energy efficiency measures and emerging technology measures that could be utilised along with a new or existing installation including insulation materials, control systems,

environmental technologies, patterns of usage, alternative products, improved designs.

Tools and equipment

- Types of tools, equipment and materials used for access, measuring when working on heating systems, their characteristics, properties, purpose and suitability for tasks.
- Operation and handling requirements of tools, equipment and materials.
- Importance of maintenance and how to maintain equipment e.g. storage, greasing, sharpening etc.

Building technology

- Types of building fabric and implications for installation and maintenance of systems.
- Techniques for penetrating building fabric and their suitability for different situations.

Performance Outcome 2: Commission heating systems

Knowledge Specific to Performance Outcome	Skills
<p>Commissioning</p> <ul style="list-style-type: none"> • Inspection techniques and how they are applied in commissioning systems e.g. visual measurement etc. • Factors to inspect during commissioning (e.g. flow rate, temperature etc.) and how expected standards are defined. • Testing techniques (e.g. pressure test, safety valve operations etc.) and their application. • Documentation required for commissioning and verification of commissioning e.g. service sheet, commissioning record etc. • Technical information required for use by different stakeholders. <p>Health and safety</p> <ul style="list-style-type: none"> • Key requirements of Codes of Practice (CoP) including Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards e.g. BS 5449. • Implications of legislation (including Control of Noise at Work Regulations, Control of Vibrations at Work Regulations, Provision and Use of Work Equipment Regulations (PUWER), Control of Asbestos Regulations RPH) to employers, those working with heating systems and how the tasks are undertaken. • Typical hazards and risks associated with heating systems (e.g. burns, dust etc.) and the controls that need to be in place. <p>Heating systems</p>	<ul style="list-style-type: none"> • Assess risks associated with completing the activities and take appropriate safety precautions e.g. prevention of scalding from hot water etc. • Set heating controls and parameters in accordance with manufacturers' instructions. • Verify fitness for purpose of tools/equipment e.g. calibrate against a known source etc. • Complete heating system handover documentation to end user. • Test heating system installation conforms to original design requirements. • Adjusting heating system parameters to commission in accordance with manufacturers' instructions. • Test heating system. • Record commissioning results e.g. temperature of primary pipework etc. • Visually inspect correct equipment is utilised in the heating system. • Compare commissioning results against design parameters to determine correct installation in accordance with original design.

- Components used in heating systems (e.g. thermostats, valves etc.), their characteristics, function within the system and how they work together to support the operation of the system.
- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location.
- Types of control systems required for heating systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by heating systems including limitations, operating parameters, legal requirements.
- Waste and waste products, types of systems, attributes (e.g. magnetite, corrosion etc.), hazards to user, interaction with other parties including the consumers.
- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage etc.
- Safety devices applicable to heating systems, their characteristics and operation.

Science

Applications of scientific principles and concepts to heating engineering including:

- Sources of energy and heat transfer.
- Gas laws including Charles's law, Boyle's law.
- Electrical systems and properties including current, magnetic flux, frequency, resistance, voltage, Ohm's law, power.

- Mechanical properties, systems and units including latent heat, capillary action, velocity, ductility, malleability, force, pressure, flow rates, dynamic pressure, humidity, atmospheric pressure, conduction, convection, heat transfer, heat losses, stack effects.
- Strength including tensile, compressive, shear.
- Thermodynamics including laws, material science, phase transition.
- Properties of materials including acoustics, corrosion, pH, permeability, castability, brittleness, creep, durability, elasticity, flexibility, fatigue limit, hardness, resilience, size, toughness, viscosity, boiling point, flammability, flash point, melting point, thermal conductivity, vapour pressure.
- Combustion including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.
- Heating Systems and the combustion process including:
 - Combustion analysis
 - Carbon monoxide (CO)
 - Types of burners
 - Interaction with other devices e.g. ventilators and MVHR etc.
- Flues in relation to gas and the combustion process the following:
 - Various Types
 - Correct Operation
 - Safe Operation
 - Sizes.
- Ventilation in relation to gas and the combustion process the following:
 - Requirements

- Types
- Methods.

Legislation and industry guidance

- Implications of legislation and additional guidance to employers and those working with heating systems including:
 - Gas Safety (Installation and Use) Regulations
 - Building Regulations
 - Water Regulations
 - CIBSE Domestic Heating Design Guide
 - Building Standards
 - Gas Industry Unsafe Situations Procedure
 - Environmental legislation.

Information and data

- Heating drawing symbols and markings.
- Building regulations related to the type of building and heating system.
- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Pipework technology

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.
- Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics.

Sustainability

- Energy efficiency measures and emerging technology measures that could be utilised along with a new or existing

installation including insulation materials, control systems, environmental technologies, patterns of usage, alternative products, improved designs.

Tools and equipment

- Types of tools, equipment and materials used for access, measuring when working on heating systems, their characteristics, properties, purpose and suitability for tasks.
- Operation and handling requirements of tools, equipment and materials.
- Importance of maintenance and how to maintain equipment e.g. storage, greasing, sharpening etc.

Building technology

- Types of building fabric and implications for installation and maintenance of systems.
- Techniques for penetrating building fabric and their suitability for different situations.

Performance Outcome 3: Maintain heating systems

Knowledge Specific to Performance Outcome	Skills
<p>Maintenance</p> <ul style="list-style-type: none"> • Types of maintenance (e.g. proactive, reactive ec.) and their suitability for different situations. • Maintenance plans, their content and typical tasks. • Typical times required to complete maintenance tasks. • Resources required to complete maintenance tasks e.g. system specifications, previous maintenance records, manufactures instructions etc. • Fault finding techniques and their application. • Typical faults in heating systems and how they are caused • Documentation required for maintenance and verification of maintenance activities e.g. manufactures instruction, maintenance check lists etc. • Types of actions required when faults cannot be rectified and implications to customer and business including time and costs. <p>Health and safety</p> <ul style="list-style-type: none"> • Key requirements of Codes of Practice (CoP) including Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards e.g. BS 5449. • Implications of legislation (including Control of Noise at Work Regulations, Control of Vibrations at Work Regulations, Provision and Use of Work Equipment Regulations (PUWER), Control of Asbestos RegulationsRPH) to employers, those working with heating systems and how the tasks are undertaken. 	<ul style="list-style-type: none"> • Use active listening and questioning to identify any end user concerns around system operation e.g. correct times of operation etc. • Calculate maintenance downtime prior to deactivating. • Conduct fault finding in a methodical manner using a range of techniques. • Engineer corrective measures to rectify fault e.g. change a selection of pipework etc. • Assemble system components. • Disassemble system components when conducting maintenance. • Repair faulty heating system components as identified e.g. cylinder thermostat etc. • Classify waste for disposal and recycling.

- Typical hazards and risks associated with heating systems (e.g. burns, dust etc.) and the controls that need to be in place.

Heating systems

- Components used in heating systems (e.g. thermostats, valves etc.), their characteristics, function within the system and how they work together to support the operation of the system.
- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location.
- Types of control systems required for heating systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by heating systems including limitations, operating parameters, legal requirements.
- Waste and waste products, types of systems, attributes (e.g. magnetite, corrosion etc.), hazards to user, interaction with other parties including the consumers.
- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage etc.
- Safety devices applicable to heating systems, their characteristics and operation.

Science

Applications of scientific principles and concepts to heating engineering including:

- Sources of energy and heat transfer.

- Gas laws including Charles's law, Boyle's law.
- Electrical systems and properties including current, magnetic flux, frequency, resistance, voltage, Ohm's law, power.
- Mechanical properties, systems and units including latent heat, capillary action, velocity, ductility, malleability, force, pressure, flow rates, dynamic pressure, humidity, atmospheric pressure, conduction, convection, heat transfer, heat losses, stack effects.
- Strength including tensile, compressive, shear.
- Thermodynamics including laws, material science, phase transition.
- Properties of materials including acoustics, corrosion, pH, permeability, castability, brittleness, creep, durability, elasticity, flexibility, fatigue limit, hardness, resilience, size, toughness, viscosity, boiling point, flammability, flash point, melting point, thermal conductivity, vapour pressure.
- Combustion including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.
- Heating Systems and the combustion process including:
 - Combustion analysis
 - Carbon monoxide (CO)
 - Types of burners
 - Interaction with other devices e.g. ventilators and MVHR etc.
- Flues in relation to gas and the combustion process the following:
 - Various Types
 - Correct Operation
 - Safe Operation

- Sizes.
- Ventilation in relation to gas and the combustion process the following:
 - Requirements
 - Types
 - Methods.

Legislation and industry guidance

- Implications of legislation and additional guidance to employers and those working with heating systems including:
 - Gas Safety (Installation and Use) Regulations
 - Building Regulations
 - Water Regulations
 - CIBSE Domestic Heating Design Guide
 - Building Standards
 - Gas Industry Unsafe Situations Procedure
 - Environmental legislation.

Information and data

- Heating drawing symbols and markings.
- Building regulations related to the type of building and heating system.
- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Pipework technology

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.
- Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics.

Sustainability

- Energy efficiency measures and emerging technology measures that could be utilised along with a new or existing installation including insulation materials, control systems, environmental technologies, patterns of usage, alternative products, improved designs.

Tools and equipment

- Types of tools, equipment and materials used for access, measuring when working on heating systems, their characteristics, properties, purpose and suitability for tasks.
- Operation and handling requirements of tools, equipment and materials.
- Importance of maintenance and how to maintain equipment e.g. storage, greasing, sharpening etc.

Building technology

- Types of building fabric and implications for installation and maintenance of systems.
- Techniques for penetrating building fabric and their suitability for different situations.

Performance Outcome 4: Decommission heating systems

Knowledge Specific to Performance Outcome	Skills
<p>Decommissioning</p> <ul style="list-style-type: none"> • Procedures involved in decommissioning. • Waste management procedures e.g. transport of licenced waste, materials that can be recycled etc. • How to safely remove different types of waste from the working area including asbestos lagging, contaminated water. • Documentation required for decommissioning and verification of decommissioning activities, their content and purpose. • Requirements for recording, labelling and reporting decommissioned systems including warning notices and labels to prevent use of decommissioned appliances. <p>Health and safety</p> <ul style="list-style-type: none"> • Key requirements of Codes of Practice (CoP) including Hazardous Waste Regulations, Waste Regulations Advisory Service (WRAS) and Building Standards e.g. BS 5449. • Implications of legislation (including Control of Noise at Work Regulations, Control of Vibrations at Work Regulations, Provision and Use of Work Equipment Regulations (PUWER), Control of Asbestos Regulations RPH) to employers, those working with heating systems and how the tasks are undertaken. • Typical hazards and risks associated with heating systems (e.g. burns, dust etc.) and the controls that need to be in place. <p>Heating systems</p>	<ul style="list-style-type: none"> • Apply control mechanisms from a risk assessment prior to working e.g. safe disposal of heating system fluids etc. • Communicate with user to establish needs when decommissioning heating e.g. temporary heating requirements etc. • Safely electrically isolate the heating system prior to decommissioning. • Extract old heating equipment from installation. • Make good building fabric post system removal. • Reinstate appropriate service post decommissioning e.g. fuel supply etc.

- Components used in heating systems (e.g. thermostats, valves etc.), their characteristics, function within the system and how they work together to support the operation of the system.
- Factors that affect the choice and suitability of components included in a system including appliances, purpose, size, location.
- Types of control systems required for heating systems (including digital controls), their characteristics, operation and suitability for different situations.
- Appliances supported by heating systems including limitations, operating parameters, legal requirements
- Waste and waste products, types of systems, attributes (e.g. magnetite, corrosion etc.), hazards to user, interaction with other parties including the consumers.
- The effects of damage interference from external sources on system operation e.g. vibration, water ingress, heat, mechanical damage etc.
- Safety devices applicable to heating systems, their characteristics and operation.

Science

Applications of scientific principles and concepts to heating engineering including:

- Sources of energy and heat transfer.
- Gas laws including Charles's law, Boyle's law.
- Electrical systems and properties including current, magnetic flux, frequency, resistance, voltage, Ohm's law, power.

- Mechanical properties, systems and units including latent heat, capillary action, velocity, ductility, malleability, force, pressure, flow rates, dynamic pressure, humidity, atmospheric pressure, conduction, convection, heat transfer, heat losses, stack effects.
- Strength including tensile, compressive, shear
- Thermodynamics including laws, material science, phase transition.
- Properties of materials including acoustics, corrosion, pH, permeability, castability, brittleness, creep, durability, elasticity, flexibility, fatigue limit, hardness, resilience, size, toughness, viscosity, boiling point, flammability, flash point, melting point, thermal conductivity, vapour pressure.
- Combustion including incomplete combustion, ventilation, stoichiometric, fuels, chemical, smouldering, diffusion, rapid, spontaneous, flue draft.
- Heating Systems and the combustion process including:
 - Combustion analysis
 - Carbon monoxide (CO)
 - Types of burners
 - Interaction with other devices e.g. ventilators and MVHR etc.
- Flues in relation to gas and the combustion process the following:
 - Various Types
 - Correct Operation
 - Safe Operation
 - Sizes.
- Ventilation in relation to gas and the combustion process the following:
 - Requirements

- Types
- Methods.

Legislation and industry guidance

- Implications of legislation and additional guidance to employers and those working with heating systems including:
 - Gas Safety (Installation and Use) Regulations
 - Building Regulations
 - Water Regulations
 - CIBSE Domestic Heating Design Guide
 - Building Standards
 - Gas Industry Unsafe Situations Procedure
 - Environmental legislation.

Information and data

- Heating drawing symbols and markings.
- Building regulations related to the type of building and heating system.
- Types of documentation produced, their content and their purpose e.g. benchmarks, dosing records etc.

Pipework technology

- Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required.
- Types of support, fittings and fixings and their suitability for different systems, purposes and building fabrics.

Sustainability

- Energy efficiency measures and emerging technology measures that could be utilised along with a new or existing

installation including insulation materials, control systems, environmental technologies, patterns of usage, alternative products, improved designs.

Tools and equipment

- Types of tools, equipment and materials used for access, measuring when working on heating systems, their characteristics, properties, purpose and suitability for tasks.
- Operation and handling requirements of tools, equipment and materials.
- Importance of maintenance and how to maintain equipment e.g. storage, greasing, sharpening etc.

Building technology

- Types of building fabric and implications for installation and maintenance of systems.
- Techniques for penetrating building fabric and their suitability for different situations.

Occupational Specialism: Refrigeration engineering

Performance Outcome 1: Install refrigeration systems

Knowledge Specific to Performance Outcome	Skills
<p>System installation</p> <ul style="list-style-type: none"> • How to check for refrigeration system leakages. • Types of substrates and implications for refrigeration system installation including types of tools and equipment needed • Types of protective materials, their properties and how to ensure the material operates effectively. • Types of pipework, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required. <p>Legislation, Regulations and Standards</p> <ul style="list-style-type: none"> • Relevant UK and international standards, Approved Codes of Practice (ACOPS) and how they are applied to refrigeration systems including Indoor Air Quality (IAQ), bacteria in water and asbestos. • Key requirements of health and safety legislation relating to refrigeration systems including fire, risk, dust, odours • Key requirements of environmental legislation relating to refrigeration systems e.g. Climate Change Act, Control on Ozone-Depleting Substances etc. • Industry Codes of Practice and other sources of information and advice on technical safety and legislative aspects of working with refrigeration system e.g. Chartered Institute of Building Services Engineers (CIBSE), Building Research Establishment (BRE) guides, codes of practice and technical memoranda etc. 	<ul style="list-style-type: none"> • Sequence and prioritise tasks e.g. plan and execute programme of works etc. • Identify information requirements from a brief e.g. scale of installation required, appropriate hardware etc. • Gather required information e.g. manufacturers' instructions & power requirements etc. • Interpret information and data. • Calculate data required e.g. heat loss, cooling requirements, unit sizes etc. • Produce written reports to different types of stakeholder (e.g. end user, construction project manager etc.) about work completed. • Measure and mark out installation requirements e.g. on components, surfaces etc. • Drill holes for fixings in various substrates. • Position units (including indoor and outdoor) including levelling and squaring. • Insert protective materials into drilled holes e.g. conduit, fireproof insulation, intumescent mastic etc. • Cut pipework (including conduit) to required dimensions • Manually bend microbore pipework. • Assemble pipework including swaging and brazing. • Permanently fix indoor and outdoor units and supports including pipework and cabling. • Leak test system with a vacuum.

Underpinning principles

- How to apply Gas laws when adaptations to a refrigeration system are needed.
- How to show a refrigeration cycle on pressure-enthalpy charts.
- How to interpret pressure-enthalpy charts.
- Components of refrigeration cycles, pressures and temperatures of different points on a circuit.
- Types of fluids including liquids and gases, how they flow and the effect of different pipe sizes on flow.
- Performance requirements for running a refrigeration cycle.
- Properties of refrigerant fluids and lubricants and implications for their use in refrigeration systems.

System fundamentals

- The function and operation of refrigeration system components and how they interact in a range of different systems and applications to operate effectively.
- Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available.
- The suitability of different types of components for refrigeration systems operating in different situations to meet differing client needs.

Sustainability

- Environmental impact of refrigerants and their Ozone Depletion Potential (ODP) and their Global Warming Potential (GWP).

- New developments in refrigeration (e.g. low GWP refrigerants etc.) and their potential uses in refrigeration systems and associated toxicity and fire risks.
- How to maximise efficient refrigeration system performance including mitigation of direct and indirect carbon emissions.

Information and data

- System drawings and symbols, conventions and terminology needed to aid interpretation.
- Types of documentation produced, their content and their purpose.

Performance Outcome 2: Commission refrigeration systems

Knowledge Specific to Performance Outcome	Skills
<p>System commissioning</p> <ul style="list-style-type: none"> • System operation requirements to be checked for commissioning including after a long period of non-use. • How to carry out a visual inspection of a refrigeration system. • Expectations of a steady state operation for refrigeration system. <p>Legislation, Regulations and Standards</p> <ul style="list-style-type: none"> • Relevant UK and international standards, Approved Codes of Practice (ACOPS) and how they are applied to refrigeration systems including Indoor Air Quality (IAQ), bacteria in water and asbestos. • Key requirements of health and safety legislation relating to refrigeration systems including fire, risk, dust, odours. • Key requirements of environmental legislation relating to refrigeration systems e.g. Climate Change Act, Control on Ozone-Depleting Substances etc. • Industry Codes of Practice and other sources of information and advice on technical safety and legislative aspects of working with refrigeration system e.g. Chartered Institute of Building Services Engineers (CIBSE), Building Research Establishment (BRE) guides, codes of practice and technical memoranda etc. <p>Underpinning principles</p> <ul style="list-style-type: none"> • How to apply Gas laws when adaptations to a refrigeration system are needed. 	<ul style="list-style-type: none"> • Interpret a risk assessment e.g. apply stated control measures etc. • Interpret information provided e.g. drawings, manufacturers' specifications etc. • Collect data from control system e.g. flow rates, temperature etc. • Interpret commissioning data collected e.g. have design parameters been met etc. • Discuss requirements with stakeholders (e.g. end user, client etc.) using open questioning and listening techniques • Inspect system installation e.g. cleanliness, secure etc. • Establish a steady state operation. • Adjust system for optimum performance. • Establish comfortable ambient conditions. • Record test results.

- How to show a refrigeration cycle on pressure-enthalpy charts.
- How to interpret pressure-enthalpy charts.
- Components of refrigeration cycles, pressures and temperatures of different points on a circuit.
- Types of fluids including liquids and gases, how they flow and the effect of different pipe sizes on flow.
- Performance requirements for running a refrigeration cycle.
- Properties of refrigerant fluids and lubricants and implications for their use in refrigeration systems.

System fundamentals

- The function and operation of refrigeration system components and how they interact in a range of different systems and applications to operate effectively.
- Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available.
- The suitability of different types of components for refrigeration systems operating in different situations to meet differing client needs.

Sustainability

- Environmental impact of refrigerants and their Ozone Depletion Potential (ODP) and their Global Warming Potential (GWP).
- New developments in refrigeration (e.g. low GWP refrigerants etc.) and their potential uses in refrigeration systems and associated toxicity and fire risks.

- How to maximise efficient refrigeration system performance including mitigation of direct and indirect carbon emissions.

Information and data

- System drawings and symbols, conventions and terminology needed to aid interpretation.
- Types of documentation produced, their content and their purpose.

Performance Outcome 3: Maintain refrigeration systems

Knowledge Specific to Performance Outcome	Skills
<p>System maintenance</p> <ul style="list-style-type: none"> • Different types of maintenance, their characteristics, requirements and suitability for different situations. • Types of resources required to carry out maintenance activities and where they are obtained. • Types of fault finding techniques, their suitability for different situations and how they are applied in practice. • Cleaning – which components require cleaning and how to clean without compromising system, tools, equipment and materials to do that. • Disassembly techniques. • Fault finding techniques. • How techniques vary according to use and operation of system. • How to extract refrigerant and manage and handle it when extracted. <p>Legislation, Regulations and Standards</p> <ul style="list-style-type: none"> • Relevant UK and international standards, Approved Codes of Practice (ACOPS) and how they are applied to refrigeration systems including Indoor Air Quality (IAQ), bacteria in water and asbestos. • Key requirements of health and safety legislation relating to refrigeration systems including fire, risk, dust, odours. • Key requirements of environmental legislation relating to refrigeration systems e.g. Climate Change Act, Control on Ozone-Depleting Substances etc. 	<ul style="list-style-type: none"> • Produce a method statement including risk assessment (RAMS). • Assess suitability of information provided e.g. sufficiency, currency etc. • Calculate resource requirements e.g. how much refrigerant required for size of system etc. • Complete documentation e.g. maintenance plan (O&M manual) etc. • Produce technical reports e.g. maintenance reports etc. • Visually inspect the system e.g. security of pipework, vibration mounts etc. • Clean system e.g. clearing leaves and other debris from outdoor units, washing filters and gauzes etc. • Extract components from the system. • Apply fault finding techniques to identify faults e.g. data analysis, testing etc. • Rectify faults e.g. poorly fitted insulation, broken condensate drain, incorrectly set controls etc. • Report on maintenance concerns e.g. hot running compressor, evidence of leaks etc. • Classify waste for disposal and recycling.

- Industry Codes of Practice and other sources of information and advice on technical safety and legislative aspects of working with refrigeration system e.g. Chartered Institute of Building Services Engineers (CIBSE), Building Research Establishment (BRE) guides, codes of practice and technical memoranda etc.

Underpinning principles

- How to apply Gas laws when adaptations to a refrigeration system are needed.
- How to show a refrigeration cycle on pressure-enthalpy charts.
- How to interpret pressure-enthalpy charts.
- Components of refrigeration cycles, pressures and temperatures of different points on a circuit.
- Types of fluids including liquids and gases, how they flow and the effect of different pipe sizes on flow.
- Performance requirements for running a refrigeration cycle.
- Properties of refrigerant fluids and lubricants and implications for their use in refrigeration systems.

System fundamentals

- The function and operation of refrigeration system components and how they interact in a range of different systems and applications to operate effectively.
- Different types of monitoring systems in place, the types of data produced by systems and how the data is produced and extracted including different types of wireless systems available.

- The suitability of different types of components for refrigeration systems operating in different situations to meet differing client needs.

Sustainability

- Environmental impact of refrigerants and their Ozone Depletion Potential (ODP) and their Global Warming Potential (GWP).
- New developments in refrigeration (e.g. low GWP refrigerants etc.) and their potential uses in refrigeration systems and associated toxicity and fire risks.
- How to maximise efficient refrigeration system performance including mitigation of direct and indirect carbon emissions.

Information and data

- System drawings and symbols, conventions and terminology needed to aid interpretation.
- Types of documentation produced, their content and their purpose.

Occupational Specialism: Air conditioning engineering

Performance Outcome 1: Install air conditioning systems

Knowledge Specific to Performance Outcome	Skills
<p>System installation</p> <ul style="list-style-type: none"> • How to check the multiple circuits and systems for leakages. • Location methods for air handling system installation including types of tools and equipment needed. • Types of ductwork and pipework, different sizes, types of materials, their suitability for different situations and tools and equipment (including fixings) required. <p>Legislation, Regulations and Standards</p> <ul style="list-style-type: none"> • Relevant UK and international standards, Approved Codes of Practice (ACOPS) and how they are applied to air conditioning systems including indoor air quality, bacteria in water and asbestos. • Key requirements of health and safety legislation relating to air conditioning systems including fire, risk, dust, odours. • Key requirements of environmental legislation relating to air conditioning systems e.g. Climate Change Act, Control on Ozone-Depleting Substances etc. • Industry Codes of Practice and other sources of information and advice on technical safety and legislative aspects of working with air conditioning systems e.g. Chartered Institute of Building Services Engineers (CIBSE), Building Research Establishment (BRE) guides, codes of practice and technical memoranda etc. 	<ul style="list-style-type: none"> • Sequence and prioritise tasks e.g. plan execution of programme of works. • Identify information requirements for the task e.g. drawings, manufacturers' specifications. • Gather information required for the task e.g. manufacturers' instructions, non-domestic building services compliance guide. • Produce written report to stakeholders about work completed. • Measure and mark out installation requirements e.g. on filters, ancillary components. • Connect components e.g. heating and cooling coils. • Fill and purge heating and cooling circuits. • Insert components into system e.g. heat exchangers, ancillary parts. • Adjust components e.g. belts, dampers. • Connect control systems including sensors and programmers. • Apply final settings e.g. from manufacturers' instructions. • Confirm system is ready to commission e.g. run "pre-flight check".

Underpinning principles

- Sound understanding of principles of thermodynamics, gas laws, psychrometrics, fluid flow, electricity, filtration, heat transfer, properties of refrigerant fluids and lubricants.
- Understanding comfort in terms of temperature, humidity, carbon monoxide, metabolism, etc.

Data analysis

- Measurements, diagrams, calculations, tools, charts, tables and formulae and apply them as appropriate.

System fundamentals

- The function and operation of air conditioning systems (e.g. centralised plant, Air Handling Units (AHUs), fan coils, chilled beams) and how they interact in a range of different systems and applications.
- The many uses of air conditioning, refrigeration and ventilation in a modern economy.

Sustainability

- Environmental technologies employed in the sector (e.g. heat recovery) which can be used to reduce heat gain, cooling load or energy use.
- Supply of energy from renewable resources.
- Reducing environmental impact of air conditioning systems through circular economics and low impact refrigerants.

Performance Outcome 2: Commission air conditioning systems

Knowledge Specific to Performance Outcome	Skills
<p>System commissioning</p> <ul style="list-style-type: none"> • System operation requirements to be checked for commissioning including after a long period of non-use. • How to carry out a visual inspection of an air conditioning system. • Expectations of a steady state operation for air conditioning systems. <p>Legislation, Regulations and Standards</p> <ul style="list-style-type: none"> • Relevant UK and international standards, Approved Codes of Practice (ACOPS) and how they are applied to air conditioning systems including indoor air quality, bacteria in water and asbestos. • Key requirements of health and safety legislation relating to air conditioning systems including fire, risk, dust, odours. • Key requirements of environmental legislation relating to air conditioning systems e.g. Climate Change Act, Control on Ozone-Depleting Substances etc. • Industry Codes of Practice and other sources of information and advice on technical safety and legislative aspects of working with air conditioning systems e.g. Chartered Institute of Building Services Engineers (CIBSE), Building Research Establishment (BRE) guides, codes of practice and technical memoranda etc. <p>Underpinning principles</p>	<ul style="list-style-type: none"> • Interpret a risk assessment e.g. apply required controls. • Interpret information provided e.g. BS/EN/ISO Standards or manufacturers' instructions including tabular and graphical information. • Interpret commissioning data including determining design parameters have been met. • Explore requirements of the task using open questioning and listening e.g. energy efficiency requirements. • Visually inspect system installation e.g. cleanliness, secure, as per specification. • Establish a steady state operation. • Collect data from control system e.g. flow rates, temperatures, humidity and filtration/air quality levels. • Record data from commissioning instrumentation e.g. air quality, differential pressure, wet and dry temperature. • Check function of system against design specification. • Adjust system to comfortable ambient conditions.

- Sound understanding of principles of thermodynamics, gas laws, psychrometrics, fluid flow, electricity, filtration, heat transfer, properties of refrigerant fluids and lubricants.
- Understanding comfort in terms of temperature, humidity, carbon monoxide, metabolism, etc.

Data analysis

- Measurements, diagrams, calculations, tools, charts, tables and formulae and apply them as appropriate.

System fundamentals

- The function and operation of air conditioning systems (e.g. centralised plant, Air Handling Units (AHUs), fan coils, chilled beams) and how they interact in a range of different systems and applications.
- The many uses of air conditioning, refrigeration and ventilation in a modern economy.

Sustainability

- Environmental technologies employed in the sector (e.g. heat recovery) which can be used to reduce heat gain, cooling load or energy use.
- Supply of energy from renewable resources.
- Reducing environmental impact of air conditioning systems through circular economics and low impact refrigerants.

Performance Outcome 3: Maintain air conditioning systems

Knowledge Specific to Performance Outcome	Skills
<p>System maintenance</p> <ul style="list-style-type: none"> • Different types of maintenance, their characteristics, requirements and suitability for different situations. • Types of resources required to carry out maintenance activities and where they are obtained. • Types of fault finding techniques, their suitability for different situations and how they are applied in practice. • Cleaning – which components and how to clean without compromising system, tools, equipment and materials to do that. • Disassembly techniques. • Fault finding techniques. • How techniques vary according to use and operation of system. • When a F-gas or other specialist is required to work on the system. <p>Legislation, Regulations and Standards</p> <ul style="list-style-type: none"> • Relevant UK and international standards, Approved Codes of Practice (ACOPS) and how they are applied to air conditioning systems including indoor air quality, bacteria in water and asbestos. • Key requirements of health and safety legislation relating to air conditioning systems including fire, risk, dust, odours. • Key requirements of environmental legislation relating to air conditioning systems e.g. Climate Change Act, Control on Ozone-Depleting Substances etc. 	<ul style="list-style-type: none"> • Produce a method statement. • Assess the suitability of information available e.g. sufficiency, accuracy. • Calculate resource requirements for servicing the system e.g. lubricants, filters, cleaning agents. • Complete documentation e.g. maintenance plan, maintenance report. • Visually inspect systems e.g. for corrosion, damage, loose screws or connectors. • Clean system e.g. drain pans, filters. • Tighten loose components e.g. screws, electrical connectors. • Adjust components e.g. dampers, belts. • Lubricate bearings and other moving parts e.g. pulleys, heat recovery wheels. • Check unit is running according to optimum settings. • Review system against minimal risks from Legionella and other potential health hazards e.g. sick building syndrome (SBS). • Assess system risks for long term performance e.g. components reaching end of life. • Report on maintenance activities. • Investigate system operation to identify faults. • Rectify system.

- Industry Codes of Practice and other sources of information and advice on technical safety and legislative aspects of working with air conditioning systems e.g. Chartered Institute of Building Services Engineers (CIBSE), Building Research Establishment (BRE) guides, codes of practice and technical memoranda etc.

Underpinning principles

- Sound understanding of principles of thermodynamics, gas laws, psychrometrics, fluid flow, electricity, filtration, heat transfer, properties of refrigerant fluids and lubricants.
- Understanding comfort in terms of temperature, humidity, carbon monoxide, metabolism, etc.

Data analysis

- Measurements, diagrams, calculations, tools, charts, tables and formulae and apply them as appropriate.

System fundamentals

- The function and operation of air conditioning systems (e.g. centralised plant, Air Handling Units (AHUs), fan coils, chilled beams) and how they interact in a range of different systems and applications.
- The many uses of air conditioning, refrigeration and ventilation in a modern economy.

Sustainability

- Environmental technologies employed in the sector (e.g. heat recovery) which can be used to reduce heat gain, cooling load or energy use.

- | | |
|---|--|
| <ul style="list-style-type: none">• Supply of energy from renewable resources• Reducing environmental impact of air conditioning systems through circular economics and low impact refrigerants. | |
|---|--|

Integrating maths, English and digital skills

Maths

The completion of a level 2 mathematics qualification (GCSE mathematics or Functional Skills) is a minimum exit requirement for all T Levels. This will ensure that all students have demonstrated fluency and competence in mathematics, and are able to recognise the importance of mathematics in their own lives, in work and to society. Achievement of a level 2 mathematics qualification will also provide the foundation to access mathematics at a higher level, if required.

Technical Qualifications should contain sufficient and appropriate maths to help students reach threshold competence in their chosen specialism(s). The following General Maths Competencies (GMCs) have been developed with input from the Royal Society Advisory Committee on Maths Education (ACME), and awarding organisations will need to embed these, and the underpinning maths, into the specifications and assessments being developed as part of the Technical Qualification.

The GMCs below are relevant to this particular Technical Qualification:

- Communicate using mathematics
- Cost a project
- Estimate, calculate and error-spot
- Measure with precision
- Optimise work processes
- Process data
- Represent with mathematical diagrams
- Understand data
- Use rules and formulae
- Work with proportion.

Awarding organisations that are awarded an exclusive licence will need to integrate these into the Technical Qualification specification and assessments, drawing upon a more detailed framework of maths that underpins the GMCs, currently being developed in association with the Royal Society ACME.

English

The completion of a level 2 English qualification (English language GCSE or Functional Skills) is a minimum exit requirement for all T Levels. This will ensure that all students have demonstrated that they can read fluently, communicate and write effectively, and demonstrate a confident control of Standard English.

The specification for a Technical Qualification should ensure that students acquire the technical vocabulary, and gain the practical communication skills (written and oral), needed to achieve threshold competence in their chosen occupational specialism(s).

The assessments for Technical Qualifications should ensure that students:

- Know the correct technical vocabulary and use it appropriately

- Apply their communication skills (written and oral) appropriately, using Standard English
- Use accurate spelling, punctuation and grammar.

Digital

Technical Qualifications should contain sufficient and appropriate digital skills to help students reach threshold competence in their chosen specialism(s).

This Technical Qualification should support students to develop the digital knowledge and skills needed in order to:

- Adopt professional approaches to using digital communications and social media
- Collate, manage, access and use digital data in spreadsheets, databases and other formats
- Design and create new digital artefacts and materials such as digital writing, digital image, digital audio and video, digital code, apps and interfaces and web pages
- Follow licensing guidelines, using only approved and licensed software applications
- Gather and organise information from different digital sources
- Make use of standard analytical tools in applications to better interpret information.

Awarding organisations that are awarded an exclusive licence will need to integrate these into the Technical Qualification specification and assessments.