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# **Pearson BTEC Levels 4 and 5 Higher Nationals specification in Construction and the Built Environment (QCF)**

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## **Unit 1: Design Principles and Application for Construction and the Built Environment**

**Unit code:** D/601/1245

**QCF level:** 4

**Credit value:** 15

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### ● **Unit aim**

This unit provides learners with the opportunity to develop an understanding of the design process and how the planning and design phases are coordinated and managed.

### ● **Unit abstract**

This unit enables learners to demonstrate an understanding of design considerations and the design process. Learners will develop their ability to evaluate the planning and design phases and consider the environmental impact of construction projects. Learners will explore the roles and legal responsibilities of all parties involved in construction projects. Learners will also gain an understanding of how emerging technologies affect the design and production phases of construction projects.

### ● **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand the planning and design phases of the construction process
- 2 Understand the factors that affect the specification of materials and building services
- 3 Understand how environmental factors affect the planning and design phases of the construction process
- 4 Understand the roles and responsibilities of all parties involved in construction projects
- 5 Understand how technology affects the design and production phases of construction projects.

## Unit content

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### 1 Understand the planning and design phases of the construction process

*Planning phase:* legal restraints; planning constraints; building regulations; building control; disabled access; current legislation e.g. Disability Discrimination Act 2005

*Design phase:* client brief; intended use; change of use; versatility; disabled access; relevant legislation; project aesthetics; influence of shape, size and proportion; position; location; structural considerations of building e.g. engineering project or plant installation; effects of green, brown and reclaimed land on planning and design; financial implications of design; sources of funding; lifecycle cost planning (costs of commissioning, costs in use, lifecycle costing, cost modelling, facilities management)

### 2 Understand the factors that affect the specification of materials and building services

*Factors:* client requirements; constraints (technical, legal, environmental); financial implications (sourcing, funding, planning, maintenance)

*Specification of materials:* aesthetics; performance in use; energy efficiencies e.g. production and processing of materials; environmental impact

*Specification of building services:* requirements for temporary and permanent service installations; disposal of waste materials during construction process; disposal of waste materials during life of the building; impact of legislation on design of service installations; sustainable urban drainage systems (SUDS); renewable energy sources; integration of services into overall design

### 3 Understand how environmental factors affect the planning and design phases of the construction process

*Environmental factors:* specification of sustainable materials; different forms of construction; new and renewable resources; use of recycled materials; safe and efficient disposal of waste materials; impact of construction process on environment

### 4 Understand the roles and responsibilities of all parties involved in construction projects

*Roles and responsibilities:* of each party to the project; current legislation applicable to each stage of a project (planning, development, design, production); responsibilities (corporate, personal) under current legislation; different responsibilities of design, planning and production teams

### 5 Understand how technology affects the design and production phases of construction projects

*Technology:* use of computer systems in the design process; modern methods of construction; effect of design on construction methods; development of new materials; use of construction plant

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the planning and design phases of the construction process	1.1 discuss the planning phase of construction projects 1.2 discuss the design phase of construction projects 1.3 evaluate how the planning and design phases are coordinated and managed
LO2  Understand the factors that affect the specification of materials and building services	2.1 examine the factors that affect the specification of materials 2.2 examine the factors that affect the specification of building services 2.3 explain the financial implications of specifying materials and building services
LO3  Understand how environmental factors affect the planning and design phases of the construction process	3.1 discuss the environmental factors that affect construction projects 3.2 evaluate environmentally responsible methods for disposing of waste materials 3.3 evaluate environmentally responsible methods for promoting environmental efficiency
LO4  Understand the roles and responsibilities of all parties involved in construction projects	4.1 explain the roles and responsibilities of all parties involved in the planning and design phases 4.2 explain the roles and responsibilities of all parties involved in the production phase 4.3 evaluate the corporate and personal responsibilities of all parties involved in construction projects
LO5  Understand how technology affects the design and production phases of construction projects	5.1 discuss the modern technology available to designers, planners and builders 5.2 evaluate the effect of technological advances on the various phases of construction projects

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 12: Conversion and Adaptation of Buildings*
- *Unit 13: Environmental Impact of Construction*
- *Unit 20: Construction Methods and Design Solutions*
- *Unit 24: Design Procedures for Construction*
- *Unit 25: Design Technology for Construction*
- *Unit 37: Advanced Civil Engineering*
- *Unit 39: Transportation for Construction and the Built Environment.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that learners have a sound understanding of the principles that underpin the planning and design of a construction project.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example design consultants, local authority officers, design technologists and/or construction managers. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.

## Unit 2: Science and Materials for Construction and the Built Environment

**Unit code:** H/601/1246

**QCF level:** 4

**Credit value:** 15

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### ● Aim

This unit provides learners with an understanding of the properties, structural behaviour and use of construction materials, and develops the skills needed to use scientific principles to solve construction problems.

### ● Unit abstract

This unit introduces scientific principles relevant to the study of construction and the built environment and provides learners with a fundamental understanding of the properties and use of construction materials. This unit has been designed to enable learners studying construction, civil engineering and/or building services engineering programmes to explore scientific principles and the behaviour of materials used in the construction and built environment sector.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the properties and use of construction materials
- 2 Understand the structural behaviour of construction materials
- 3 Be able to apply scientific principles to the design and use of buildings
- 4 Be able to solve scientific problems in construction and the built environment.

## Unit content

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### 1 Understand the properties and use of construction materials

*Materials:* metals and alloys e.g. iron, steel, zinc, copper, brass, aluminium, lead; timber and timber products; clay products e.g. bricks, tiles; cements and concretes; plastics and other artificial materials; coatings and finishes e.g. paints, clear finishes, wood treatments

*Properties of materials:* as appropriate to field of study e.g. strength, elasticity, porosity and water absorption, thermal and moisture movement, thermal and electrical conductivity/resistivity, durability, workability, density, specific heat capacity, viscosity

*Uses of materials:* construction; refurbishment; maintenance; replacement; energy efficiency; environmental issues; use of renewable resources

### 2 Understand the structural behaviour of construction materials

*Structural behaviour:* relationship between behaviour and use; forms of loading; inherent properties of structural materials (timber, steel, reinforced concrete); behaviour of structural materials when formed into structural members e.g. beams, columns, frames, pads, bases, studs, steel brackets

### 3 Be able to apply scientific principles to the design and use of buildings

*Design and use of buildings:* factors affecting human comfort levels; building services; thermal performance

*Factors affecting human comfort:* thermal comfort (air temperature, mean radiant temperature, air velocity, relative humidity); lighting comfort (natural light, artificial light, minimum levels of illumination, glare); acoustic comfort (sound transmission, sound absorption, sound insulation, reverberation)

*Building services:* cold water supply and distribution; gas supply and distribution; electricity supply and distribution; safe and effective disposal of waste products; refrigeration and air conditioning; fluid flow (hydrostatics, fluid dynamics)

*Thermal performance levels:* thermal properties of materials; heat losses (fabric, ventilation, hot water); heat gains (solar, casual); required level of heat input; adequate levels of ventilation

### 4 Be able to solve scientific problems in construction and the built environment

*Scientific problems:* experimentation relevant to the above as appropriate to field of study; use of scientific method (nature of experiment, intended aims and objectives, apparatus, method, results, calculations, analysis, conclusion)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the properties and use of construction materials	1.1 describe the properties of construction materials 1.2 evaluate the properties and uses of construction materials 1.3 justify the specification of construction materials regarding their performance in use
LO2  Understand the structural behaviour of construction materials	2.1 discuss the effects of loading structural materials 2.2 compare the behaviour of timber, steel and reinforced concrete structural members under load
LO3  Be able to apply scientific principles to the design and use of buildings	3.1 relate scientific principles to human comfort levels 3.2 discuss the methods used to integrate building services into the overall building design 3.3 determine the thermal performance of buildings regarding heat gains and heat losses
LO4  Be able to solve scientific problems in construction and the built environment	4.1 perform scientific experiments associated with construction science and materials 4.2 derive conclusions from the results of the scientific experiments

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 3: Applied Mathematics for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 10: Building Services Design, Installation and Maintenance in Construction*
- *Unit 12: Conversion and Adaptation of Buildings*
- *Unit 21: Specification and Contract Documentation for Construction*
- *Unit 22: Structural Behaviour and Detailing*
- *Unit 24: Design Procedures for Construction*
- *Unit 26: Properties and Performance of Construction Materials*
- *Unit 34: Structural Analysis and Design*
- *Unit 38: Hydraulic Principles and Applications*
- *Unit 40: Thermofluids and Acoustic Criteria for Building Services Engineering*
- *Unit 41: Air Conditioning for Industrial and Commercial Buildings*
- *Unit 42: Low Pressure Hot Water Heating for Non-domestic Buildings*
- *Unit 44: Air Conditioning for Complex Industrial and Commercial Buildings*
- *Unit 45: Heating Systems for Industrial and Specialist Applications*
- *Unit 58: Application of Scientific Principles to Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## **Employer engagement and vocational contexts**

Tutors should use real-life case studies as part of the assessment for this unit. The assessment could include an oral exposition of the materials used to satisfy scientific and environmental aspects of building or civil engineering projects.



## Unit 3: Applied Mathematics for Construction and the Built Environment

**Unit code:** K/601/1247

**QCF level:** 4

**Credit value** 15

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- **Aim**

This unit provides learners with an opportunity to develop skills in using analytical methods and statistics to solve construction and engineering problems.

- **Unit abstract**

This unit provides learners with an understanding of analytical techniques and the mathematical skills needed to solve construction and engineering problems. This unit has been designed to enable learners to use mathematical processes to solve construction, civil engineering and building services engineering problems. It is also intended to provide a basis for further study of the analytical methods and engineering mathematics needed for learners working in civil engineering and building services engineering disciplines.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Be able to apply analytical methods to construction problems
- 2 Be able to apply analytical methods to surveying and setting out procedures
- 3 Be able to apply statistics to construction problems
- 4 Be able to apply analytical methods to engineering problems.

## Unit content

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### 1 Be able to apply analytical methods to construction problems

*Analytical methods:* algebra; graphical techniques; laws of motion; matrices; application to construction problems

*Algebra:* linear; simultaneous and quadratic equations; laws of indices and logarithms; common and Naperian logarithms; indicial equations; direct and inverse proportion; inequalities; functional notation and manipulation of algebraic problems

*Graphical techniques:* functions; points of intersection between two graphs; graph sketching (straight line, polynomial, exponential, logarithmic), fitting lines to experimental data (using least squares method)

*Laws of motion:* space/time and velocity/time diagrams; determination of displacement, velocity and acceleration; momentum; impulse; projectiles

*Matrices:* multiplication; transposition; inversion; use in solution of simultaneous equations

*Application to construction problems:* analysis and design issues; processes and operations; resource issues e.g. labour, materials, plant and equipment, finance; project planning; costs (analysis, control, management)

### 2 Be able to apply analytical methods to surveying and setting out procedures

*Analytical methods:* trigonometry; irregular areas and volumes; applications

*Trigonometry:* coordinate systems (rectangular, polar, bearings); basic trigonometric ratios and their inverses; trigonometric ratios for the four quadrants; solution of triangles; areas and volumes of regular solids

*Irregular areas and volumes:* mid-ordinate rule; trapezoidal rule; Simpson's rule

*Applications:* levelling; contouring; triangulation; traversing; cut and fill; setting out (buildings, roads, drains)

### 3 Be able to apply statistics to construction problems

*Statistical methods:* tables and graphs; central tendency and dispersion; distribution theory; applications

*Tables and graphs:* data collection and presentation e.g. histograms, bar charts, line diagrams, cumulative frequency diagrams, scatter plots

*Central tendency and dispersion:* concept of central tendency (mean, median, mode); dispersion (standard deviation, variance, interquartile range)

*Distribution theory:* normal distribution; confidence limits; Null hypothesis; significance testing

*Applications:* presentation of data; estimation; prediction; quality control

**4 Be able to apply analytical methods to engineering problems**

*Analytical methods:* trigonometrical techniques; calculus; applications

*Trigonometrical techniques:* vector analysis e.g. static forces, relative motion, frameworks

*Calculus:* differentiation and integration of simple functions

*Applications:* analysis of engineering problems e.g. growth and decay, turning points, locating maxima and minima, areas under graphs, root mean square values; use in electrical theory, structural mechanics, fluid mechanics as appropriate

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to apply analytical methods to construction problems	1.1 determine resource requirements for construction projects  1.2 perform calculations for project planning and cost analysis
LO2  Be able to apply analytical methods to surveying and setting out procedures	2.1 solve surveying problems  2.2 perform calculations to support setting out procedures
LO3  Be able to apply statistics to construction problems	3.1 compile construction data for statistical purposes 3.2 present construction data in appropriate formats 3.3 use statistical methods to solve problems involving estimation, prediction and quality control
LO4  Be able to apply analytical methods to engineering problems	4.1 solve engineering problems using vector analysis  4.2 solve engineering problems using calculus

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 10: Building Services Design, Installation and Maintenance in Construction*
- *Unit 16: Measuring, Tendering and Estimating for Construction and the Built Environment*
- *Unit 18: Measurement Processes for Construction*
- *Unit 22: Structural Behaviour and Detailing*
- *Unit 23: Advanced Measurement for Construction*
- *Unit 27: Site Surveying Procedures for Construction and the Built Environment*
- *Unit 34: Structural Analysis and Design*
- *Unit 36: Applied Mathematics for Complex Engineering Problems*
- *Unit 38: Hydraulic Principles and Applications*
- *Unit 39: Transportation for Construction and the Built Environment.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to a suitable electronic calculator and will be introduced to mathematical software packages where appropriate.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.



## Unit 4: Management Principles and Application for Construction and the Built Environment

**Unit code:** T/601/1249

**QCF level:** 5

**Credit value:** 15

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- **Aim**

This unit provides learners with an opportunity to understand management principles and their application to the construction and built environment sector.

- **Unit abstract**

This unit introduces learners to the principles and application of management as they relate to the technical and professional disciplines of construction, civil engineering and building services engineering. It is based on the principles of the *Latham Report of 1994*, which advocated non-adversarial, multi-disciplinary teamworking. Learners will gain an understanding of how these principles may be applied to the management of construction, building services engineering or civil engineering activities through the application of recognised management techniques.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand the evolution of management principles and their application to the construction and built environment sector
- 2 Understand the construction and built environment sector in terms of structures and activities
- 3 Understand management techniques used in the construction and built environment sector
- 4 Understand the methods of procurement and contracting used in the construction and built environment sector.

## Unit content

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### 1 Understand the evolution of management principles and their application to the construction and built environment sector

*Principles of management:* management pioneers and thinkers e.g. McGregor, Maslow, Herzberg, Drucker; definitions; processes e.g. forecasting, planning, organising, motivating, controlling, coordinating, communicating

*Human resources management:* individuals and teams (behaviour, motivation, leadership)

### 2 Understand the construction and built environment sector in terms of structures and activities

*Structure and activities:* sectors e.g. construction, civil engineering, building services engineering; nature of services provided by each sector; general roles and responsibilities of members of project teams; specific roles and responsibilities of professionals within project teams

*Organisational structures and approaches:* direct line; lateral, functional and staff relationships; chain of command; span of control; concepts of responsibility e.g. duty, authority, accountability, delegation; corporate theories e.g. mission, strategy, planning, policies, objectives, values; centralised and decentralised organisations; project-based organisations; job design; team structures; teamworking

*Influence of scale and size of contracts:* project and contract procurement; contractual methods; impact of contract on management of organisations e.g. role of designer, main contractor, sub-contractor, supplier

### 3 Understand management techniques used in the construction and built environment sector

*Planning:* project organisation (layout and accommodation, method statements, plans of work, safety plans) coordination; monitoring; control e.g. Gantt charts, critical path arrow diagrams, precedence diagrams, line of balance; manual and computer-based techniques

*Procurement scheduling and control:* materials; plant; supply chain management; Just In Time; recycling and safe disposal of demolished materials; waste management; scheduling; resourcing and utilisation of sub-contracted and direct labour; budget and cost control (estimated cost, planned performance cost, actual cost, cash flow)

*Quality control:* audit; inspection; statutory liaison

*Risk management:* assessment; liabilities; risks; security; insurance requirements

*Other considerations:* workforce recruitment; training; assessment and legislative requirements e.g. equal opportunities, health and safety; information verification and control; site meetings; communication and reporting; client liaison; public liaison; government initiatives

### 4 Understand the methods of procurement and contracting used in the construction and built environment sector

*Procurement methods:* traditional methods of tendering; other methods e.g. partnering, public private partnerships, Private Finance Initiative (PFI); client and project objectives

*Contracts:* legal definitions; forms of contract; stages within a contract; contractual obligations of performance (time, cost, quality, insurance, warranty arrangements); rights of parties to contract

*Practice of procurement:* construction teams e.g. multi-disciplinary teams, integrated teams, partnering; government initiatives e.g. Latham Report, Egan Report; benchmarking; key performance indicators (KPIs); sustainability and environmental management issues; legislation; corporate values; professional standards

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the evolution of management principles and their application to the construction and built environment sector	1.1 explain the principles of management used in the construction and built environment sector  1.2 explain the influence of human resources management on the performance of individuals and teams
LO2  Understand the construction and built environment sector in terms of structures and activities	2.1 discuss the structure and activities of the construction and built environment sector  2.2 evaluate the organisational structures and approaches used in the construction and built environment sector  2.3 discuss how the scale and size of contracts influence business practices within the construction and built environment sector
LO3  Understand management techniques used in the construction and built environment sector	3.1 explain the use of planning in the management of construction projects  3.2 explain how procurement scheduling and control are managed  3.3 explain how quality control and risk management are managed
LO4  Understand the methods of procurement and contracting used in the construction and built environment sector	4.1 evaluate the procurement methods used in the construction and built environment sector  4.2 explain the use of contracts to manage construction projects  4.3 evaluate the impact of procurement techniques on the organisation and operation of construction firms and construction projects

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 11: Contractual Procedures and Procurement for Construction and the Built Environment*
- *Unit 14: Economics for Construction and the Built Environment*
- *Unit 15: Production Management for Construction*
- *Unit 17: Project Management for Construction and the Built Environment*
- *Unit 57: Project Management for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to appropriate IT, library and internet resources, case study material and, where possible, examples of actual organisations in various sectors of the industry using different types of contract/procurement arrangements.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to local construction sites, to help learners understand the application of management techniques within design and construction processes. To ensure site visits are successful tutors should outline the aims and objectives of the visits and conduct preparatory briefings. Tutors should organise presentations by visiting speakers, for example representatives from local firms detailing how the sector operates in terms of its structures and activities, or methods of procurement, contracting and other practices used within the construction and built environment sector. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 5: Group Project in the Construction Industry

**Unit code:** K/601/1250

**QCF level:** 5

**Credit value:** 20

### ● Aim

This unit provides learners with an opportunity to develop the skills needed to devise and implement a project scope and scheme of work, and evaluate and present the project.

### ● Unit abstract

This unit will develop learners' skills in terms of the evaluation and resolution of realistic practical problems and the ability to work as part of a team. This unit also enables the application of knowledge, understanding and skills developed in other units, and where possible experiences from work, to a major piece of work. This unit is designed to bring together small groups of learners into teams so that they can coordinate their individual skills and abilities. The scheme of work should give individual learners an opportunity to take responsibility for their contribution to the outcome, and demonstrate their ability to work as part of a team. The brief will include an agreed timescale, within defined constraints, with the teamworking towards an acceptable and viable solution to the agreed brief. Learners will also develop skills to carry out evaluations of the group project and be able to present solutions.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to devise a project scope and scheme of work
- 2 Be able to implement the scheme of work
- 3 Be able to evaluate the group project
- 4 Be able to present the group project.

## Unit content

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### 1 Be able to devise a project scope and scheme of work

*Group roles and activities:* team roles and responsibilities; record keeping processes e.g. logbook and team meeting minutes; assessment criteria

*Specification:* client brief; technical and non-technical specifications (materials and components); constraints (environmental, sustainability, operational, cost, time); legislation, standards and codes of practice; quality control; health and safety

*Initial proposals:* brainstorming; sketches; appraisal and review e.g. materials, sustainability, environment, cost

### 2 Be able to implement the scheme of work

*Developmental stage:* field data; geotechnical information; statistical data; drawings and graphical displays; calculations; costing; feasibility analysis; risk and impact assessments; method statements

*Documentary evidence:* logbook entries; team meeting minutes

### 3 Be able to evaluate the group project

*Evaluation:* initial proposal; final proposals; conclusions; suggestions for improvement; key decisions; group dynamics

### 4 Be able to present the group project

*Format and content of project:* reports; calculations; costing; drawings; method statements; risk assessments; data; product and component specifications; minutes of meetings; correspondence; logbooks

*Presentation of project:* preparation, documentation; suitable format; media appropriate to format; target audience; delivery

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to devise a project scope and scheme of work	1.1 plan group roles and activities 1.2 formulate specifications with regard to constraints 1.3 formulate initial proposal(s)
LO2  Be able to implement the scheme of work	2.1 produce documentary evidence of the project development 2.2 produce a final design proposal to meet the agreed specification
LO3  Be able to evaluate the group project	3.1 evaluate the project making recommendations for improvement
LO4  Be able to present the group project	4.1 present records of project development and group activity 4.2 present the project solution in a suitable format, using appropriate media

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 30: Work-based Learning and Assessment in Construction and the Built Environment*
- *Unit 31: Work-based Training and Development in Construction and the Built Environment*
- *Unit 59: Employability Skills*
- *Unit 61: Project Design, Implementation and Evaluation.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Tutors must ensure that the roles and responsibilities of the individuals within the group are understood and agreed. Higher-level skills should feature strongly throughout the project development, implementation and presentation stages and learners must be aware of how and where these will be assessed.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## **Unit 6: Health, Safety and Welfare for Construction and the Built Environment**

**Unit code:** T/601/1252

**QCF level:** 4

**Credit value:** 15

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### ● **Aim**

This unit enables learners to develop an understanding of health, safety and welfare legislation and effective health and safety policies. Learners will develop the skills needed to undertake risk assessments.

### ● **Unit abstract**

On completion of this unit, learners will understand current health, safety and welfare legislation applicable to the construction and built environment sector. Learners will understand the main requirements of an effective health and safety policy and its successful implementation in the workplace. Learners will understand how to identify and record hazards, assess risks and select appropriate control measures to prevent or mitigate ill health and injuries on site. Work carried out for this unit will contribute to health and safety plans within project work and allows learners to contribute to the safety policy and arrangements. Learners will also gain an understanding of the need to review, revise and monitor risk assessments.

### ● **Learning outcomes**

#### **On successful completion of this unit a learner will:**

- 1 Understand the health, safety and welfare legislation applicable to the construction and built environment sector
- 2 Understand the main requirements of an effective health and safety policy
- 3 Understand hazard and risk identification in design and construction
- 4 Understand the need to review, revise and monitor risk assessments
- 5 Be able to undertake risk assessments.

## Unit content

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### 1 Understand the health, safety and welfare legislation applicable to the construction and built environment sector

*Legislation and approved codes of practice:* current relevant legislation to include The Health and Safety at Work etc. Act 1974, The Construction (Design and Management) Regulations 2007, approved codes of practice and guidance notes, The Management of Health and Safety at Work Regulations 1999

*Implications of legislation:* roles and responsibilities of individual team members; requirement for compliance with all relevant legislation; likely results of non-compliance; penalties associated with non-compliance

### 2 Understand the main requirements of an effective health and safety policy

*Health and safety policy statement:* sections e.g. statement of intent, organisation section, arrangements

*Health and safety organisation and arrangements:* health and safety procedures; legal requirement to report accidents; effectiveness of health and safety procedures; importance of training and competency e.g. induction training, Construction Skills Certificate Scheme (CSCS); statutory requirements for inspection of plant and equipment; recording of health and safety data to meet legal requirements; communicating procedures; recording findings of health and safety inspections and supporting data

### 3 Understand hazard and risk identification in design and construction

*Hazard identification:* direct observation; examining records; conducting interviews

*Hazard ratings:* quantitative grading of severity of hazards and risks

*Recording:* scheduled recording; documentation of hazards and risks from a variety of perspectives e.g. physical, environmental, chemical, biological, psychosocial; chronic occupational health risks to include asbestos, lead and crystalline silica; hazards leading to risks in the workplace

### 4 Understand the need to review, revise and monitor risk assessments

*Reasons to review, revise and monitor risk assessments:* changes to legislation; changes in workplace practice; impact of accidents and ill health; subsequent investigations; feedback from employees and safety representatives (unsafe conditions, dangerous occurrences, near misses); other information and advice

*Recording and implementation of reviews, revisions and monitoring:* revised risk and other assessments; alerting employees to new policies, procedures and findings; monitoring the effectiveness of new procedures

**5 Be able to undertake risk assessments**

*Types of risk assessment:* nature of specialist knowledge required; generic and specific risk assessment requirements; assessment (level of risk, who is at risk; risk outcome from hazards that cannot be eliminated)

*Assessment of specific risks:* effects of hazardous substances (short term, long term); need for manual handling assessments; assessment of possible likelihood and severity of injury; use of quantifiable risk rating systems

*Undertaking of risk assessment:* standard format; recording risk assessment findings; production of appropriate paperwork

*Reviewing preventative and protective measures:* workplace precautions and risk control systems; risk control hierarchy; personal protective equipment

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the health, safety and welfare legislation applicable to the construction and built environment sector	1.1 discuss the use of approved codes of practice to ensure compliance with health and safety legislation  1.2 explain the responsibilities for providing welfare facilities on-site  1.3 evaluate the penalties for non-compliance with current health and safety at work legislation
LO2  Understand the main requirements of an effective health and safety policy	2.1 analyse organisational health and safety policies and procedural documents  2.2 determine training needs from given risk assessments, including on-site induction training and relevant sector certification
LO3  Understand hazard and risk identification in design and construction	3.1 select a method of hazard identification using data supplied  3.2 identify the hazards associated with construction processes  3.3 explain the use of standard formats for identifying and recording hazards  3.4 explain how risk assessments are used to address significant hazards
LO4  Understand the need to review, revise and monitor risk assessments	4.1 monitor and review risk assessments in light of changes to circumstances  4.2 evaluate changes in procedure or policy  4.3 justify the effectiveness of the implemented changes
LO5  Be able to undertake risk assessments	5.1 produce risk assessments for different workplaces and forms of work

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 8: Technology of Complex Buildings*
- *Unit 9: Law and Contract for Construction and the Built Environment*
- *Unit 10: Building Services Design, Installation and Maintenance in Construction*
- *Unit 11: Contractual Procedures and Procurement for Construction and the Built Environment*
- *Unit 12: Conversion and Adaptation of Buildings*
- *Unit 16: Measuring, Tendering and Estimating for Construction and the Built Environment*
- *Unit 19: Building Control Procedures and Legislation*
- *Unit 24: Design Procedures for Construction*
- *Unit 33: Civil Engineering Technology.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners must undertake risk assessments for three different workplace environments. Case studies, case law review and individual assignments are an essential part of delivery.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## **Employer engagement and vocational contexts**

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review their site visits, for example producing risk assessments and reports for management on the hazards and risks, risk mitigation and recommendations for improvement based on site visits. Tutors should organise presentations by visiting speakers, for example occupational health professionals on pre-employment, chronic and acute health effects and/or health surveillance regarding asbestos. Tutors should use real-life case studies for part of the assessment for this unit, analysing own centre and/or companies policies, procedures and case law (both statute breaches and prosecution/compensation cases).

## Unit 7: Construction and Maintenance of Buildings

**Unit code:** F/601/1254

**QCF level:** 4

**Credit value:** 15

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- **Aim**

This unit enables learners to gain an understanding of how the techniques of site investigation and evaluation can influence the design, construction and maintenance of buildings and their substructures.

- **Unit abstract**

This unit introduces learners to the fundamental aspects of construction technology. This unit has been designed to enable learners studying construction-related programmes to understand and compare the standard design forms, site investigation and evaluation methods used in construction and the built environment. Learners will also gain an understanding of how decay, pollution and dilapidations can affect buildings.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand the techniques used in site investigation and evaluation
- 2 Understand how the techniques used in site investigation and evaluation influence the type of substructure
- 3 Understand the types of superstructure design and construction
- 4 Understand the causes of decay and deterioration of buildings.

## Unit content

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### 1 Understand the techniques used in site investigation and evaluation

*Site investigation and evaluation:* survey of existing buildings and building services, topography of site; access to site; location of water table; nature, thickness and inclination of subsoil strata; classification of soils and sub-soils; testing of soils e.g. density, moisture content, void ratio, degree of saturation, permeability, porosity, shear strength, liquid limit, chemical nature; environmental issues associated with contaminated land

### 2 Understand how the techniques used in site investigation and evaluation influence the type of substructure

*Type of substructure:* characteristics of substructure; types of foundation; functions of substructure and foundations

*Design of substructure:* factors that influence selection of foundations; building control and regulations; structural considerations; soil type, effect of water and chemicals in soils; need for temporary and permanent dewatering; classification and characteristics of soils; issue of contaminated land; excavation techniques; disposal of soil; materials; sizing

### 3 Understand the types of superstructure design and construction

*Types of superstructure:* walls; roofs; structural frames; claddings; finishes; services

*Walls and roofs:* domestic, industrial and commercial; external and internal walls; flat and pitched roof construction and coverings; medium and long span construction techniques

*Structural frames:* selection and types e.g. steel, concrete, timber, laminated timber

*Claddings:* steel; plastic; concrete; glass; industrial and commercial roof construction and coverings; insulation; fire protection; issues of corrosion; protection from corrosion

*Finishes and services:* internal and external joinery and ironmongery; internal structures; internal finishes; simple primary services design and installation

### 4 Understand the causes of decay and deterioration of buildings

*Decay and deterioration of buildings:* causative factors e.g. human, chemical, biological, atmospheric, structural, thermal movement, moisture movement, fire, vandalism

*Maintenance:* routine maintenance works and adaptation works; conservation of scarce materials; routine cleaning; cyclical and preventative maintenance; cause and effect of dilapidations

*Common faults:* poor or inappropriate design; poor workmanship; inappropriate selection and use of materials and systems

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the techniques used in site investigation and evaluation	1.1 explain the techniques used to investigate and evaluate sites  1.2 compare the techniques used to investigate and evaluate soils  1.3 analyse soils in terms of their classification and chemical composition
LO2  Understand how the techniques used in site investigation and evaluation influence the type of substructure	2.1 explain how the classification and properties of soils affect substructure design  2.2 evaluate the effects of water, chemicals and contaminated soils on the design and construction of a substructure
LO3  Understand the types of superstructure design and construction	3.1 evaluate the types of construction used for the superstructure of domestic buildings  3.2 evaluate the types of construction used for the superstructure of industrial and commercial buildings  3.3 discuss the specifications of internal finishes commonly used in buildings  3.4 evaluate how the installation of primary services affects the design of buildings
LO4  Understand the causes of decay and deterioration of buildings	4.1 explain the causes of decay and deterioration in buildings and building services  4.2 compare planned, cyclical and reactive maintenance works  4.3 evaluate the relationship between design, construction, maintenance and the causes of dilapidations

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 8: Technology of Complex Buildings*
- *Unit 13: Environmental Impact of Construction*
- *Unit 16: Measuring, Tendering and Estimating for Construction and the Built Environment*
- *Unit 18: Measurement Processes for Construction*
- *Unit 19: Building Control Procedures and Legislation*
- *Unit 20: Construction Methods and Design Solutions*
- *Unit 21: Specification and Contract Documentation for Construction*
- *Unit 23: Advanced Measurement for Construction*
- *Unit 24: Design Procedures for Construction*
- *Unit 25: Design Technology for Construction*
- *Unit 26: Properties and Performance of Construction Materials.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Consideration must be given to sustainable methods of construction and environmental issues when selecting and using materials. Construction methods and practices must comply with health, safety and welfare legislation and practice. Particular attention must also be given to the implications that site investigation and design of buildings has on their safe construction, use and maintenance. The Construction (Design and Management) Regulations 2007 Safety Plans are important in linking design and building aspects in order to avoid risk.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example building surveyors and/or designers on how to design out potential building defects. Tutors should use real-life case studies, for example superstructures for multi-storey buildings, and/or practical building surveys with maintenance recommendations.



## Unit 8: Technology of Complex Buildings

**Unit code:** J/601/1255

**QCF level:** 5

**Credit value:** 15

### ● Aim

This unit provides learners with an understanding of the materials, methods and buildability features of complex structures, and the sustainability, alteration, remediation and safe demolition of complex structures.

### ● Unit abstract

This unit focuses on the erection of complex multi-storey buildings and the use of modern systems to provide flexible internal space planning and design. These themes are developed to include how the useful life of buildings can be extended by alteration and repair techniques. The principles of buildability in terms of health and safety, efficiency, economy and quality of construction projects are analysed. The importance of developing a sustainable construction strategy is emphasised and learners will explore the methods and procedures involved in the safe demolition of buildings.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the materials and construction methods used for multi-storey buildings
- 2 Know the systems used to provide flexibility for internal layouts
- 3 Understand the features of buildability
- 4 Understand sustainable construction strategies
- 5 Understand the alteration, remediation and safe demolition of complex structures.

## Unit content

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### 1 **Understand the materials and construction methods used for multi-storey buildings**

*Construction methods:* structural frame; external envelope; structural floors; roofing; compatibility of materials and construction forms

### 2 **Know the systems used to provide flexibility for internal layouts**

*Internal layout systems:* demountable partitioning systems; infinite access floors; temporary room division; suspended ceilings; underfloor and vertical service ducting

### 3 **Understand the features of buildability**

*Features of buildability:* dimensional coordination and standardisation; considerations of access; services coordination; specification of materials; components and assemblies; simplicity of construction; effective communications; The Construction (Design and Management) Regulations 2007 (CDM)

### 4 **Understand sustainable construction strategies**

*Sustainable construction strategies:* environmental concerns; deforestation and manageable forestry; energy efficiency and insulation; alternative energy sources; embedded energy costs

### 5 **Understand the alteration, remediation and safe demolition of complex structures**

*Alteration and remediation:* project feasibility; underpinning; temporary support; modern conversion; adaptation and refurbishment techniques

*Demolition methods and procedures:* legal constraints e.g. building control constraints; health and safety considerations, CDM requirements

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the materials and construction methods used for multi-storey buildings	1.1 discuss the types of structural design used for multi-storey buildings  1.2 analyse the construction techniques used for multi-storey buildings  1.3 justify the materials specification for given multi-storey designs
LO2  Know the systems used to provide flexibility for internal layouts	2.1 describe the systems used to provide flexibility of spatial planning  2.2 describe how the choice of internal system layout can impact on building services
LO3  Understand the features of buildability	3.1 analyse buildability in terms of health and safety, efficiency, economy and quality of construction projects
LO4  Understand sustainable construction strategies	4.1 discuss the key features of sustainable construction strategies  4.2 explain how sustainable construction strategies benefit both modern and traditional methods of construction  4.3 evaluate construction methods and spatial planning used for multi-storey buildings in relation to sustainable construction strategies
LO5  Understand the alteration, remediation and safe demolition of complex structures	5.1 analyse alteration and repair techniques used to meet the needs of future occupiers of buildings  5.2 evaluate the methods used to demolish structures referring to associated documentation and compliance with legal constraints

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 12: Conversion and Adaptation of Buildings*
- *Unit 13: Environmental Impact of Construction*
- *Unit 20: Construction Methods and Design Solutions*
- *Unit 22: Structural Behaviour and Detailing*
- *Unit 23: Advanced Measurement for Construction*
- *Unit 25: Design Technology for Construction*
- *Unit 26: Properties and Performance of Construction Materials.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Construction methods and practices must comply with health, safety and welfare legislation. CDM Safety Plans are important in linking design and build aspects together in order to avoid risk.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example practical audits of centre buildings to determine their environmental credentials. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to work in teams and present their findings to the other groups. Tutors should organise presentations by visiting speakers, for example designers outlining methods used to design out potential building defects and/or building surveyors explaining the methods of eradicating common defects. Tutors should use real-life case studies, for example investigations into modern internal layout systems, structural frame types for multi-storey buildings and/or methods used for demolishing complex buildings.

## Unit 9: Law and Contract for Construction and the Built Environment

**Unit code:** R/601/1257

**QCF level:** 4

**Credit value:** 15

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### ● Aim

This unit provides learners with an opportunity to gain a knowledge and understanding of the principles and procedures of law as applied to the construction and built environment sector.

### ● Unit abstract

This unit will enable learners to develop an understanding of the national legal system, the Law of Contract and the liabilities and responsibilities of each party to a contract. Learners will also develop a working knowledge of the legal principles, procedures and requirements relating to the different types of contract used when undertaking national or international construction or civil engineering projects.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the principles and procedures of law and legislation as applied to the construction and built environment sector
- 2 Understand the liabilities and responsibilities of parties to construction contracts
- 3 Know the principles and procedures of law used to ensure the effective organisation and practice of construction companies
- 4 Know the legal principles and requirements used when undertaking construction projects in Europe.

## Unit content

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**1 Understand the principles and procedures of law and legislation as applied to the construction and built environment sector**

*Construction law:* the workings of the national legal system; the legal structures; principles of arbitration; alternative dispute resolution (ADR) and adjudication; Common Law; industrial tribunals; the nature of tort; the law of tort (significance for the construction and built environment sector); negligence; nuisance; trespass; statutory duties; liability

**2 Understand the liabilities and responsibilities of parties to construction contracts**

*Liabilities and responsibilities:* concept of contract as enforceable agreement; identification of main parties to contract; description of the responsibilities of main parties; contractual liabilities of main parties

**3 Know the principles and procedures of law used to ensure the effective organisation and practice of construction companies**

*Law relating to organisation and practice of construction companies:* company law; legal status of companies; employment law; law of land and property; sale; purchase and rental of goods; health, safety and welfare; employer liability; sub-contractor tax requirements

**4 Know the legal principles and requirements used when undertaking construction projects in Europe**

*European legal requirements:* principal requirements of the European legal system; tort; employment law; company law; contract law

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the principles and procedures of law and legislation as applied to the construction and built environment sector	1.1 explain how the national legal system applies to the construction and built environment sector 1.2 explain the legal structure and its procedures 1.3 explain the significance of common law to the construction and built environment sector 1.4 discuss the effect of the law of tort on the construction and built environment sector 1.5 compare the methods of alternative dispute resolution ADR and the industrial tribunal process
LO2  Understand the liabilities and responsibilities of parties to construction contracts	2.1 evaluate the roles and responsibilities of the main parties to construction contracts 2.2 analyse the contractual liabilities of the main parties to construction contracts
LO3  Know the principles and procedures of law used to ensure the effective organisation and practice of construction companies	3.1 describe how company law affects the operation of construction companies 3.2 describe how employment law affects the operation of construction companies
LO4  Know the legal principles and requirements used when undertaking construction projects in Europe	4.1 describe how European legal requirements affect the operation of construction companies

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 11: Contractual Procedures and Procurement for Construction and the Built Environment*
- *Unit 17: Project Management for Construction and the Built Environment*
- *Unit 57: Project Management for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is important that learners have access to the main types of building and engineering contracts and use these where appropriate. These contracts should be current or include amendments where necessary.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise presentations by visiting speakers, for example arbitrators and expert witnesses to explain their role in the legal process.

## **Unit 10: Building Services Design, Installation and Maintenance in Construction**

**Unit code:** R/601/1260

**QCF level:** 4

**Credit value:** 15

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- **Aim**

This unit provides learners with the opportunity to develop an understanding of the principles that underpin the design, installation and maintenance of building services in domestic, industrial and commercial buildings.

- **Unit abstract**

This unit provides learners with an understanding of the principal applications of building services to domestic, industrial and commercial buildings. Learners will also gain an understanding of issues related to the maintenance of building services. This unit should reinforce the need to coordinate building services installations within the overall construction process.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand the principles that underpin the design and installation of space heating, ventilation and air conditioning systems
- 2 Understand the principles that underpin the design and installation of building services distribution systems
- 3 Understand the principles that underpin the design and installation of building services disposal systems
- 4 Understand the principles that underpin the design and installation of lifts and escalators
- 5 Understand the issues associated with the maintenance of building services.

## Unit content

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### 1 Understand the principles that underpin the design and installation of space heating, ventilation and air conditioning systems

*Space heating systems:* space heating in buildings; type of systems available; criteria for the specification of systems (comfort needs, storage needs, availability of plant space, relationship to structure and finishes)

*Design and installation principles for space heating:* systems (low, medium and high pressure hot water systems; steam, warm air and radiant tube systems; gas and electric local appliances); issues associated with choice of fuel; energy sources and controls; types of boiler and ancillary plant; space requirements; issues associated with noise, loading and heat gains

*Ventilation and air conditioning systems:* need for ventilation and air conditioning in buildings; statutory and legal requirements; ventilation and air conditioning systems for industrial, commercial and public buildings; criteria for specification of systems (comfort needs; health, safety and welfare; user requirements; relationship to building design)

*Design and installation principles for ventilation and air conditioning:* natural and mechanical systems of ventilation; application to a range of building types and situations; natural ventilation; action of wind and thermal forces; use and interrelationship of air conditioning control systems (temperature, humidity, air cleanliness); types of system and their application; plant and space relationships; distribution and re-circulation systems; control mechanisms; fire dampers

### 2 Understand the principles that underpin the design and installation of building services distribution systems

*Building services distribution systems:* cold water, hot water, electricity, gas, telecommunications, fire alarm and detection; integration of distribution services

*Cold water distribution systems:* quality and characteristics of cold water supplies; by-law requirements; materials and components; special requirements for high-rise buildings; storage; related loadings on structure

*Hot water distribution systems:* hot water generators; direct and indirect systems; pressurised systems; safety requirements

*Electrical distribution systems:* power and lighting circuits; controls and cable systems; IEE Regulations for safe operation of installations; testing and inspection; temporary supplies on construction sites

*Gas distribution systems:* pipework; meters and associated controls; flues; ventilation requirements (balanced and fan-diluted flues)

*Telecommunication distribution systems:* data handling; control systems; ICT systems (including networking between buildings)

*Fire alarm and detection distribution systems:* alarm and detection systems; emergency lighting; relationship of systems to other services and escape routes; components and equipment; selection according to nature of hazard

*Integration of distribution services:* planning, design and installation of integrated services; effect on design of building structure; access issues; safety issues e.g. incompatibility of water and electricity

**3 Understand the principles that underpin the design and installation of building services disposal systems**

*Building services disposal systems:* foul water; surface water; domestic and commercial refuse

*Foul water disposal:* selection of sanitary appliances; layouts compatible with type of building; associated services; special provision for people with disabilities; criteria for the selection and installation of above-ground and below-ground drainage for domestic, industrial and commercial buildings; principles, applications and installation requirements for sewage disposal systems

*Surface water disposal:* domestic and small commercial buildings; flat and pitched roofs; criteria for the selection and installation of above-ground and below-ground drainage systems

*Domestic and commercial refuse disposal:* refuse handling; on-site storage and chute systems; mechanical handling; maceration; land fill; incineration; problems related to material separation and storage provision when recycling

**4 Understand the principles that underpin the design and installation of lifts and escalators**

*Design and installation of lifts and escalators:* operation; space for construction of shafts; structural and builders' work requirements; pits; motor rooms for electrical and hydraulic lifts; floor openings for escalators

*Health and safety risks:* special requirements for safe working (during construction, operation and maintenance)

**5 Understand the issues associated with the maintenance of building services**

*Building services maintenance issues:* integration at design and installation stages; consideration of space requirements; sequencing of installation procedures; access to installations; commissioning and testing; processes of coordinating and commissioning building services (at design, project planning and handover stages); construction of ducts, holes and voids (for purposes of access, safety and fire resistance)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
<p>LO1</p> <p>Understand the principles that underpin the design and installation of space heating, ventilation and air conditioning systems</p>	<p>1.1 justify the criteria used to specify space heating systems for buildings</p> <p>1.2 analyse the principles that underpin the design and installation of space heating systems</p> <p>1.3 justify the criteria used to specify ventilation systems and air conditioning systems</p> <p>1.4 analyse the principles that underpin the design and installation of ventilation systems and air conditioning systems</p>
<p>LO2</p> <p>Understand the principles that underpin the design and installation of building services distribution systems</p>	<p>2.1 analyse the principles that underpin the design and installation of hot and cold water systems</p> <p>2.2 analyse the principles that underpin the design and installation of electricity and gas distribution systems</p> <p>2.3 analyse the principles that underpin the design and installation of telecommunication, fire alarm and detection systems</p> <p>2.4 justify the methods used to integrate building services distribution services in a single building</p>
<p>LO3</p> <p>Understand the principles that underpin the design and installation of building services disposal systems</p>	<p>3.1 justify the design criteria used to specify foul water and surface water disposal systems</p> <p>3.2 evaluate the methods and techniques used in above-ground and below-ground disposal of foul water, including sewage treatment</p> <p>3.3 evaluate the methods and techniques used in above-ground and below-ground disposal of surface water</p> <p>3.4 compare the methods used to remove and dispose of domestic and commercial refuse from buildings</p>
<p>LO4</p> <p>Understand the principles that underpin the design and installation of lifts and escalators</p>	<p>4.1 assess the need to provide mechanical circulation for people and goods around buildings</p> <p>4.2 analyse design criteria and principles for lifts and escalators</p> <p>4.3 evaluate the health and safety risks associated with lift and escalator installations and operations</p>

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
L05  Understand the issues associated with the maintenance of building services	5.1 discuss the importance of an integrated approach to building design and building services  5.2 assess the health, safety and welfare aspects in relation to the maintenance of building services  5.3 evaluate the need for formal commissioning of all building services installations  5.4 justify the need to maintain buildings throughout their life

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 3: Applied Mathematics for Construction and the Built Environment*
- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 42: Low Pressure Hot Water Heating for Non-domestic Buildings*
- *Unit 45: Heating Systems for Industrial and Specialist Applications*
- *Unit 46: Piped Distribution Services for Non-domestic Buildings*
- *Unit 53: Electrical Protection and Transportation Installations for Non-domestic Buildings*
- *Unit 54: Building Management Systems for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Risk assessments must be produced, and complied with, for all practical activities, including visits to building services installations, building services merchants and component manufacturer premises. Learners require access to design data, CIBSE guides, Building Regulations, IEE Regulations and BSI codes of practice.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to building services installations, building services merchants and/or component manufacturer premises. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example building services engineers, planning consultants and/or environmental consultants. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.

## **Unit 11: Contractual Procedures and Procurement for Construction and the Built Environment**

**Unit code:** T/601/1266

**QCF level:** 5

**Credit value:** 15

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### ● **Aim**

This unit provides learners with the opportunity to gain knowledge of the roles, responsibilities and activities of the parties and organisations involved in contractual procedures and the procurement of building projects.

### ● **Unit abstract**

This unit develops a working knowledge of the nature and purpose of the legal requirements and procurement arrangements used in the construction and built environment sector. Learners will also gain knowledge of the parties and organisations involved in construction projects and how current issues and best practice are applied to the procurement of contracts. The varying available procurement arrangements will be considered throughout the design and construction cycle, from inception to completion of the contract. Learners will gain an understanding of the types of construction contracts in terms of time, cost, quality and supply chain management issues.

### ● **Learning outcomes**

#### **On successful completion of this unit a learner will:**

- 1 Understand the factors that affect the choice of construction procurement methods and contractual arrangements
- 2 Know current issues and best practice associated with the procurement of construction projects
- 3 Know the roles and activities of the parties and organisations involved in the procurement of construction projects
- 4 Understand construction contracts in terms of time, cost and quality
- 5 Understand construction contracts in terms of supply chain management.

## Unit content

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### 1 Understand the factors that affect the choice of construction procurement methods and contractual arrangements

*Procurement methods and contractual arrangements:* client requirements and priorities (project development); methods of procurement (for projects); variable factors associated with procurement and contractual recommendations e.g. time, cost, performance and risk; relationship between variable factors and procurement arrangements; surveys of the current use of procurement methods

*Selection of contract arrangements and procurement methods:* distinction between contract and non-contract documents; articles of agreement; conditions of and appendices to the different forms of contract; forms of contract used (construction and civil engineering projects)

### 2 Know current issues and best practice associated with the procurement of construction projects

*Issues associated with procurement of projects:* current issues (associated with procurement and contractual arrangements), issues originating from government, professional, trade and statutory bodies and contracting organisations; comparisons with practice in similar industries; recommendations from the sector and government-sponsored reports; developments and trends in practice; aspects of practice (Europe and other international markets)

### 3 Know the roles and activities of the parties and organisations involved in the procurement of construction projects

*Roles and activities of parties and organisations:* pre-contract activities; post-contract activities; different project phases; plans of work

*Duties and responsibilities:* involvement of specialists (planning, programming and progressing, on-site communications); roles and contractual responsibilities; role and activities of professional bodies, trade associations, government departments, statutory bodies

#### 4 Understand construction contracts in terms of time, cost and quality

*Forms of contract:* in terms of time; cost; quality

*Time:* commencement; completion; delays; extensions of time; postponement; phased completions; early commencement; optimum timescales; fast-tracking

*Cost:* price competition and negotiations e.g. fixed-price arrangements, price certainty, price forecasting, contract sum, interim certificates, payments, cash flows, retention, cost penalties, variations, dayworks, provisional and prime cost sums, sub-contractors and suppliers, claims, final costs, final certificate

*Quality:* materials; goods; standards of workmanship; specification; statutory obligations; The Construction (Design and Management) Regulations 2007; methods of working; testing; removal of defective work; quality assurance; other clauses of the contract

#### 5 Understand construction contracts in terms of supply chain management

*Supply chain management:* nominated, named and other sub-contractors; suppliers

*Nominated and named sub-contractors:* contract conditions; tendering arrangements; information requirements; main contract implications; forms and agreements

*Other sub-contractors:* contract conditions; domestic; directly employed; tendering criteria; information requirements; main contract implications; forms and agreements

*Suppliers:* contract conditions (identification, comparison); nominated; named; direct; specialist

## Learning outcomes and assessment criteria

<b>Learning outcomes</b> On successful completion of this unit a learner will:	<b>Assessment criteria for pass</b> <b>The learner can:</b>
LO1 Understand the factors that affect the choice of construction procurement methods and contractual arrangements	1.1 discuss the needs of clients for construction projects in the public and private sectors 1.2 analyse the choice of different procurement arrangements 1.3 compare the main contractual arrangements of the common forms of contract
LO2 Know current issues and best practice associated with the procurement of construction projects	2.1 describe current trends in procurement practice 2.2 outline the current issues associated with procurement and contractual procedures 2.3 outline the advantages and disadvantages of international methods of procurement
LO3 Know the roles and activities of the parties and organisations involved in the procurement of construction projects	3.1 describe how design and construction are sequenced in terms of procurement 3.2 describe the roles and principal contractual responsibilities of the parties involved in the procurement phase of a typical contract 3.3 outline the purpose and activities of the organisations involved in procurement for the construction and built environment sector
LO4 Understand construction contracts in terms of time, cost and quality	4.1 explain the implications of being ahead of or behind schedule for completion 4.2 compare project costs regarding pre-contract, tender and final account stages 4.3 evaluate contractual measures to ensure compliance with quality requirements
LO5 Understand construction contracts in terms of supply chain management	5.1 analyse contractual arrangements used with nominated, named and other types of sub-contractor 5.2 evaluate the types of contractual arrangements used with suppliers

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 4: Management Principles and Application for Construction and the Built Environment*
- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 9: Law and Contract for Construction and the Built Environment*
- *Unit 16: Measuring, Tendering and Estimating for Construction and the Built Environment*
- *Unit 57: Project Management for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is important that learners have access to the main types of building and engineering contracts and use these where appropriate. These contracts should be current or include amendments where necessary. Learners should be provided with extracts from the forms of contracts where appropriate. The form of contract will depend on whether learners are studying construction, civil engineering or building services engineering.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise presentations by visiting speakers, for example clients, designers and/or contract managers on the roles and responsibilities of parties involved in a contract and the roles and activities of the professional bodies. Tutors should use real-life case studies, for example procurement methods used for significant buildings, illustrating the implication of standard forms of contract for the client and contractor (time, cost and quality) and contractual conditions for nominated and named sub-contractors and suppliers.



## Unit 12: Conversion and Adaptation of Buildings

**Unit code:** A/601/1267

**QCF level:** 5

**Credit value:** 15

### ● Aim

This unit enables learners to understand the feasibility of modifying buildings for specific purposes and develop skills to produce drawings, specifications and construction plans to modify buildings using design briefs.

### ● Unit abstract

This unit enables learners to develop their understanding of building conversion and adaptation work. Learners will examine the feasibility of modifying existing buildings, the requirements of a design brief and the preparation of drawings and specifications to meet planning, building control and other current legislative requirements. Learners will prepare working drawings, specifications and produce construction plans to modify buildings.

### ● Learning outcomes

#### **On successful completion of this unit a learner will:**

- 1 Understand the feasibility of modifying existing buildings for specific requirements
- 2 Be able to use design briefs to modify existing buildings
- 3 Be able to produce drawings and specifications to modify existing buildings
- 4 Be able to produce construction plans.

## Unit content

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### 1 Understand the feasibility of modifying existing buildings for specific requirements

*Feasibility:* environmental requirements and considerations e.g. contribution to the built environment, carbon footprint, end-of-life options

*Requirements:* use of internal space; economic implications; structural implications; compliance with current legislation

### 2 Be able to use design briefs to modify existing buildings

*Design brief:* building layout (access, structural implications, limitations of modification); services (location, scope, limitations of modification); health, safety and welfare requirements (during construction phase)

*Legal aspects of modifying existing buildings:* planning; listed building status; building regulations; disability discrimination in relation to access; fire regulations

### 3 Be able to produce drawings and specifications to modify existing buildings

*Building survey:* condition survey; structural survey; measured survey; services layout

*Drawings:* outline drawings; sketch designs; production drawings

*Specifications:* materials; components; compliance with current legislation and codes of practice

### 4 Be able to produce construction plans

*Construction plan:* site layout; traffic management scheme; method statements (construction process); programming and progressing techniques; plant and labour requirements; The Construction (Design and Management) Regulations 2007 (CDM) requirements; health and safety plans; pre-commencement plans

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the feasibility of modifying existing buildings for specific requirements	1.1 evaluate the feasibility of modifying existing buildings to meet specific client requirements
LO2  Be able to use design briefs to modify existing buildings	2.1 produce appropriate schemes to modify existing buildings in compliance with current building legislation
LO3  Be able to produce drawings and specifications to modify existing buildings	3.1 undertake building surveys of existing buildings  3.2 prepare production drawings that fulfil the design requirements for conversion schemes for existing buildings  3.3 produce specifications for the conversion schemes
LO4  Be able to produce construction plans	4.1 produce viable construction plans

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 8: Technology of Complex Buildings*
- *Unit 19: Building Control Procedures and Legislation*
- *Unit 20: Construction Methods and Design Solutions*
- *Unit 25: Design Technology for Construction*
- *Unit 26: Properties and Performance of Construction Materials*
- *Unit 29: Computer-aided Design for Construction.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

At all times construction practices and methods must comply with health, safety and welfare legislation and practice. The CDM Safety Plan must demonstrate that, where possible, risks have been managed for construction, use and maintenance.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example architects, local authority officers, clients and/or conservation consultants for listed buildings. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.

## Unit 13: Environmental Impact of Construction

**Unit code:** A/601/1270

**QCF level:** 4

**Credit value:** 15

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### ● Aim

This unit provides learners with the opportunity to develop an understanding of the impact of the construction and built environment sector on the internal and external environment.

### ● Unit abstract

This unit investigates the potential threats to the environment posed by the construction and built environment sector. It evaluates the technical and legal processes and procedures used to eliminate or minimise the environmental impact and achieve sustainable construction. Learners will explore how the construction process impacts on the environment and the global and local issues of concern to the construction and built environment sector. Learners will also study indoor environmental effects and evaluate environmental assessment systems used to minimise these effects.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand how the construction and built environment sector impacts on the environment
- 2 Understand the local environmental impact of the construction and built environment sector
- 3 Understand the global environmental impact of the construction and built environment sector
- 4 Understand the indoor environmental impact of the construction and built environment sector
- 5 Understand environmental assessment systems in common use.

## Unit content

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### 1 Understand how the construction and built environment sector impacts on the environment

*Environmental impact:* pre-construction; during construction; post-construction

*Pre-construction:* location, extraction, transportation and refinement of raw materials; manufacture of construction materials and components

*During construction:* noise from construction sites; dust, dirt and disturbance from construction sites; use of hazardous materials

*Post-construction:* increased pressure on existing services; increased pressure on existing infrastructure; increased consumption of energy; increased production of greenhouse gases

### 2 Understand the local environmental impact of the construction and built environment sector

*Local environmental issues:* air pollution; water pollution; increased water abstraction; noise pollution; contaminated land; remediation; landfill; waste management

*Methods used to reduce local environmental impact:* legislation e.g. acts of Parliament, UK regulations, European Union (EU) directives; control e.g. Health and Safety Executive (HSE), local authority planning and environmental health departments; sustainable design e.g. improved energy efficiency, reduced embedded energy, specification of sustainable materials, recycling of materials and components; improved site management e.g. use of sustainable construction techniques, sharing of good practice, improved waste management, raising awareness, improved communication

### 3 Understand the global environmental impact of the construction and built environment sector

*Global environmental issues:* global warming; deforestation; depletion of the ozone layer; acid rain; climate change; finite availability of fossil fuels; threat to habitats and biodiversity

*Methods used to reduce global environmental impact:* ban on use of chlorofluorocarbons (CFCs); increased use of renewable energy sources; reduced reliance on coal; raising awareness; improved communication; Intergovernmental Panel on Climate Change (IPCC); international environmental conferences e.g. Kyoto (1997), Copenhagen (2009)

### 4 Understand the indoor environmental impact of the construction and built environment sector

*Indoor environmental issues:* Sick Building Syndrome (SBS) e.g. modern artificial lighting, noise, electromagnetic fields, radon, legionellosis, carbon monoxide, house dust mites, volatile organic compounds (VOCs)

*Methods used to reduce indoor environmental impact:* removal or modification of pollutant source; increasing ventilation rates; air cleaning; education; communication

**5 Understand environmental assessment systems in common use**

*Environmental assessment systems:* required qualities (relevance, accuracy, reliability, validity); sections of Building Research Establishment Environmental Assessment Method (BREEAM) e.g. construction, maintenance, use and demolition of buildings, global issues, neighbourhood issues and indoor effects, materials, services and techniques used to construct buildings, height and shape of buildings, characteristics of the site; home information packs (HIPs); energy performance certificates (EPCs)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand how the construction and built environment sector impacts on the environment	1.1 explain how the construction process impacts on the environment during the pre-construction stage  1.2 explain how the construction process impacts on the environment during construction  1.3 explain how the built environment impacts on the environment in the post-construction stage
LO2  Understand the local environmental impact of the construction and built environment sector	2.1 discuss local environmental issues of concern to the construction and built environment sector  2.2 examine the methods used to address these issues
LO3  Understand the global environmental impact of the construction and built environment sector	3.1 discuss global environmental issues of concern to the construction and built environment sector  3.2 examine the methods used to address these issues
LO4  Understand the indoor environmental impact of the construction and built environment sector	4.1 explain the indoor environmental issues commonly referred to as Sick Building Syndrome (SBS)  4.2 evaluate the processes and procedures used to minimise the effects of Sick Building Syndrome (SBS)
LO5  Understand environmental assessment systems in common use	5.1 examine the environmental assessment systems in common use  5.2 evaluate one environmental assessment system in terms of utility and benefit

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 8: Technology of Complex Buildings*
- *Unit 15: Production Management for Construction*
- *Unit 17: Project Management for Construction and the Built Environment*
- *Unit 20: Construction Methods and Design Solutions*
- *Unit 24: Design Procedures for Construction*
- *Unit 33: Civil Engineering Technology*
- *Unit 37: Advanced Civil Engineering*
- *Unit 39: Transportation for Construction and the Built Environment*
- *Unit 47: Energy Utilisation and Efficiency for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Some of the issues dealt with in this unit are global in nature and, as a result, the relevant measuring equipment is not readily available. Relatively inexpensive and accurate equipment is available to measure the parameters associated with local environmental issues, such as air pollution and water pollution, and sound level meters are generally available in most centres. Local authority environmental services departments may be prepared to provide guest speakers or equipment on loan. Learners require access to copies of BREEAM and other environmental assessment methods. Useful source material is available, in bulk and at a reasonable cost, from the National Society for Clean Air. Both Greenpeace and Friends of the Earth offer a similar resource.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## **Employer engagement and vocational contexts**

Tutors should organise site visits, for example quarries, landfill sites and/or sustainable development materials processor. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example representatives from contractors, consultants, renewable energy companies and/or research agencies for example BRE. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.

## Unit 14: Economics for Construction and the Built Environment

**Unit code:** J/601/1272

**QCF level:** 5

**Credit value:** 15

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### ● Aim

This unit provides learners with an opportunity to understand how wider market forces, government policies and economic activity influence the construction and built environment sector.

### ● Unit abstract

This unit provides learners with an understanding of how the economic environment affects the construction and built environment sector. This unit has been designed to enable learners to examine, analyse and discuss the implications of economic theories on the construction and built environment sector. Learners will also gain an understanding of government economic activity and its implications for the construction and built environment sector.

### ● Learning outcomes

#### **On successful completion of this unit a learner will:**

- 1 Understand the allocation of scarce resources and determination of price within the construction and built environment sector
- 2 Understand the factors that affect the economics of an organisation within the construction and built environment sector
- 3 Understand the size and economic significance of the work carried out by different sectors within construction and built environment
- 4 Understand how government economic activity affects the construction and built environment sector.

## Unit content

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### 1 Understand the allocation of scarce resources and determination of price within the construction and built environment sector

*Factors affecting resource allocation and price:* markets; supply; demand; cost benefit analysis

*Markets:* determination of market equilibrium; shortages, scarcity and effect on price; price determination; changes in price; opportunity costs; consumer choice; price mechanism

*Supply:* definition; determinants of supply; supply curves; shifts and movements in supply curves

*Demand:* definition; determinants of demand; demand curves; shifts and movements in demand curves

*Cost benefit analysis:* operation of cost benefit analysis

### 2 Understand the factors that affect the economics of an organisation within the construction and built environment sector

*Factors affecting the economics of an organisation:* competition; scale of production; sources of finance

*Competition:* perfect; imperfect; monopolistic

*Scale of production:* economies of scale (internal and external); returns to scale (increasing and decreasing)

*Sources of finance:* types; sources e.g. loans, overdrafts, issue of shares, venture capital, factoring, hire purchase, leasing, European Union (EU); other grants

### 3 Understand the size and economic significance of the work carried out by different sectors within construction and built environment

*Factors affecting sector:* client base; area of operation; size

*Client base:* public; private; voluntary; local; regional; national; international

*Area of operation:* building; civil engineering maintenance; sub-sectors in each sector e.g. housing, commercial, public buildings

*Size:* number of organisations in each sector; volume of work in each sector; value of work in each sector

### 4 Understand how government economic activity affects the construction and built environment sector

*Government policies:* fiscal and monetary policies e.g. taxation, grants, subsidies, availability of finance, exchange rates

*Government activities:* legislation; initiatives e.g. urban regeneration schemes, sustainable development, Public Private Partnerships (PPP)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the allocation of scarce resources and determination of price within the construction and built environment sector	1.1 explain how markets operate using supply and demand curves  1.2 assess the feasibility of construction schemes using cost benefit analysis
LO2  Understand the factors that affect the economics of an organisation within the construction and built environment sector	2.1 examine the type of competition in the construction and built environment sector  2.2 discuss how the scale of production can vary within construction projects  2.3 analyse the sources of project finance available to the construction and built environment sector
LO3  Understand the size and economic significance of the work carried out by different sectors within construction and built environment	3.1 examine the component parts of the construction and built environment sector in terms of size and client base  3.2 compare the outputs of component parts of the construction and built environment sector
LO4  Understand how government economic activity affects the construction and built environment sector	4.1 explain how government policies impact on the viability of construction projects  4.2 assess how government activities stimulate or reduce activity in the construction and built environment sector

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 4: Management Principles and Application for Construction and the Built Environment*
- *Unit 17: Project Management for Construction and the Built Environment*
- *Unit 57: Project Management for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to local firms to observe the impact of government activities. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers covering local government activities and/or the work of specific local firms. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.

## Unit 15: Production Management for Construction

**Unit code:** L/601/1273

**QCF level:** 5

**Credit value:** 15

### ● Aim

This unit enables learners to understand site management techniques for production in relation to communication, planning, cost control, quality and environmental issues. Learners will also gain skills to plan construction projects.

### ● Unit abstract

This unit provides learners with an understanding of the application of management principles, such as effective communication methods, control and reporting techniques. Learners will gain skills in cost forecasting and creating planning and programming charts for construction projects. Learners will also understand the importance of efficient productivity, whilst addressing quality and environmental issues.

### ● Learning outcomes

#### **On successful completion of this unit a learner will:**

- 1 Understand the principles and application of effective site management
- 2 Understand the importance of effective communication in planning and resource management
- 3 Be able to apply cost forecasting, control and reporting techniques
- 4 Be able to create planning and programming charts for construction projects
- 5 Understand how quality issues and environmental considerations are addressed during the production process.

## Unit content

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### 1 Understand the principles and application of effective site management

*Principles of site management:* forecasting; planning; organising; motivating; controlling; coordinating; communicating; leadership of teams; management of the workforce and sub-contractors; site induction; training; competence; skill requirements

*Application of effective site management to:* contractor-employed sub-contractors, specialist sub-contractors, nominated sub-contractors, named sub-contractors, labour-only personnel, artists and tradespeople, nominated suppliers and manufacturers, prime cost sums

### 2 Understand the importance of effective communication in planning and resource management

*Communication techniques:* written; visual; oral; IT

*Barriers to effective communication:* physical; psychological; intellectual; as applied to site communications e.g. site meetings, site diaries

*Planning techniques:* programming and progression; sub-contract organisations; key dates and milestones

### 3 Be able to apply cost forecasting, control and reporting techniques

*Costing techniques:* variance analysis e.g. unit costing, marginal costing, variable costs, standard costing, absorption costing; break-even analysis e.g. estimated costs, target costs, actual costs

*Forecasting, control and reporting techniques:* site cost control; cost forecasting e.g. cash flow, profit, return, cost, value; liquidity e.g. borrowing, working capital, profitability

*Reconciliation:* cost and value reconciliation; value-time relationships; cost-time relationships

*Purchasing:* selection of suppliers and goods; orders; specification; quality; goods received; standards; ownership of goods and materials; maintenance

### 4 Be able to create planning and programming charts for construction projects

*Planning:* reasons for planning; types of plan e.g. method statements, pre-contract, pre-tender, project, short-term and long-term plans

*Planning tools:* type of programmes e.g. bar charts, linked bar charts, network analysis, precedence diagrams, line of balance, time-change diagrams

*Programming:* design of systems; production control; production coordination

*Progress:* control; implementation; control and coordination of sub-contractors

**5 Understand how quality issues and environmental considerations are addressed during the production process**

*Quality considerations:* e.g. material and workmanship samples; testing of materials and workmanship (including sub-contract suppliers and manufacturers); supervision of own and sub-contracted labour

*Environmental considerations:* e.g. law, national, local and company policies, strategies for environmental protection during the construction process; environmental impact of construction e.g. materials manufacture, embodied energy, on-site construction, pre-fabrication

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the principles and application of effective site management	1.1 explain how the principles of site management are applied  1.2 justify the principles of site management in terms of good site practice
LO2  Understand the importance of effective communication in planning and resource management	2.1 compare communication techniques used on-site and off-site  2.2 evaluate the barriers to communication for typical construction projects  2.3 evaluate the planning techniques used in the construction and built environment sector
LO3  Be able to apply cost forecasting, control and reporting techniques	3.1 evaluate different forms of costing systems  3.2 write a report on cash flow, profit, return cost and value and purchasing, using site data and contractors' annual reports  3.3 produce cost and value reconciliation statements for individual work sections
LO4  Be able to create planning and programming charts for construction projects	4.1 explain how progress is measured  4.2 explain how remedial action is implemented in the case of a delay in the programme  4.3 explain how sub-contractors are incorporated into the overall programme  4.4 produce a programme of activities using at least two different planning tools (one of which must determine the critical path) including key dates for sub-contractors
LO5  Understand how quality issues and environmental considerations are addressed during the production process	5.1 explain how quality is assured on construction sites with reference to case studies  5.2 evaluate the use of environmental assessments for construction projects

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 4: Management Principles and Application for Construction and the Built Environment*
- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 13: Environmental Impact of Construction*
- *Unit 17: Project Management for Construction and the Built Environment*
- *Unit 24: Design Procedures for Construction*
- *Unit 57: Project Management for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example contractors, planning consultants, architects and/or quantity surveyors. Tutors should use real-life case studies, based on site visits and visiting speakers, for part of the assessment for this unit.



## **Unit 16: Measuring, Tendering and Estimating for Construction and the Built Environment**

**Unit code:** R/601/1274

**QCF level:** 4

**Credit value:** 15

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- **Aim**

This unit provides learners with an understanding of the tendering processes and procedures used in construction and the built environment. Learners will also gain skills to estimate for construction operations.

- **Unit abstract**

The principles and techniques of estimating form an integral part of the tender process. The identification and selection of contractors and the available methodology are contrasted in terms of their appropriateness for construction procurement. Learners will gain an understanding of the contract documentation required for the tender process along with the constraints on a tender both in the pre-stages and post-stages of procurement. The factors that affect the level of tenders will be investigated by examining the build up of estimates for construction work, including profit, overheads and on-costs. Learners will also develop the skills needed to formulate estimates for construction operations.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand the information required to produce a tender
- 2 Be able to apply the principles and techniques of estimating
- 3 Be able to formulate estimates for construction operations
- 4 Understand tendering procedures and contractual arrangements.

## Unit content

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### 1 Understand the information required to produce a tender

*Clients:* government; private; commercial

*Tender constraints:* client objectives and constraints; financial; design influences

*Contract documentation:* bills of quantities; drawings; specifications; conditions of contract; information provided (nature, source, validity); collection of additional data

### 2 Be able to apply the principles and techniques of estimating

*Collection of data:* characteristics; labour; labour costs; plant rates data; company data on output levels; cost of materials; terms of supply; delivery costs; handling; wastage; conversion

*Processes and procedures for estimate:* factors affecting prime costs; method statements (effect on estimating); use of standard reference documents; coverage rules for units of work e.g. Standard Method of Measurement (SMM) 7, New Rules of Measurement (NRM), Civil Engineering Standard Method of Measurement (CESMM); calculation of unit rates

### 3 Be able to formulate an estimate for construction operations

*Bills of quantities:* format; contents; sections; production; preliminaries

*Commercial factors:* final estimate; tender price; profit margin; payment terms; on-costs and overheads; competition; capacity; risk; insurance

*Health, safety and welfare plan:* provision of pre-construction information pack; all items to be included and costed; effect on tender

### 4 Understand the tendering procedures and contractual arrangements

*Tendering stages:* decision to tender; considerations; tender preparation strategy and arrangements; stages in open and select tendering; procedures

*Contractors invited to tender:* 'select list' of contractors; factors involving placement on select list e.g. quality of workmanship, capacity to carry out the work, ability to work to required deadlines, value for money, prior performance on similar projects

*Contractual arrangements:* types of contract e.g. forms and agreements; terms and conditions; schedule of rates; lump sum; design and build; legal responsibilities

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the information required to produce a tender	1.1 explain the client’s involvement in the tender process  1.2 analyse the constraints that apply to the tender process  1.3 discuss the contractual documentation required to support the tender process
LO2  Be able to apply the principles and techniques of estimating	2.1 collect the data required to build up unit costs  2.2 make use of standard data documentation and measurement rules  2.3 produce method statements suitable for compiling unit costs  2.4 calculate unit costs for identified items
LO3  Be able to formulate an estimate for construction operations	3.1 demonstrate how the bill of quantities format may be used to build up estimates  3.2 determine the critical factors that affect profit margin  3.3 demonstrate how the health, safety and welfare plan affects the tender  3.4 calculate on-costs and overheads using supplied data
LO4  Understand the tendering procedures and contractual arrangements	4.1 compare the stages of open and selective tendering  4.2 analyse the factors that are used to create ‘select lists’ of contractors  4.3 evaluate the different forms of contract used in the construction process

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 3: Applied Mathematics for Construction and the Built Environment*
- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 11: Contractual Procedures and Procurement for Construction and the Built Environment*
- *Unit 18: Measurement Processes for Construction*
- *Unit 57: Project Management for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to computer packages to use in the production of estimates.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise presentations by visiting speakers, for example main contractor estimators presenting on collection of data, output rates and company data.

## **Unit 17: Project Management for Construction and the Built Environment**

**Unit code:** Y/601/1275

**QCF level:** 5

**Credit value:** 15

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- **Aim**

This unit provides learners with the opportunity to develop an understanding of the principles and application of project management in the construction and built environment sector.

- **Unit abstract**

This unit enables learners to demonstrate their understanding of project management and the role of project managers. Learners will have the opportunity to understand how the client's objectives affect the project and how these objectives can be achieved through successful project management. Learners will also understand the different types of project management and how they impact on and add value to construction projects.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand the practice of project management
- 2 Understand the competencies and training required of project managers
- 3 Understand the duties and responsibilities of project managers
- 4 Understand how client objectives can be achieved through project management
- 5 Understand how project management adds value to a project.

## Unit content

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### 1 Understand the practice of project management

*Project management:* definition; historical developments; advantages and disadvantages in practice; review of current literature; research information

*Role of project manager:* development of project plan; management of project e.g. project stakeholders, project team, project risk, project schedule, project budget, any issues and conflicts that may arise

### 2 Understand the competencies and training required of project managers

*Key competencies:* managerial skills; technical knowledge and abilities; personality and psychological factors; leadership; delegation; negotiation; decision making and clarity of thinking; education and training for specific projects

*Education training and standards:* job requirements; person profile; occupational standards; continuing professional development

### 3 Understand the duties and responsibilities of project managers

*Duties and responsibilities:* understanding the client brief; appointing the design team; working with the production team; reports and recommendations

*Internal teams and external consultants:* contractual implications; relationships; roles and responsibilities

*Contractual relationships:* coordination and control; project management; responsibilities e.g. duties, authority, accountability, fees

### 4 Understand how client objectives can be achieved through project management

*Client objectives:* on time; within budget; high performance; quality outcome

*Advantages of project management:* time savings; higher-level of management control; cost predictions; better control of risks; improved communication; better information management; value for money; higher quality e.g. improving standards, achieving quality in building, getting it right first time, best practice

### 5 Understand how project management adds value to a project

*Changes in priorities:* factors that affect how project management can manage a changing industry; change management in the construction and built environment sector; culture of best practice in construction, Respect for People; adding value

*Performance indicators:* benchmarking against other systems and practices; use of key performance indicators (KPIs); best practice projects

*Adding value:* doing more for less e.g. reduced costs, improved affordability, enhanced value, improved productivity, reduced waste and defects

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the practice of project management	1.1 describe project management practices in the construction and built environment sector  1.2 evaluate the role of project managers in the construction and built environment sector
LO2  Understand the competencies and training required of project managers	2.1 evaluate the key characteristics of effective project managers  2.2 explain the type of education, training and occupational standards required of project managers
LO3  Understand the duties and responsibilities of project managers	3.1 explain the duties and responsibilities of project managers  3.2 compare the contractual implications of using external consultants or internal teams for project management  3.3 discuss the relationship of project managers with the design and production teams
LO4  Understand how client objectives can be achieved through project management	4.1 explain the role of the client in the construction process  4.2 explain the advantages to clients of using project management to meet their aims and objectives  4.3 evaluate how quality and standards are improved in the construction and built environment sector
LO5  Understand how project management adds value to a project	5.1 evaluate changes to the priorities of the construction and built environment sector  5.2 explain the use of best practice in project management to develop key performance indicators (KPIs)  5.3 evaluate how project managers are able to add value to the construction process

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 4: Management Principles and Application for Construction and the Built Environment*
- *Unit 9: Law and Contract for Construction and the Built Environment*
- *Unit 13: Environmental Impact of Construction*
- *Unit 14: Economics for Construction and the Built Environment*
- *Unit 15: Production Management for Construction*
- *Unit 57: Project Management for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is important that learners have access to current information from the sector regarding the use and development of project management in practice.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example contractors, consultants, architects and/or management contractors. Tutors should use site production simulations and real-life case studies for part of the assessment for this unit.

## Unit 18: Measurement Processes for Construction

**Unit code:** H/601/1277

**QCF level:** 4

**Credit value:** 15

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- **Aim**

This unit provides learners with the opportunity to understand measurement techniques and develop the skills needed to produce bills of quantities.

- **Unit abstract**

This unit provides learners with an understanding of measurement techniques and their uses in various project stages. Learners will gain an understanding of methods of measurement in terms of format, coding and measurement rules. Learners will develop the skills needed to produce quantities by applying appropriate mensuration techniques. Learners will be able to perform take-off and produce quantities for foundations and substructure, superstructure and simple mechanical services. Learners will develop skills to produce bills of quantities and analyse their various forms. Learners will also be able to analyse techniques and processes to suit particular situations.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand measurement techniques
- 2 Be able to produce quantities
- 3 Be able to produce bills of quantities.

## Unit content

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### 1 Understand measurement techniques

*Techniques:* floor area method; elemental estimating; approximate estimating techniques; measurement of variations

*Standard methods of measurement:* for construction, civil engineering and building services engineering; format; coding schemes; measurement rules; dimension sheets

*Uses:* project stages; sub-contract and supply chain packages; final account; maintenance and refurbishment works

### 2 Be able to produce quantities

*Producing quantities:* take-off procedures; mensuration procedures; computation of quantities

*Applications:* foundations and substructures; superstructure e.g. external walls, internal walls, flat roofs, pitched roofs (construction and coverings), internal finishes, external finishes, internal components (doors, windows, staircases, floors); simple mechanical engineering services (plumbing, below-ground drainage)

### 3 Be able to produce bills of quantities

*Measurement techniques and processes:* techniques e.g. traditional, cut-and-shuffle, computer-aided systems; associated working up processes

*Contract documentation:* different forms of bills of quantities, codes and other contract documentation; prime cost; provisional sums

*Application:* to construction projects (simple work sections, trade sections)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand measurement techniques	1.1 describe measurement techniques  1.2 discuss the requirements of a standard method of measurement  1.3 evaluate measurement techniques in relation to their uses on construction projects
LO2  Be able to produce quantities	2.1 perform a take-off  2.2 compute quantities using appropriate mensuration techniques  2.3 produce quantities for foundations and substructures  2.4 produce quantities for superstructure works  2.5 produce quantities for simple mechanical engineering services
LO3  Be able to produce bills of quantities	3.1 analyse measurement techniques and processes to suit particular applications  3.2 analyse the different forms of bills of quantities and contract documents  3.3 explain the application of prime cost and provisional sums  3.4 produce bills of quantities

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 3: Applied Mathematics for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 16: Measuring, Tendering and Estimating for Construction and the Built Environment*
- *Unit 21: Specification and Contract Documentation for Construction*
- *Unit 23: Advanced Measurement for Construction.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is important that the learners have access to the main standard methods of measurement and use them where appropriate. These should be current or include amendments where appropriate.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to the quantity surveying section of a main contractor/government agency. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example quantity surveyors on current industrial practices.

## Unit 19: Building Control Procedures and Legislation

**Unit code:** K/601/1278

**QCF level:** 5

**Credit value:** 15

### ● Aim

This unit enables learners to develop their understanding of the principles of building control systems and their knowledge of the statutory regulations and procedures for enforcing building control regulations.

### ● Unit abstract

This unit introduces learners to the requirements of the Building Regulations and the legislation used to control building construction works. Learners will explore the historical aspects that have brought about the present legal arrangements, and the application of these legal arrangements to ensure basic provisions and minimum standards of public safety in construction. Learners will explore the notification procedures that developers must follow, under the legislation, for informing the building control authority of their building plans. The procedures to be undertaken to deal with cases of non-compliance, and the court action taken in extreme cases of non-compliance, are also investigated. This unit will develop learners' knowledge and understanding of the construction process and is an essential preparation for work experience in this area. It is relevant for learners seeking careers in building control, building design and construction.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the principles of building control systems and the associated primary legislation
- 2 Know the origins of the statutory regulations and controls in England and Wales
- 3 Understand the requirements of statutory controls and regulations for construction works
- 4 Know the procedures for the enforcement of legislation regarding building control regulations.

## Unit content

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### 1 Understand the principles of building control systems and the associated primary legislation

*Systems of building control:* local authority; private approved inspectors

*Primary legislation:* principles of current legislation and building control regulations in England and Wales; structure of the legislation e.g. primary legislation, secondary legislation (codes of practice, approved documents), regulations; role of central government in legislation

### 2 Know the origins of the statutory regulations and controls in England and Wales

*Origins of modern building control:* historical aspects of the need for control; history of legislation; introduction of suitable standards

*Control procedures:* building design process; construction process; responsibilities of those intending to carry out building work; process of submission and notification; limitations of control procedures

### 3 Understand the requirements of statutory controls and regulations for construction works

*Statutory controls and regulations:* importance of compliance; basic provisions; minimum standards; submission of applications; approvals and inspections; notification; issues of interpretation, relaxation and dispensation

*Application of Building Regulations:* current Building Regulations (buildings up to and including medium-rise commercial); industrial and residential developments

### 4 Know the procedures for the enforcement of legislation regarding building control regulations

*Building control legislation:* applied to construction process; dangerous structures (control of demolition work to protect the public); listing of buildings

*Enforcement procedures:* service of notices; magistrates' court orders; providing evidence; appeals procedure

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the principles of building control systems and the associated primary legislation	1.1 examine the relevant primary legislation and its application to the control of construction works  1.2 assess the role of central government in creating building control legislation  1.3 compare the two systems of controlling construction projects
LO2  Know the origins of the statutory regulations and controls in England and Wales	2.1 describe the origins of modern building control and the legislation that has resulted in the current system  2.2 describe the procedures for controlling construction projects, including the processes of submission and notification to a building control authority  2.3 outline the uses and limitations of building control systems
LO3  Understand the requirements of statutory controls and regulations for construction works	3.1 explain how statutory controls ensure basic provision and the achievement of minimum standards in the construction process  3.2 analyse the application of the Building Regulations to building works up to and including medium-rise commercial, industrial and residential developments
LO4  Know the procedures for enforcement of legislation regarding building control regulations	4.1 describe appropriate enforcement procedures under the legislation for dangerous buildings  4.2 describe enforcement procedures used when taking non-compliance cases to court

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 8: Technology of Complex Buildings*
- *Unit 12: Conversion and Adaptation of Buildings*
- *Unit 20: Construction Methods and Design Solutions*
- *Unit 24: Design Procedures for Construction*
- *Unit 25: Design Technology for Construction.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners need access to the legislation, regulations and approved documents in order to understand their requirements. Appropriate attention must be given to the requirements of the relevant legislation throughout the delivery of this unit, and for it to be constantly reviewed and updated. Access to the Building Regulations, approved documents, British and relevant European Standard specifications, a range of design guides, manufacturers' specifications, relevant legislation and advanced construction textbooks is required.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## **Employer engagement and vocational contexts**

Tutors should organise site visits, for example shadowing a building control officer carrying out an inspection. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example building control officers on how they carry out their work on various developments.



## Unit 20: Construction Methods and Design Solutions

**Unit code:** M/601/1279

**QCF level:** 5

**Credit value:** 15

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### ● Aim

This unit provides learners with an opportunity to develop understanding and skills to research current construction issues, modern methods of construction, and analyse information to present the chosen design solution.

### ● Unit abstract

This unit provides learners with an opportunity to explore current practices and issues in construction and gain an understanding of the modern methods of construction. This will enable learners to develop skills in research and analysis to support the design process. Learners will also develop communication skills through presenting design solutions. This unit is particularly relevant to learners following the design discipline in construction and the built environment.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand current construction issues and practices
- 2 Understand modern methods of construction
- 3 Be able to research and analyse information to support the design process
- 4 Be able to present the chosen design solution.

## Unit content

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### 1 Understand current construction issues and practices

*Current construction issues:* concept to reality; buildability; sustainable construction; lean construction; fast track construction; greenfield versus brownfield developments

*Whether to develop or redevelop:* refurbishment, conversion and adaptation practices

### 2 Understand modern methods of construction

*Modern methods of construction (MMC):* prefabrication; sustainable construction; energy saving construction; recycled building; applications of alternative technology; cultural buildings; tall structures; large span structures; hi tec construction forms; applied engineering constructional forms; impact of MMC on traditional design process

### 3 Be able to research and analyse information to support the design process

*Research:* methodologies; current issues and practices; consideration of MMC in design

*Analysis:* of technical information used in design e.g. standards for material and component production, methods of working, manufacturers' product information, environmental information such as climatic information, local topography, local authority guidelines and requirements, outcomes of site and soil investigations

### 4 Be able to present the chosen design solution

*Presentation:* main theories and processes; current design practices; level of competence typical of industrial practice; appropriate graphical and written communication

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand current construction issues and practices	1.1 analyse current construction issues and practices  1.2 explain the implications of current issues and practices for the construction and built environment sector  1.3 compare the benefits of greenfield and brownfield development  1.4 compare the benefits of development and redevelopment
LO2  Understand modern methods of construction	2.1 discuss modern methods of construction  2.2 explain how modern methods of construction affect the traditional design process
LO3  Be able to research and analyse information to support the design process	3.1 present evidence of research into current issues, practices and modern methods of construction  3.2 perform analytical techniques to support the design process
LO4  Be able to present the chosen design solution	4.1 produce a solution to given design problems in an agreed format  4.2 develop a presentation of the design solution to peers and assessors

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 8: Technology of Complex Buildings*
- *Unit 12: Conversion and Adaptation of Buildings*
- *Unit 13: Environmental Impact of Construction*
- *Unit 19: Building Control Procedures and Legislation*
- *Unit 24: Design Procedures for Construction*
- *Unit 25: Design Technology for Construction*
- *Unit 26: Properties and Performance of Construction Materials.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners must demonstrate the ability to draw detailed architectural style drawings both manually and by using computer-aided design (CAD) and other current, modern IT facilities. Learners need access to design and CAD facilities, and a wide range of library resources including internet access to consider information from a wider source.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## Employer engagement and vocational contexts

Tutors should organise site visits, for example to construction sites using modern methods of construction, manufacturers of prefabricated items and/or refurbishment sites. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example contractors, consultants, and/or statutory body representatives. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 21: Specification and Contract Documentation for Construction

**Unit code:** H/601/1280

**QCF level:** 4

**Credit value** 15

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- **Aim**

This unit enables learners to develop knowledge and understanding of the contracts used in construction and the built environment and how construction works are specified in respect of standards and quality.

- **Unit abstract**

This unit introduces learners to the application of contract documents within the construction and built environment sector. This unit has been designed to provide learners with the opportunity to demonstrate their knowledge and understanding of the production of contract documents, and the skills needed to apply their effects and outcomes to all stages of construction projects. Learners will also develop an understanding of how construction works are specified in respect of national and international standards and quality.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Know the type of contract documents required for construction projects
- 2 Understand how construction works are specified in respect of standards and quality
- 3 Understand the provisions of the contract documents required for construction projects
- 4 Be able to apply the contract documents to all stages of construction projects.

## Unit content

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### 1 Know the type of contract documents required for construction projects

*Contract documents:* drawings e.g. domestic, industrial or commercial buildings, small engineering projects, design information such as sketches, schedules and other drawn information, layout, content; management of drawings e.g. evolution through the design process, priority of drawings, ownership, return of drawings; forms of contract (types, articles of agreement; contract conditions, appendices, priority of information); bills of quantities (purpose, preparation, uses, content, types); specifications (project specification, performance specification, schedules of rates, National Building Specification); schedules (internal finishings, doors and windows, inspection chambers, drainage); master programme (preparation by contractor, information requirements); Coordinated Project Information (CPI) (common arrangements for production of CPI)

### 2 Understand how construction works are specified in respect of standards and quality

*Specification:* purpose and uses (basis for tendering, ordering materials, goods and components, on-site by contractor, clerk of works)

*Contents of specification:* quality of materials; standards of work; samples of materials and workmanship; testing of materials and work; description of the work to be executed; pricing by the contractor

*National and international quality and standards:* British Standards (quality of materials); codes of practice (standard of workmanship); National Building Specification, Eurocodes (for civil and structural engineering); other international comparisons

### 3 Understand the provisions of the contract documents required for construction projects

*Contract documents:* different forms of construction contracts; issues relating to contract documents (within the different forms of sub-contract)

*Contractual requirements:* copies of contract documents; availability of documents on-site; discrepancies between documents; ownership of design

*Construction disputes:* poorly prepared and deficient contract documents; origin of disputes; use of contract documents to resolve construction disputes

### 4 Be able to apply the contract documents to all stages of construction projects

*Application of contract documents:* pre-contract and post-contract phases; drafting of specifications (clear, concise and accurate descriptions of materials, workmanship, work to be executed); use of information technology and specialist computer software

*Specification clauses:* understanding the client brief; liabilities of the parties involved; user needs and requirements; legal rights and responsibilities; statutory controls imposed on the project; environmental factors; planning and building control requirements

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Know the type of contract documents required for construction projects	1.1 identify the contract documents used in construction contract procurement  1.2 describe the relationship between the contract documents
LO2  Understand how construction works are specified in respect of standards and quality	2.1 review the purpose of specification writing within the construction and built environment sector  2.2 discuss clause content of a specification for major work sections  2.3 discuss national and international quality and standards within major work sections
LO3  Understand the provisions of the contract documents required for construction projects	3.1 compare the purpose and uses of different contract documents within the forms of contract  3.2 analyse the relationship of different contract documents within the forms of contract  3.3 explain how disputes arise and how they can be resolved
LO4  Be able to apply the contract documents to all stages of construction projects	4.1 prepare a complete specification for a building  4.2 produce valid specification clauses to communicate design information to members of the design and construction team

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 8: Technology of Complex Buildings*
- *Unit 18: Measurement Processes for Construction*
- *Unit 23: Advanced Measurement for Construction*
- *Unit 26: Properties and Performance of Construction Materials*
- *Unit 57: Project Management for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is important that learners have access to the main forms of building contract and the associated contract documents, such as architectural drawings and specifications. A large proportion of this unit will involve learners analysing and preparing materials and workmanship specification clauses appropriate to specific projects depicted in working drawings. Learners need access to a wide range of IT and library resources, including textbooks and journals, government and industry publications, including forms and conditions of construction contracts and previously prepared drawings and specifications that have been used in the construction and built environment sector.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## **Employer engagement and vocational contexts**

Tutors should organise site visits, for example to working projects using design and build, traditional and/or Private Finance Initiative (PFI). To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example consultants, contractors, local authority representatives and/or statutory body representatives. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 22: Structural Behaviour and Detailing

**Unit code:** M/601/1282

**QCF level:** 4

**Credit value:** 15

### ● Aim

This unit enables learners to understand structural concepts and develop skills to determine properties of typical structure materials. Learners will analyse statically determinate structures and design and detail structural elements.

### ● Unit abstract

Learners will develop the understanding and skills needed to apply the scientific principles associated with the properties and behaviour of structures, loading on structures and load transference to individual elements. The factors that affect structural behaviour and underpin the design of simple structural elements are explored, both in theory and through their application to analysis and design. Learners will also develop skills to translate design calculations into detailed drawings for the purpose of fabrication and construction.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to determine the properties of typical structural materials
- 2 Understand fundamental structural concepts
- 3 Be able to analyse statically determinate structures
- 4 Be able to design elements of a structure
- 5 Be able to detail elements of a structure.

## Unit content

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### 1 Be able to determine the properties of typical structural materials

*Properties:* material classification (malleable, ductile, brittle); elastic and plastic deformation; limits of proportionality; stress; strain; modulus of elasticity

*Typical structural materials:* timber; steel; concrete

### 2 Understand fundamental structural concepts

*Fundamental structural concepts:* loads, load transfer; structural theory

*Loads:* dead, imposed and wind loads; load configuration; British Standards and codes of practice on loading; limit states and load factors

*Load transfer:* load transference at joints, both restrained and unrestrained, transfer of loading from superstructure to foundation

*Structural theory:* beams, frames and columns; shear force; bending moment; loading and support conditions; conditions of equilibrium; determinate and indeterminate structures; degree of indeterminacy; redundancy

### 3 Be able to analyse statically determinate structures

*Statically determinate factors:* forces and reactions caused by direct loading; assumptions made when analysing simple structural elements (beams, cantilevers, columns, framed structures); compressive, tensile, shear and bending stresses; permissible stress; factors of safety including partial safety factors in limit state design

*Analysis:* shear force (SF) and bending moment (BM) diagrams; relationship between SF and BM diagrams; forces acting on a frame

### 4 Be able to design elements of a structure

*Design issues:* properties of sections; variations in bending stress; combination of axial and bending stress

*Properties of sections:* sectional properties (simple beam sections); use of standard formulae or manufacturer's published tables ( $I_{xx}$ ,  $I_{yy}$ ,  $Z_{xx}$ ,  $Z_{yy}$ ); in timber, steel and in-situ reinforced concrete

*Variation in bending stresses:* across a section for simply supported beams and cantilevers; axial stress and bending stress on a column (simple concentric and asymmetrical loading)

*Combinations of axial and bending stresses:* maximum stress on column cross-section; maximum stress on simply supported beams (SSBs) subject to both point and uniformly distributed loads; determination of sectional sizes for columns and SSBs

*Elements of a structure:* simply supported reinforced concrete, timber and steel beams; one-way spanning concrete floor slabs; plain masonry columns and walls; timber floor joists to carry a given load over a simply supported span

## 5 Be able to detail elements of a structure

*Detail structural elements:* use of manual and computer-aided design (CAD) techniques; structural steel elements; in-situ reinforced concrete elements; structural timber elements

*Manual and CAD techniques:* working drawings; use of standard conventions and practices

*Structural steel elements:* e.g. roof trusses, portal frames, plate girders including details of node arrangements, cleats, shear plates, bolts, welding requirements, any external fittings

*In-situ reinforced concrete structural elements:* e.g. column foundations, continuous beams, continuous one-way spanning floor slabs, columns and column/floor intersections including chairs for top steel, cut-off points for reinforcement, distribution reinforcement, cover distances, main bars, distribution bars and links, shear reinforcement, starter bars and kickers for column shutters

*Structural timber elements:* e.g. joist-to-joist and joist-to-support connections, timber connectors, bolts, plates, gang-nail connectors, cleats, shear rings and hangers, suspended timber floors including strutting, lateral restraint into walls and trimming of openings, grade and type of timber; nominal and actual sizes, sawn, planed and prepared components

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to determine the properties of typical structural materials	1.1 compare properties of typical structural materials 1.2 calculate stresses and strains applied to typical structural materials 1.3 determine the modulus of elasticity of typical structural materials
LO2  Understand fundamental structural concepts	2.1 discuss loading conditions for a structure 2.2 illustrate load transfer from superstructure to foundation 2.3 analyse beams, columns and frames using basic structural theory
LO3  Be able to analyse statically determinate structures	3.1 discuss the factors to be considered when analysing the elements of a structure 3.2 analyse the forces acting in members of a statically determinate frame 3.3 produce bending moment and shear force diagrams
LO4  Be able to design elements of a structure	4.1 produce suitable designs for simply supported beams 4.2 produce suitable designs for a one-way spanning slab in in-situ reinforced concrete 4.3 produce suitable designs for plain masonry columns and walls 4.4 produce suitable designs for timber floor joists
LO5  Be able to detail elements of a structure	5.1 produce details of structural steel elements 5.2 produce details of elements of an in-situ reinforced concrete structure 5.3 produce details of structural timber elements

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 3: Applied Mathematics for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 8: Technology of Complex Buildings*
- *Unit 26: Properties and Performance of Construction Materials*
- *Unit 29: Computer-aided Design for Construction*
- *Unit 34: Structural Analysis and Design.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to experimental and modelling equipment in order to appreciate and understand structural concepts. Access to design and drafting equipment is also essential.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to the design sections of consulting firms. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example representatives with structural design backgrounds on current industrial practices. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 23: Advanced Measurement for Construction

**Unit code:** T/601/1283

**QCF level:** 5

**Credit value:** 15

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- **Aim**

This unit provides learners with an opportunity to develop skills in applying measurement techniques to the production of quantities for complex construction projects, in accordance with standard methods and rules.

- **Unit abstract**

This unit has been designed to enable learners studying construction, civil engineering and building services engineering to apply, analyse and measure a range of components and elements found in large-scale buildings or structures, and produce approximate and detailed quantities. The application of measurement and its use in the various stages of the lifecycle of construction projects are also examined in some detail, in terms of the design, production and maintenance of the completed structure. This unit covers the techniques used to produce preliminary items, take-off of quantities and the rules that must be followed when producing a bill of quantities. Learners will investigate the use of measurement in interim and final account valuations with regard to contract payments.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Be able to apply measurement techniques
- 2 Be able to produce measured quantities for elements and components of large-scale commercial structures
- 3 Be able to prepare preamble and preliminary items
- 4 Be able to produce measured bills of quantities.

## Unit content

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### 1 Be able to apply measurement techniques

*Application of measurement in the construction lifecycle:* design; production; maintenance

*Measurement techniques:* production of bills of quantities; measurement of variations; production of supply and sub-contract packages; final account; maintenance; refurbishment works

### 2 Be able to produce measured quantities for elements and components of large-scale commercial structures

*Produce take-off and approximate quantities:* complex foundations; substructures (including brick and concrete basement); sloping site excavations; underpinning

*Components of a large-scale commercial structure:* concrete and steel framed buildings; in-situ; pre-cast; pre-stressed concrete structures; brick and masonry structures; complex flat and pitched roof construction; roof coverings; internal and external finishes and treatments; internal components e.g. doors, windows, panelling staircases and kitchen units; differing types of floor system e.g. raised access floors, floating floors

*Building engineering services:* plumbing; heating; ventilation; electrical installations; above-ground and below-ground disposal systems

*Measurement techniques:* interim payments; final account work; forms of procurement; types of contractual arrangement

### 3 Be able to prepare preamble and preliminary items

*Preamble clauses:* standard method of measurement requirements; preamble clauses e.g. workmanship, materials specification; inclusion in a bill of quantities

*Preliminary clauses:* items e.g. time related, unmeasurable items, supervision, plant

### 4 Be able to produce measured bills of quantities

*Methods:* traditional; cut and shuffle; computer-aided systems; computer-aided design (CAD) software e.g. measurement software, estimating software

*Production:* working up processes; method of producing of bills of quantities (for a major work section or trade section of a construction project)

*Payment:* production of interim and final accounts

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to apply measurement techniques	1.1 compare the different uses of measurement in the lifecycle of complex construction projects  1.2 demonstrate the role of measurement in the design, production and maintenance stages of complex construction projects
LO2  Be able to produce measured quantities for elements and components of large-scale commercial structures	2.1 apply appropriate techniques to obtain approximate quantities for different elements of complex projects  2.2 produce take-off quantities in accordance with the requirements of a standard method(s) of measurement  2.3 determine appropriate measurement techniques and processes for particular contracts or stages
LO3  Be able to prepare preamble and preliminary items	3.1 produce specific and appropriate draft preamble clauses  3.2 produce draft preliminary clauses for inclusion in a bill of quantities
LO4  Be able to produce measured bills of quantities	4.1 demonstrate the different methods of producing bills of quantities  4.2 produce bills of quantities for complex work sections  4.3 produce interim and final account valuations and certificates for payment

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 3: Applied Mathematics for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 8: Technology of Complex Buildings*
- *Unit 18: Measurement Processes for Construction*
- *Unit 21: Specification and Contract Documentation for Construction.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is important that learners have access to the appropriate standard methods of measurement. These should be current or include amendments where appropriate. Learners require access to relevant IT facilities and software packages to assist the measurement process.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise presentations by visiting speakers, for example quantity surveyors on computer-aided measurement techniques.

## Unit 24: Design Procedures for Construction

**Unit code:** A/601/1284

**QCF level:** 4

**Credit value:** 15

### ● Aim

This unit enables learners to understand design practices and develop the skills needed to produce design solutions, manage construction contracts and direct the project management phase of the construction process.

### ● Unit abstract

This unit is designed to develop learner understanding of the evolving role of the design technologist within the construction and built environment sector. Learners will produce a design solution that fulfils a design brief and takes into account technological developments, design approaches and initiatives. Learners will produce design solutions whilst working within a number of design constraints. This unit allows learners to develop the skills needed to manage the construction process during contract and project management phases. Learners will gain an understanding of the roles and responsibilities of design technologists in terms of retrieving information and leading the team successfully. Learners will also develop skills needed to compare quality control methods and evaluate project documentation required for certification of work.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand design practices
- 2 Be able to produce a design solution
- 3 Be able to manage the contract phase of the construction process
- 4 Be able to direct the project management phase of the construction process.

## Unit content

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### 1 Understand design practices

*Role of the design technologist:* evolution and emerging modern practice (group and multi-disciplinary approaches); membership of design team; contribution of the design technologist (delivery of successful design)

*Relationship:* designer, client and other members of the design team; negligence and indemnity insurance

*Design practices:* Royal Institute of British Architects (RIBA) Plan of Work; organisational framework

*Constraints:* client requirements; site-specific issues; economics of design and production; specialist design requirements (disabled access); material selection

### 2 Be able to produce a design solution

*Successful design:* historic developments in building design and resultant design terminology; basis of design concepts (communication within the design team); need to freeze design to enable design development

*Technologies, approaches and initiatives:* current technologies to assist the designer; technological influence on design; 'green' approaches e.g. sustainability, adaptability, buildability; initiatives e.g. carbon neutral buildings; development frameworks such as Code for Sustainable Homes

*Design brief:* appropriate information; stakeholder requirements; information coordination; legal aspects; specifications

*Design solution:* design brief (meeting requirements); set of architectural and structural drawings

### 3 Be able to manage the contract phase of the construction process

*Inspection and certification of work:* control of works; payments; insurance; administrative and contract documentation; coordination of information with specialists and consultants

*Quality control:* methods of quality control (on-site, off-site)

*Contract completion:* contractual conditions; main contract implications; commencement and completion; handover; defects; liability; final certification

### 4 Be able to direct the project management phase of the construction process

*Documentation:* drawing office programmes; time sheets; fee stages; standard contract documents

*Role of design technologist:* effective team leadership and personnel management; legal requirements and responsibilities

*Information retrieval:* computer-aided design (CAD) packages; Building Information Modelling (BIM); '4-D' software packages

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand design practices	1.1 discuss the evolving role of design technologists 1.2 discuss the relationship between members of the design team, in accordance with design practices 1.3 evaluate design constraints
LO2  Be able to produce a design solution	2.1 discuss the principles of successful design 2.2 evaluate the influence of technologies, approaches and initiatives on the final design 2.3 produce consolidated design briefs including specification clauses 2.4 produce a design solution
LO3  Be able to manage the contract phase of the construction process	3.1 discuss the role of design technologists at the contract completion stage 3.2 compare quality control methods used on-site and off-site 3.3 carry out an audit of the project documentation required to certificate works
LO4  Be able to direct the project management phase of the construction process	4.1 explain the documentation required during the project management phase of the construction process 4.2 evaluate the role of design technologists in leading project teams 4.3 compare information retrieval systems

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 9: Law and Contract for Construction and the Built Environment*
- *Unit 13: Environmental Impact of Construction*
- *Unit 15: Production Management for Construction*
- *Unit 19: Building Control Procedures and Legislation*
- *Unit 20: Construction Methods and Design Solutions*
- *Unit 28: IT Applications for Construction*
- *Unit 35: The Use of Information and Communication Technology for Construction and the Built Environment.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits to locations with innovative designs, for example design offices and/or exhibitions. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example architects, designers, and/or people with a project management background on current approaches, initiatives and solutions.

## Unit 25: Design Technology for Construction

**Unit code:** F/601/1285

**QCF level:** 5

**Credit value:** 15

### ● Aim

This unit provides learners with the opportunity to gain an understanding of buildability and sustainability. Learners will develop skills in applying graphical communication techniques to support design solutions.

### ● Unit abstract

This unit extends the specification of materials and workmanship to realise a design to a known quality standard. This unit looks at how building components and component assembly can be used to satisfy user needs and achieve a final design solution. Learners will cover essential design aspects that must be provided for the construction process and develop technical skills to realise the design solution. The causes of material defects are evaluated in terms of the techniques that can be used to prevent materials failure and the remedial techniques that are used to prevent future deterioration. The importance of sustainability and buildability issues are investigated in relation to the economies of energy use and consumption. Learners will explore the graphical interface of computer and manual systems required to support design solutions.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to produce specifications to achieve quality in design
- 2 Understand the preventive and remedial measures that reduce materials failure
- 3 Understand how the concepts of buildability and sustainability address current issues confronting the construction and built environment sector
- 4 Be able to apply graphical communication techniques to support a design solution.

## Unit content

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### 1 Be able to produce specifications to achieve quality in design

*Specification of materials:* specifying items (reference to British Standards, approved codes of practice, British Board of Agrément Certificates, trade associations)

*Quality solutions:* NBS descriptors; ISO series; manufacturers' data sheets; BS 8000; sample panels; employer representatives; testing

### 2 Understand the preventive and remedial measures that reduce materials failure

*Building defects:* preventive techniques; remedial techniques

*Preventive and remedial measures:* planned maintenance and repair programmes (lifespan and cost-in-use issues); legal and design aspects (associated health and safety issues)

### 3 Understand how the concepts of buildability and sustainability address current issues confronting the construction and built environment sector

*Technical design:* buildability: economic criteria of design; design methods; problem-solving techniques (matrices, networking, gaming)

*Sustainability issues:* improved energy efficiency; reduced energy consumption; renewable and alternative sources of energy; use of renewable materials; improved recycling and reuse of materials and components; off-site prefabrication; modern methods of construction

### 4 Be able to apply graphical communication techniques to support a design solution

*Manual drawing techniques:* sketching; conceptual; technical; measured drawing

*Computer systems and communication techniques:* computer-aided design (CAD); filing; retrieval systems; CAD documentation

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to produce specifications to achieve quality in design	1.1 produce a specification for materials and construction processes in different formats  1.2 write procedures for the quality control of materials and components on-site and off-site  1.3 extract appropriate information from British Standard specifications and approved codes of practice
LO2  Understand the preventive and remedial measures that reduce materials failure	2.1 evaluate the causes of common building defects  2.2 assess material defects and suggest remedial actions  2.3 illustrate how the effective use of design can reduce defects  2.4 justify planned maintenance schemes
LO3  Understand how the concepts of buildability and sustainability address current issues confronting the construction and built environment sector	3.1 evaluate the effectiveness of the technical design of successful commercial projects  3.2 evaluate the application of the principles of buildability and sustainability to recent buildings  3.3 analyse the environmental factors that influence the design of buildings
LO4  Be able to apply graphical communication techniques to support a design solution	4.1 use manual drawing techniques to communicate design proposals  4.2 demonstrate how computer systems and communication techniques assist the modern designer

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 8: Technology of Complex Buildings*
- *Unit 12: Conversion and Adaptation of Buildings*
- *Unit 19: Building Control Procedures and Legislation*
- *Unit 20: Construction Methods and Design Solutions*
- *Unit 26: Properties and Performance of Construction Materials*
- *Unit 28: IT Applications for Construction*
- *Unit 29: Computer-aided Design for Construction.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits for learners to identify building defects and their links to poor design. To ensure site visits are successful tutors should outline the aims and objectives of the visits. Tutors should organise presentations by visiting speakers, for example architects (refurbishment specialist) and/or building surveyors (remedial specialist).

## Unit 26: Properties and Performance of Construction Materials

**Unit code:** L/601/1287

**QCF level:** 5

**Credit value:** 15

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- **Aim**

This unit provides learners with the opportunity to develop an understanding of the properties of modern composite materials and how structural materials can fail in use.

- **Unit abstract**

This unit investigates the physical and chemical mechanisms that underpin the properties of common structural materials. It focuses on how and why materials fail and how such failures can be avoided or prevented. Learners will analyse the properties and performance of modern composite materials in terms of their relevance to construction and the built environment. In addition learners will evaluate the environmental issues that link energy efficiency and the 'embodied energy cost' of materials.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand how structural materials fail in use
- 2 Understand the properties of modern composite materials
- 3 Be able to determine the embodied energy costs of common construction materials.

## Unit content

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### 1 Understand how structural materials fail in use

*Structural materials:* metals; concrete; timber

*Failure in use:* fracture; fatigue; creep; corrosion; chemical, degradation (physical and biological)

*Fracture:* strain energy; fracture energy; Griffith crack theory

*Fatigue:* cyclical loading; stress concentrations; corrosion; residual stresses; surface finish; temperature

*Creep:* duration of loading; stress; temperature; modulus of elasticity

*Corrosion of metals:* dry oxidation; wet corrosion

*Chemical degradation:* cements and concrete; degradation (sulphates, sea water, acids, alkali-silica reaction, carbonation)

*Physical degradation:* by changes in temperature and moisture content; frost and fire

*Biological degradation:* fungi; insects

### 2 Understand the properties of modern composite materials

*Properties:* strength; hardness; durability of component materials; strength, composite materials (hardness and durability); reasons for superior properties of composite materials

*Use:* common composite materials e.g. asbestos cement, glass-reinforced cement, polymer-fibre-reinforced cement and concrete, natural-fibre reinforced concrete, steel-fibre concrete

### 3 Be able to determine the embodied energy costs of common construction materials

*Embodied energy costs:* locating, extracting and refining materials; manufacturing building elements from raw materials; transporting building elements to site; working building elements on site; potential energy savings; time taken to recover cost in 'saved' energy terms

*Construction materials:* in common use e.g. cements, concrete, plaster, plasterboard, metals, timber, timber products, plastics, clay products, insulation materials

*Embodied energy costs:* calculation of embodied energy costs; calculation of lifetime energy savings; audit of embedded energy costs against lifetime energy savings

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand how structural materials fail in use	1.1 describe the different types of structural failure  1.2 explain the scientific principles that underpin structural failure  1.3 evaluate how structural failure occurs
LO2  Understand the properties of modern composite materials	2.1 compare the properties of composite materials and the component materials they are made from  2.2 analyse the physical and chemical factors that affect the strength, hardness and durability of composite materials  2.3 justify the use of composite materials in terms of their superior properties in use
LO3  Be able to determine the embodied energy costs of common construction materials	3.1 evaluate the factors that contribute to embodied energy costs  3.2 calculate total embodied energy costs for a given building  3.3 carry out an audit of embodied energy costs against potential lifetime energy savings for a given building

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 7: Construction and Maintenance of Buildings*
- *Unit 8: Technology of Complex Buildings*
- *Unit 10: Building Services Design, Installation and Maintenance in Construction*
- *Unit 12: Conversion and Adaptation of Buildings*
- *Unit 20: Construction Methods and Design Solutions*
- *Unit 21: Specification and Contract Documentation for Construction*
- *Unit 22: Structural Behaviour and Detailing*
- *Unit 24: Design Procedures for Construction*
- *Unit 25: Design Technology for Construction.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Risk assessments must be produced for all practical activities, including visits made to construction sites, material testing organisations and manufacturers' premises. This unit could be delivered without extensive testing apparatus but it is recommended that the following equipment is used where available: compression, tension and flexural testing apparatus; creep, fatigue, hardness and impact testing apparatus; drying kilns and accelerated testing rigs.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## **Employer engagement and vocational contexts**

Tutors should organise site visits, for example to material testing organisations. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example design consultants, materials scientists and/or environmental consultants. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 27: Site Surveying Procedures for Construction and the Built Environment

**Unit code:** T/507/0419

**QCF level:** 4

**Credit value:** 15

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### ● Aim

This unit develops an understanding of the principles of site surveying and cartographic detailing of construction works and the skills to use site surveying instruments, alongside an understanding of the software available.

### ● Unit abstract

This unit is designed to develop learners' skills in using modern surveying equipment to carry out a range of typical site surveying procedures in the construction and built environment sector. Learners will undertake setting-out and control of alignment of construction work. This unit develops the understanding and skills required to perform surveying calculations. It is intended that the procedures outlined in the specification are performed using semi-manual methods and learners will also gain an understanding of the software available for site surveying. Learners will develop the skills required to produce cartographic details from survey information using a manual approach, alongside the benefits of computer-aided plotting.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the principles of site surveying
- 2 Be able to use site surveying instruments
- 3 Understand cartographic detailing of construction works
- 4 Understand the software available for site surveying.

## Unit content

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### 1 Understand the principles of site surveying

*Linear measurement:* errors in using steel tapes; adjustments for tension, sag and temperature; change of standard length; semi-permanent adjustments to Electromagnetic Distance Measurement (EDM) instruments (for temperature, pressure, curvature of the Earth)

*Levelling:* errors in levelling and compensation methods; reciprocal levelling; flying levels; location of Ordnance Bench Mark (OBM); principle and practice of setting up a Temporary Bench Mark (TBM); levelling large areas (grid and radial methods); direct and indirect methods of contouring

*Angular measurement:* errors and methods for reducing errors; reduction of angular measurement; horizontal and vertical angles; computation of true horizontal length (from slope distance and angle of inclination)

*Distinction between open, link and closed traverse:* traverse for area control; factors affecting choice of traverse stations; whole circle bearings; distinction between grid, true and magnetic north; coordinate system; Ordnance Survey (OS); grid references; angular closing error and correction; Bowditch correction for misclosure errors

*Setting out:* principles; control of spread of error (working from the whole to the point); procedure for coordinated setting out; appropriate accuracy; procedures and practices for setting out ground works; upper floors; road construction; drainage and sewerage works; embankments and cuttings

### 2 Be able to use site surveying instruments

*Appropriate instruments:* linear measuring instruments e.g. steel bands, sonic measuring devices, EDM instruments

*Levels:* optical (automatic and tilting); water level; general construction laser; pipe alignment laser; electronic and optical levels; angular measuring instruments; optical and electronic theodolites; magnetic compasses and compass attachments to theodolites; combined theodolites and EDM devices (total station instruments); vertical alignment instruments e.g. plumb bob, spirit level, optical plumb, laser alignment

*Electronic and laser instruments:* electronic reading levels; electronic logging of field data; laser construction levels; laser alignment levels; EDMs; Global Positioning Systems (GPS); digital terrain modelling

### 3 Understand cartographic detailing of construction works

*Raw data and translation for cartographic detail/setting out:* levelling; plotting contours by graphic interpolation; plotting of cross-sections from contoured plans; area measurement (manual, mechanical, electronic methods); computation of volumes from spot heights; ground sections and contours; calculations of volumes of cut and fill (straight road with transverse sloping ground)

*Angular measurement:* correction to measured angles, distances, bearings and coordinates for a closed traverse, manual and electronic plotting of traverse surveys, survey symbols

*Setting out:* computation of deflection angles; distances for coordinated setting out

### 4 Understand the software available for site surveying

*Surveying computer software:* software for capturing data in the field; dedicated software for setting out; built-in capabilities of total station instruments; commercial software and programmed spreadsheets to facilitate repetitive surveying calculations; Geographical Information Systems (GIS) and OS digital data

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the principles of site surveying	1.1 describe procedures and instrumentation for transferring control points  1.2 describe procedures for producing large horizontal curves used in road construction  1.3 explain the use of electronic surveying instruments
LO2  Be able to use site surveying instruments	2.1 set up and use appropriate instruments  2.2 record readings to produce contoured plans and traverse surveys  2.3 set out horizontal and vertical controls and small radii horizontal curves  2.4 check the verticality of perpendicular members of construction frames
LO3  Understand cartographic detailing of construction works	4.1 evaluate the benefits of computer software to solve typical surveying problems  4.2 explain the use of information taken from digital mapping databases  4.3 evaluate the use of GPS within construction and civil engineering work
LO4  Understand the software available for site surveying	3.1 explain how to determine contours and ground sections for an area of ground, using raw survey data  3.2 explain how to determine areas and volumes of cut and fill, using survey data  3.3 explain how to correct coordinate points within control traverse networks  3.4 explain how to determine setting out data for coordinated points

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 3: Applied Mathematics for Construction and the Built Environment*
- *Unit 12: Conversion and Adaptation of Buildings*
- *Unit 28: IT Applications for Construction*
- *Unit 33: Civil Engineering Technology*
- *Unit 36: Applied Mathematics for Complex Engineering Problems*
- *Unit 37: Advanced Civil Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

This unit requires learners to use of Personal Protective Equipment (PPE) when undertaking practical activities. Surveying software and spreadsheet programs must be readily available to learners. Manual drawing and computer-aided design (CAD) are an integrated part of this unit. Learner access to ancillary equipment and carpenters' workshops to help with the production of sight rails and other setting out items is strongly recommended.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.



## Unit 28: IT Applications for Construction

**Unit code:** Y/601/1292

**QCF level:** 4

**Credit value:** 15

### ● Aim

This unit provides learners with an opportunity to develop skills to word process complex construction documents and develop spreadsheets and databases to process construction data.

### ● Unit abstract

This unit develops the skills that will enable learners to use word processing, spreadsheet and database software in the construction and built environment sector. It is intended that Windows or a similar graphical user interface is used. Expertise in using this interface is developed so that the acquired skills may be transferred easily to other software packages. Skills to format and manipulate text and images are developed, enabling learners to produce reports and assignments that meet the professional requirements of the construction and built environment sector. Learners will gain the skills of simple programming of spreadsheets to manipulate numbers and deal with repetitive calculations that are met in construction and the built environment. The automatic chart and graph plotting capability of spreadsheets is explored. Learners will gain an appreciation of the data manipulation power of databases and the skills needed to produce simple outputs from construction and the built environment data. Learners will also understand the application of specific software relevant to the construction and built environment sector.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to use computing and software applications
- 2 Be able to use a standard word processing application to produce complex construction documents
- 3 Be able to use a standard spreadsheet application to produce construction data
- 4 Be able to use a standard database application to process construction data
- 5 Understand the application of software relevant to construction and the built environment.

## Unit content

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### 1 Be able to use computing and software applications

*Operating system applications:* switching on; access graphical user interface (GUI); shortcuts; start menu; file manager/explorer; closing down application and system, maintaining data integrity

*Standard software packages:* word processor (WP); spreadsheet (SS); database (DB)

*File operations:* access existing files; produce new files; save files in the appropriate location; printing files (whole files, parts of files, single copy, multiple copies); access two files simultaneously

*Software applications:* print preview; change views; zooming in/out; view several files; format controls; toolbar buttons; drop down menus; customise toolbars; help files

### 2 Be able to use a standard word processing application to produce complex construction documents

*Manipulate bodies of text:* insert; edit; cut; copy; paste; move; find and replace words

*Format:* font (type, size, superscript, subscript, bold, underline, italic); bullet points; numbering; paragraph

*Layout and structures:* margins; headers; footers; line spacing; column layout; tabs; page breaks; borders; shading; table structures

*Fields:* e.g. auto page numbering, date

*Drawings:* insert; manipulate using drawing toolbar

*Pictures and objects:* insert; manipulate

*Word processing tools:* spellcheck; grammar check; thesaurus

### 3 Be able to use a standard spreadsheet application to produce construction data

*Workbooks:* worksheets; insert data; format cells (texts and numbers); fill; clear and delete operations; insert and delete rows and columns; resize cells, rows and columns; hide cells; protect cells; protect worksheets

*Formulae, functions and tools:* formula entry; cell reference (absolute, relative); autosum and other built-in functions; conditional commands; auditing tool

*Present data:* sorted data; tables; charts (functions, manipulate, save, print); change printable area; graphs

**4 Be able to use a standard database application to process construction data**

*Plan a database:* inputs; outputs; structure

*Produce a database:* fields; records; data entry forms; list view

*Reports:* produce; print

*Manipulate data:* search; sort; query (filter)

*Specification:* format; information to be displayed

*Mailshots:* mailmerge; multiple individualised mailshots

**5 Understand the application of software relevant to construction and the built environment**

*Benefits and applications:* quantity surveying; project planning; design; computer-aided design (CAD); surveying

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to use computing and software applications	1.1 perform operating system applications to run standard software packages  1.2 perform file operations for standard software packages  1.3 perform software operations to view and process data
LO2  Be able to use a standard word processing application to produce complex construction documents	2.1 manipulate bodies of text to produce complex formatted documents  2.2 insert and manipulate drawings, pictures and objects  2.3 use word processing tools
LO3  Be able to use a standard spreadsheet application to produce construction data	3.1 produce programmed workbooks to facilitate the input of various input parameters for differing scenarios  3.2 enter new input data to programmed spreadsheets to determine results for new scenarios  3.3 use relevant formula, functions and tools to produce input data for differing scenarios  3.4 present data illustrating results from the analysis of input data
LO4  Be able to use a standard database application to process construction data	4.1 plan databases for specific purposes  4.2 produce databases to enable input of data in form view  4.3 produce and print reports of manipulated data to required specifications
LO5  Understand the application of software relevant to construction and the built environment	5.1 evaluate the benefits of commercially relevant software  5.2 examine the application of software to different construction disciplines

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 24: Design Procedures for Construction*
- *Unit 25: Design Technology for Construction*
- *Unit 27: Site Surveying Procedures for Construction and the Built Environment*
- *Unit 29: Computer-aided Design for Construction*
- *Unit 35: The Use of Information and Communication Technology for Construction and the Built Environment*
- *Unit 54: Building Management Systems for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require individual access to personal computer stations with a Windows environment or similar GUI and which have access to Microsoft Office and Microsoft Works, or similar applications. Display Screen Regulations must be considered throughout the delivery of this unit.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise presentations by visiting speakers which, focus and advise on commercially used software. Tutors should use real-life case studies, based on visiting speakers, for part of the assessment for this unit.



## Unit 29: Computer-aided Design for Construction

**Unit code:** H/601/1294

**QCF level:** 4

**Credit value:** 15

### ● Aim

This unit provides learners with the opportunity to develop the skills needed to produce two- and three-dimensional drawings using industry-standard computer-aided design (CAD) software.

### ● Unit abstract

This unit develops the skills needed to use industry-standard CAD software. It is intended that the software should operate within the Windows environment, in order to maximise transferable skills to other IT units. This unit enables learners with no prior knowledge of CAD applications to develop their skills in basic 2D drawing, complex 3D drawings and solid modelling. Health and safety issues associated with the use of computer applications will be considered throughout the delivery and assessment of this unit. Learners will develop the ability to produce drawings, of a professional quality, using industry-standard conventions for a variety of construction-related situations. These drawings will use a variety of media and scales in order to highlight the versatility, adaptability and accuracy of CAD drawings.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to work safely when using computing and software facilities
- 2 Be able to produce 2D drawings using industry-standard CAD software applications
- 3 Be able to produce 3D drawings using industry-standard CAD software applications
- 4 Be able to plot drawings to various media and scales and export drawings to different formats.

## Unit content

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### 1 Be able to work safely when using computing and software facilities

*Working safely:* health and safety; data protection (data loss, file protocols)

*Health and safety:* The Health and Safety (Display Screen Equipment) Regulations 1992; hazards (eye strain, posture, repetitive strain injury); control measures associated with hazards

*Data protection:* backing-up protocols; backing-up systems; power cuts; uninterruptible power supplies (UPS); closing-down applications and systems

*Folder structure:* creating folders (hard drives, external drives); accessing existing folders; saving files to different folders; file management

### 2 Be able to produce 2D drawings using industry-standard CAD software applications

*2D drawings:* setting up; data input; drawing; modifying; text; dimension; insert; file formats; views

*Setting up:* open software application; use of templates; entities; aids; snap; polar; User Coordinate System (UCS); layers; line types; units; model space; paper space; viewports; scale; drawing page; title block

*Data input:* dynamic input; menu and icon input

*Drawing:* line; multiline; polyline; spline; circles; arcs; rectangles; polygons; ellipse; hatching; boundaries; triangulation

*Modifying:* erase; copy; trim; extend; scale; stretch; mirror; move; rotate; chamfer; array; fillet; break; join; lengthen

*Text:* multiline; single line; text style

*Dimension:* aligned; linear; ordinate; angular; diameter; arc length; baseline; continuation; dimension style

*Insert:* blocks; attributed blocks; dynamic blocks; raster image; text; spreadsheets; images; copy/paste; explode; purge

*File formats:* DWG; DXF; OLE; 3ds; Xrefs

*Views:* zoom; pan; aerial; named; viewports

### 3 Be able to produce 3D drawings using industry-standard CAD software applications

*3D drawings:* setting up; data input; 3D surface models; 3D solids; solid modelling; modify; rendering; shade; views

*Setting up:* open software application; use of templates; entities; aids; snap; Osnap; polar; UCS; layers; line types; units; model space; paper space; viewports; scale; drawing page; title block

*Data input:* dynamic input; menu and icon input

*3D surface models:* edge; mesh; revolved; tabulated; ruled; edge; loft; sweep; 3D polyline

*3D solids:* box; sphere; cylinder; cone; wedge; torus

*Solid modelling:* extrude; revolve; slice; section; union; subtract; interest; move; offset; delete; rotate; taper; copy faces; separate faces; shell; clean

*Modify:* 3D array; 3D mirror; 3D rotate

*Rendering:* scene; materials; background; lighting

*Shade:* wireframe; hidden; flat; edges; gouraud

*Views:* viewpoint; isometric; plan view; 3D orbit; viewports; UCS

### 4 Be able to plot drawings to various media and scales and export drawings to different formats

*Plot drawings:* plotter selection; page set up; paper type; paper size; plot extents; plot window; scale; pen weights; pen colours; viewports; shaded viewports; styles

*Export files:* different formats e.g. DXF, DWG; save and share; save as; publish

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to work safely when using computing and software facilities	1.1 justify the safe working practices associated with CAD work  1.2 evaluate standard methods of data protection  1.3 create hierarchical folder structures for the storage of CAD files
LO2  Be able to produce 2D drawings using industry-standard CAD software applications	2.1 produce industry-standard 2D drawings of residential properties  2.2 produce industry-standard 2D drawings of commercial properties
LO3  Be able to produce 3D drawings using industry-standard CAD software applications	3.1 produce complex 3D models  3.2 produce a fully rendered set of elevations for properties
LO4  Be able to plot drawings to various media and scales and export drawings to different formats	4.1 plot drawings using different media and scales  4.2 create and export CAD files in different formats

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 12: Conversion and Adaptation of Buildings*
- *Unit 22: Structural Behaviour and Detailing*
- *Unit 25: Design Technology for Construction*
- *Unit 28: IT Applications for Construction*
- *Unit 35: The Use of Information and Communication Technology for Construction and the Built Environment.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to CAD systems and relevant software. Learners require individual access to personal computer stations with a graphical user interface and industry-standard CAD applications. Visual Display Unit (VDU) Regulations must be considered throughout the delivery and assessment of this unit.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.



## **Unit 30: Work-based Learning and Assessment in Construction and the Built Environment**

**Unit code:** T/601/1297

**QCF level:** 5

**Credit value:** 15

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- **Aim**

This unit provides learners with an opportunity to develop an understanding of and the skills needed to use work-based activities as evidence for assessment purposes and achievement of the unit.

- **Unit abstract**

This unit is specifically designed to capture evidence of achievement arising out of naturally occurring work-based learning and assessment opportunities. It is therefore an assessed experiential learning tool. The onus is on learners to identify and capture appropriate work-based learning and relevant assessment evidence to meet the outcomes of the unit. Tutors will need to provide guidance, advice and support on the methodology and structure of this process. Health, safety and welfare aspects must be considered before learners begin this unit.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Be able to apply relevant work-based learning opportunities to the unit requirements
- 2 Understand the issues arising from work-based techniques, methods and procedures used in the construction and built environment sector
- 3 Be able to report continuous improvement in work-based learning and performance
- 4 Be able to present a portfolio of evidence for assessment.

## Unit content

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### 1 Be able to apply relevant work-based learning opportunities to the unit requirements

*Role at work:* undertake a role within the construction and built environment sector e.g. architect, architectural technologist, quantity surveyor, building surveyor, land surveyor, clerk of works, contract manager, site manager, estimator and buyer, planner, site engineer

*Diversity of work:* perform duties within the construction and built environment sector e.g. architectural design, tendering and estimating, planning, construction, site engineering, land surveying, building surveying, quantity surveying, estate management, facilities management, maintenance

*Range of work:* undertake work across the construction and built environment sector e.g. residential, commercial, retail, recreational and leisure, industrial, health, educational, agricultural, public buildings

*Action planning:* identification of appropriate work-based learning and assessment opportunities; selection of relevant work-based learning opportunities; agree work plan with nominated parties in the centre and workplace

*Activities:* personal skills audit; gather evidence; monitor and review action plan as appropriate to work-based learning assessment opportunities

### 2 Understand the issues arising from work-based techniques, methods and procedures used in the construction and built environment sector

*Specifications:* technical; non-technical

*Constraints:* client requirements; timescale; components; materials; technical; operational; legal; financial; environmental

*Working relationships:* subordinates; colleagues; line managers; clients; sub-contractors; main contractor as appropriate; development of higher-level skills

*Key issues:* health, safety and welfare; The Construction (Design and Management) Regulations 2007; sustainability; best practice; quality control; quality assurance; key performance indicators (KPIs); equal opportunities; Respect for People

### 3 Be able to report continuous improvement in work-based learning and performance

*Professional development:* improvements in professional development e.g. career development, performance at work, skill development, breadth of learning strategies; improvements in job-related skills e.g. target setting, action planning, progress monitoring, evaluation, reflective practices, rescheduling, contingency planning, reviews (daily/weekly review, periodical), work logs; competence e.g. NVQ

*Personal developments:* improvements in personal skills e.g. communication, IT, research, negotiation, supervision, management, self-appraisal, higher-level skills

**4 Be able to present a portfolio of evidence for assessment**

*Contents of portfolio:* range of evidence e.g. action plan, reviews, witness testimony, self-assessment, peer assessment, tutor-marked assignments and projects, line manager input to process, case studies, personal logs, research evidence; presentation

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
L01  Be able to apply relevant work-based learning opportunities to the unit requirements	1.1 carry out complex work-based activities related to role at work, diversity and range of work  1.2 produce agreed action plans  1.3 carry out agreed work-based activities
L02  Understand the issues arising from work-based techniques, methods and procedures used in the construction and built environment sector	2.1 examine the specifications and constraints linked to the selected techniques, methods and procedures  2.2 assess working relationships when using selected techniques, methods and procedures  2.3 appraise the key issues involved in the selected areas
L03  Be able to report continuous improvement in work-based learning and performance	3.1 report on professional and personal development through involvement in the selected work-based techniques, methods and procedures
L04  Be able to present a portfolio of evidence for assessment	4.1 produce a portfolio of evidence for complex work-based activities

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 5: Group Project in the Construction Industry*
- *Unit 59: Employability Skills*
- *Unit 60: Personal and Professional Development*
- *Unit 61: Project Design, Implementation and Evaluation*
- *Unit 62: Research Project*
- *Unit 63: Work-based Experience.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

## Essential requirements

The approach taken to generating evidence must recognise that work-based learning:

- is not a subject for learning but a mechanism for learning
- is primarily intended for learners in full-time employment or for learners with access to a workplace for a reasonable period of time
- is about reflecting on work practices and not merely about gaining knowledge, understanding and skills
- arises from action and problem solving within a work environment
- is centred on the learner work, live projects and challenges to individuals and organisations
- implies the creation of knowledge as a shared and collective activity, the discussion of ideas and the sharing of problems and solutions
- assesses not only the products of learning but also the processes of learning such as reflection, self-direction and improvement
- requires learners to address fundamental issues including the rationale for undertaking work-based learning, the benefit to their employer(s), what they personally hope to achieve and how they will achieve their goals
- requires learners to exercise appropriate judgement in a number of complex planning, design, technical, resource and management functions related to products, services, operations and processes
- requires learners to produce evidence of their ability to communicate effectively with other members of the construction team in an appropriate and professional manner.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## Unit 31: Work-based Training and Development in Construction and the Built Environment

**Unit code:** A/601/1298

**QCF level:** 5

**Credit value:** 15

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### ● Aim

This unit provides learners with an opportunity to develop an understanding of and skills in planning relevant work-based training and development activities as evidence for assessment purposes and continuous improvement.

### ● Unit abstract

This unit is specifically designed to capture evidence of relevant work-based training and development that learners have, or will successfully complete during their programme. Examples of such events include:

- company in-house training programmes (learning at work)
- work placement and work-shadowing (that can formally be recorded)
- continuing professional development organised by professional bodies
- seminars and courses offered by commercial training organisations (where attendance can be evidenced)
- product-based and service-based training offered by vendors and suppliers of systems, components, hardware, software, materials and/or tools (where attendance can be evidenced).

This unit is designed to provide a structure and assessment regime that will enable learners to gain recognition for work-based training and development within the context of a BTEC Higher National qualification. This will enhance learners' overall experiences of training and development and bring added benefit to their programmes of study.

● **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Be able to plan for relevant work-based training and development activities relevant to the construction and built environment sector
- 2 Understand the outcomes from the work-based training and development opportunities to be undertaken
- 3 Understand the benefits of the work-based training and development to be undertaken
- 4 Be able to report on continuous improvement in work-based learning and performance.

## Unit content

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### 1 Be able to plan for relevant work-based training and development activities relevant to the construction and built environment sector

*Training and development activities:* personal development e.g. time management and self-management; business skills e.g. finance, marketing, teamwork and negotiation; technical skills (IT and computer-aided design (CAD)); legislation; health, safety and welfare; environmental and sustainability issues

*Personal goals:* career development; salary and job satisfaction; goals and objectives; maintenance of training records; appraisal and feedback on performance; reflection

*Organisational goals:* staff knowledge, understanding and skills; motivation and retention; analysis of future needs, 'learning organisations'; appraisal and performance review; policies on recruitment, selection, training and development of staff; awards e.g. Investors in People (IiP), International Organisation for Standardisation (ISO)

### 2 Understand the outcomes from the work-based training and development opportunities to be undertaken

*Content:* knowledge; understanding; skills

*Assessment process and grading criteria:* standards; grading; feedback

*Evidence:* action plan, reviews, witness testimony, self-assessment, peer assessment, tutor-marked assignments and projects, line manager input to process, case studies, personal logs, presentation

### 3 Understand the benefits of the work-based training and development to be undertaken

*Personal:* improved knowledge and understanding; enhanced practical, cognitive transferable and intellectual skills; higher-level skills; increased confidence and job satisfaction; awareness of future training and development needs

*Organisational:* return on investment analysis; appraisal; future training and development needs

### 4 Be able to report on continuous improvement in work-based learning and performance

*Professional development:* improvements in professional development e.g. career development, performance at work, skill development, breadth of learning strategies; improvements in job-related skills e.g. target setting, action planning, progress monitoring, evaluation, reflective practices, rescheduling, contingency planning, reviews (daily/weekly review; periodical), work logs; competence e.g. NVQ

*Personal development:* improvements in personal skills e.g. communication, IT, research, negotiation, supervision, management, self-appraisal, higher-level skills

## **Learning outcomes and assessment criteria**

<b>Learning outcomes</b>	<b>Assessment criteria for pass</b>
<b>On successful completion of this unit a learner will:</b>	<b>The learner can:</b>
<p>LO1</p> <p>Be able to plan for relevant work-based training and development activities relevant to the construction and built environment sector</p>	<p>1.1 compile portfolios of training and development activities accessed through work</p> <p>1.2 produce an assessment of personal and organisational goals when engaging in training and development</p>
<p>LO2</p> <p>Understand the outcomes from the work-based training and development opportunities to be undertaken</p>	<p>2.1 explain how the content is used to achieve the learning outcomes</p> <p>2.2 review how the assessment process and grading criteria from training and development activities are determined through evidence</p>
<p>LO3</p> <p>Understand the benefits of the work-based training and development to be undertaken</p>	<p>3.1 discuss the personal and organisational benefits gained from training and development</p>
<p>LO4</p> <p>Be able to report on continuous improvement in work-based learning and performance</p>	<p>4.1 report on professional and personal development by participating in training and development</p>

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 5: Group Project in the Construction Industry*
- *Unit 59: Employability Skills*
- *Unit 60: Personal and Professional Development*
- *Unit 61: Project Design, Implementation and Evaluation*
- *Unit 62: Research Project*
- *Unit 63: Work-based Experience.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

## Essential requirements

The evidence required to achieve this unit will be learner attendance at training and development events and the completion of the associated work required for assessment. These events will tend to be non-accredited and may not be assessed, and be without clear or explicit learning outcomes or assessment criteria. However, each unit of a BTEC Higher National qualification requires that evidence for assessment is provided against the learning outcomes and assessment criteria.

The important issues for learners are:

- training and development opportunities selected for inclusion in the portfolio of evidence must address learning outcomes and assessment criteria at a level equivalent to the BTEC Level 5 Higher National qualification
- evidence must be authentic, valid and reliable to support attendance at, and successful completion of, the selected training and development opportunities
- the learning outcomes of these events must be clearly stated where explicit, or must be extracted from the delivery and assessment of the content where they are either absent or implied
- the assessment criteria associated with these events must be clearly stated where explicit, or must be extracted from the delivery and assessment of the content where they are either absent or implied
- work-based learners must have access to regular feedback on their progress and achievements to inform self-appraisal and reflection
- assessors will need to be satisfied that they can assess the evidence learners provide against the learning outcomes and assessment criteria and apply the generic merit and distinction grade descriptors where applicable.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## Unit 32: Engineering Geology and Soil Mechanics

**Unit code:** F/601/1299

**QCF level:** 4

**Credit value:** 15

### ● Aim

This unit enables learners to develop an understanding of common rock types, their use in construction and develop the skills to classify and analyse the properties and characteristics of soils.

### ● Unit abstract

This unit provides learners with skills to classify soil types and establish primary design parameters for soils. Learners will discuss the significance of the ground investigation element of site investigation. This unit also covers the skills required to test soils to current codes of practice and the associated analysis of laboratory data. Learners will also gain a working understanding of the tests needed to classify soils and establish their design parameters.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the common rock types, their mode of formation and uses within construction
- 2 Be able to classify soil types from the determination of their basic soil properties
- 3 Be able to establish the primary design parameters for soils
- 4 Be able to analyse the results from common soil tests.

## Unit content

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### 1 Understand the common rock types, their mode of formation and uses within construction

*Classification of common rocks:* engineering description of rocks to current codes of practice

*Mode of formation:* petrographic classification of igneous rocks; common stable and unstable minerals; diverse nature of sedimentary rocks; grades of metamorphism

*Rock and un-cemented sediments for construction use:* common usage of geological materials for construction; characteristics of the main rock and soil deposits which make them suitable/unsuitable for construction use; differences between rock mass and rock material in construction; type and nature of rock discontinuities; characteristics of discontinuities which influence the engineering performance of rock materials

### 2 Be able to classify soil types from the determination of their basic soil properties

*Soil description and classification:* differences between description and classification; classification tests to current codes of practice; liquidity and consistency indices for fine grained soils

*Fundamental soil properties:* particulate nature of soils; three-phase and two-phase states, calculations for soil density, moisture content, void ratio and degree of saturation; characteristics of fine grained soil responsible for development of apparent cohesion

*Principles of effective stress:* influence on the strength and deformation of soil, drained and undrained behaviour; influence of seepage on effective stress

*Calculations and graphs:* total stress, pore water pressure and effective stress for soil sequence under hydrostatic conditions

### 3 Be able to establish the primary design parameters for soils

*Geotechnical design parameters:* common methods for the determination of shear strength, compressibility and permeability to current codes of practice; potential limitations associated with the methods

*Ground investigation and in-situ sampling:* current techniques for the acquisition of soil samples for laboratory testing; impact of sample quality on measured parameters; common methods of in-situ testing

*Laboratory measurements:* e.g. density, moisture content, void ratio, degree of saturation, permeability, porosity, shear strength, liquid limit, chemical nature

**4 Be able to analyse the results from common soil tests**

*Laboratory data:* shear box tests; volumetric response to shear; unconsolidated undrained and consolidated undrained with pore pressure measurement triaxial tests; triaxial shear strength parameters by Mohr's Stress Circles and stress path methods

*Permeability tests:* constant head and falling head permeameters; process results from field pumping tests (in terms of coefficient of permeability and radius of the cone of depression)

*One-dimensional consolidation test:* oedometer tests for coefficient of volume compressibility

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the common rock types, their mode of formation and uses within construction	1.1 examine modes of formation, engineering descriptions and classifications of common rock types  1.2 describe the common rock forming minerals and their susceptibility to weathering  1.3 evaluate the common usage of rock and un-cemented sediments for construction
LO2  Be able to classify soil types from the determination of their basic soil properties	2.1 produce soil descriptions for in-situ and sampled materials  2.2 classify soils  2.3 determine basic soil properties  2.4 produce calculations and graphs relating to basic soil properties
LO3  Be able to establish the primary design parameters for soils	3.1 explain the measurement of geotechnical design parameters  3.2 discuss the methods of ground investigation and/or in-situ sample acquisition and testing  3.3 carry out laboratory measurements on soils
LO4  Be able to analyse the results from common soil tests	4.1 evaluate laboratory data to determine shear strength parameters using current codes of practice  4.2 carry out permeability and one-dimensional consolidation tests

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 33: Civil Engineering Technology*
- *Unit 37: Advanced Civil Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Laboratory sessions must be incorporated as a practical aid to the learning process and learners require access to appropriate laboratory resources. Learners will also need access to standards, current codes of practice and computer facilities for the analysis of test data.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example geology field trips to active sites. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers related to ongoing and/or previous geotechnical schemes. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 33: Civil Engineering Technology

**Unit code:** M/601/1301

**QCF level:** 4

**Credit value:** 15

### ● Aim

This unit enables learners to develop an understanding of the methods and techniques used to create civil engineering structures and the skills needed to solve problems associated with civil engineering activities.

### ● Unit abstract

This unit introduces learners to the methods and techniques used to create civil engineering structures. This unit has a strong theoretical underpinning and learners will develop an understanding of the technical requirements for substructures and superstructures. Learners will gain an understanding of hazards related to construction and civil engineering activities and consider the required health, safety and welfare legislation. Learners will also develop skills to design solutions and produce safety plans for civil engineering problems.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the methods and techniques used in earthwork activities
- 2 Understand the methods and techniques used to create substructures
- 3 Understand the methods and techniques used to create superstructures
- 4 Understand the hazards associated with civil engineering activities
- 5 Be able to solve problems associated with civil engineering activities.

## Unit content

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### 1 Understand the methods and techniques used in earthwork activities

*Earthworks activities:* formation of cuttings and embankments; use of earthmoving equipment; groundwater problems; techniques used to deal with issues of ground and slope stability; dewatering techniques (temporary and permanent) deep excavation techniques; trenching works

### 2 Understand the methods and techniques used to create substructures

*Substructure:* foundations; piling works; drainage works; culverts; underpasses; utilities

### 3 Understand the methods and techniques used to create superstructures

*Structures:* bridges; industrial and commercial buildings

*Construction methods:* reinforced concrete; formwork and falsework; structural steelwork

### 4 Understand the hazards associated with civil engineering activities

*Hazards:* risks; safety arrangements for activities e.g. excavations, working in confined spaces, working on structures, working within temporary works

*Legal framework:* The Construction (Design and Management) Regulations 2007 (CDM); sections applicable to civil engineering activities; roles and responsibilities of all parties in civil engineering projects

*Specific role of planning supervisor:* ensure Health, Safety and Welfare Inspectorate (HSWI) is notified of project; ensure cooperation between designers; ensure that a pre-tender stage health and safety plan is prepared, advise the client when requested to do so; ensure that a health and safety file is prepared; maintain health and safety file

### 5 Be able to solve problems associated with civil engineering activities

*Principles of effective and efficient management of construction activities:* interrelationships of activities e.g. safety, environmental, quality, technical and economic factors; analysis of issues arising out of civil engineering activities; importance of safety plans; application of agreed solution to such issues

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the methods and techniques used in earthwork activities	1.1 explain the use of earthmoving equipment 1.2 discuss appropriate techniques to ensure safe and productive activities in deep excavations 1.3 illustrate temporary works required to deal with ground stability and groundwater
LO2  Understand the methods and techniques used to create substructures	2.1 explain techniques to install piling systems and ground stabilisation activities 2.2 describe methods of constructing complex foundations 2.3 illustrate construction methods used in drainage works, culverts and utilities
LO3  Understand the methods and techniques used to create superstructures	3.1 discuss appropriate construction methods 3.2 explain the use of falsework and formwork in reinforced concrete structures
LO4  Understand the hazards associated with civil engineering activities	4.1 assess hazards from civil engineering activities 4.2 explain the legal framework of health, safety and welfare and the requirements of the CDM Regulations 4.3 evaluate the role of the planning supervisor in civil engineering activities
LO5  Be able to solve problems associated with civil engineering activities	5.1 design appropriate solutions to civil engineering problems 5.2 produce safety plans for problems arising from civil engineering activities

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 13: Environmental Impact of Construction*
- *Unit 27: Site Surveying Procedures for Construction and the Built Environment*
- *Unit 37: Advanced Civil Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits to two different civil engineering works. To ensure site visits are successful tutors should outline the aims and objectives of the visits, for example the identification of scope of works (health, safety and welfare requirements and associated problems with excavation or complex construction work), conduct preparatory briefings and encourage learners to review the site visits and compare construction techniques used on site works. Tutors should organise presentations by visiting speakers, for example contractors to contextualise site visits to complex civil engineering works and the associated health, safety and welfare requirements. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit, for example excavation and temporary works associated with earthworks, piling and foundations including relevant health, safety and welfare requirements and/or erection of low-rise to medium-rise prefabricated buildings including relevant health, safety and welfare requirements. Tutors should encourage learners to produce written solutions supported by oral presentations.

## Unit 34: Structural Analysis and Design

**Unit code:** T/601/1302

**QCF level:** 5

**Credit value:** 15

### ● Aim

This unit provides learners with an opportunity to develop skills to analyse and design statically determinate structures in compliance with current codes of practice and standards.

### ● Unit abstract

This unit focuses on the skills required to analyse construction designs and appraise statically determinate structures. Learners will design common structural elements to the appropriate British Standard, code of practice or European Code of Practice. Learners are encouraged to work with real-life examples and develop the skills needed to produce effective and economic designs.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to analyse bending moments and shear forces for statically determinate structures
- 2 Be able to analyse bending deflections for statically determinate structures
- 3 Be able to appraise the behaviour of elastic columns subjected to axial loading
- 4 Be able to apply design methods.

## Unit content

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### 1 Be able to analyse bending moments and shear forces for statically determinate structures

*Cantilevers and supported beams:* variety of point loads and uniformly distributed loads; bending moment diagrams; shear force diagrams

*Three pin frame:* inclined; horizontal and vertical members; variety of point loads and uniformly distributed loads; bending moment diagrams; shear force diagrams

### 2 Be able to analyse bending deflections for statically determinate structures

*Cantilevers and supported beams:* Mohr's moment-area method (variety of point loads and uniformly distributed loads); Macauley's method (variety of point loads and uniformly distributed loads); bending deflection in beams (variety of materials for beam section)

### 3 Be able to appraise the behaviour of elastic columns subjected to axial loading

*Axial load carrying capacity:* elastic buckling; Euler's method for determining the critical load; concept of effective length

### 4 Be able to apply design methods

*Steel beams and columns:* concept of limit state design; classification of Universal Beam (UB) and Universal Column (UC) sections; moment capacity, shear resistance and deflection for simply supported UB; buckling characteristics of UC and Structural Hollow Sections (SHS); load capacity of axially-loaded sections with bending moments about the major axis

*Reinforced concrete beams and columns:* concept of limit state design; reinforcing requirements and deflection for singly reinforced rectangular beams; design status of column; reinforcing requirements of a short reinforced column under axial load with bending moments about one axis

*Timber beams and posts:* natural characteristics of timber and their relevance to design; moment capacity, shear capacity, bearing capacity and deflection for beams; axial load capacity of rectangular posts

*Masonry columns:* vertical load capacity of square and rectangular masonry columns

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to analyse bending moments and shear forces for statically determinate structures	1.1 calculate bending moments and shear forces for cantilevers and supported beams  1.2 calculate bending moments and shear forces in a three pin frame
LO2  Be able to analyse bending deflections for statically determinate structures	2.1 calculate bending deflection for cantilevers and supported beams
LO3  Be able to appraise the behaviour of elastic columns subjected to axial loading	3.1 determine the axial load carrying capacity of perfectly elastic columns
LO4  Be able to apply design methods	4.1 produce valid designs for steel beams and columns  4.2 produce valid designs for reinforced concrete beams and columns  4.3 produce valid designs for timber beams and posts  4.4 produce valid designs for a masonry column

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 3: Applied Mathematics for Construction and the Built Environment*
- *Unit 22: Structural Behaviour and Detailing*
- *Unit 36: Applied Mathematics for Complex Engineering Problems.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to extracts from the appropriate design standards and relevant structural analysis and design software.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example on design schemes. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.

## Unit 35: The Use of Information and Communication Technology for Construction and the Built Environment

**Unit code:** D/601/1312

**QCF level:** 4

**Credit value:** 15

### ● Aim

This unit provides learners with an opportunity to develop skills in using information and communication technology and gain an understanding of the implications of technology and security for organisations.

### ● Unit abstract

This unit provides learners with a fundamental understanding of the growing importance and application of information and communication technology (ICT) within the construction and built environment sector. Learners will investigate a variety of software packages currently used within the construction and built environment sector, and produce outcomes using Word, spreadsheets and computer-aided design (CAD) software packages. Computing technology underpins many aspects of the construction and built environment sector, from design to production management, and is beginning to have an integrating role within the overall sector. The implications of ICT are far reaching and learners will gain an understanding of the influence of technology, and the opportunities it offers within the sector.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the technology that is available
- 2 Be able to use ICT software for various purposes
- 3 Be able to use electronic communication techniques
- 4 Understand the importance of security and control
- 5 Understand the implications of the growing use of new technologies.

## **Unit content**

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### **1 Understand the technology that is available**

*ICT:* constituent parts of a PC; specification; performance; processors; memory; hard disks (internal, external); CD ROM; multimedia; screens (including appropriate resolution); input and output devices; voice; scanners; digitisers; printers; plotters

### **2 Be able to use ICT software for various purposes**

*Generic software:* design packages; management packages; operating systems

*Office software:* word processors; spreadsheets; presentation packages; databases; CAD

*Task-specific software:* design; surveying; structural analysis; transportation planning

### **3 Be able to use electronic communication techniques**

*Electronic communication techniques:* interaction between people, offices, firms, sites; usage; methods; formats; issues; conflicts; flow of information; access to information

*Data transfer mechanisms:* formats and conversion; dial up; EDI; intranets; WANs; LANs; internet; WiFi; ISDN; bandwidth (broadband)

### **4 Understand the importance of security and control**

*Management control issues:* viruses; legislation; health and safety; Visual Display Unit (VDU) risk assessments; cost benefits of ICT investment

*Security issues:* ownership; copyright of data; hacking; firewalls

### **5 Understand the implications of the growing use of new technologies**

*Implications of new technologies:* ownership; accessibility; implementation; issue of deskilling; integrated project databases; paperless office; currency and updating; potential shift of control and power; role of expert and non-expert clients; globalisation

## **Learning outcomes and assessment criteria**

<b>Learning outcomes</b>	<b>Assessment criteria for pass</b>
<b>On successful completion of this unit a learner will:</b>	<b>The learner can:</b>
<p>L01</p> <p>Understand the technology that is available</p>	<p>1.1 explain the component parts of modern ICT systems</p> <p>1.2 evaluate ICT in relation to performance and cost</p>
<p>L02</p> <p>Be able to use ICT software for various purposes</p>	<p>2.1 demonstrate the benefits of generic design and management software</p> <p>2.2 create documents using the advanced functions of a standard word processing package</p> <p>2.3 create spreadsheet applications to solve technical problems</p> <p>2.4 produce simple CAD drawings using task-specific software</p>
<p>L03</p> <p>Be able to use electronic communication techniques</p>	<p>3.1 evaluate the impact of electronic communication techniques on design and management</p> <p>3.2 perform electronic communication techniques using two different data transfer mechanisms</p>
<p>L04</p> <p>Understand the importance of security and control</p>	<p>4.1 explain the importance of the effective management control of ICT systems</p> <p>4.2 evaluate the issues that affect the security of electronic data</p>
<p>L05</p> <p>Understand the implications of the growing use of new technologies</p>	<p>5.1 discuss the implications of new technologies for the sector and for those working in the sector</p>

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 24: Design Procedures for Construction*
- *Unit 28: IT Applications for Construction*
- *Unit 29: Computer-aided Design for Construction*
- *Unit 54: Building Management Systems for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

The practical elements must be carried out individually and will require the dedicated use of a computer terminal for each learner. Learners require access to a wide variety of materials and facilities to enable group discussions to take place. Learners will also need access to up-to-date computing facilities with appropriate storage and output devices. In addition the following software is required; a word processor, spreadsheets, CAD and specific engineering applications software. VDU Regulations must be considered throughout the delivery and assessment of this unit.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to design offices. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example software package suppliers. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.

## Unit 36: Applied Mathematics for Complex Engineering Problems

**Unit code:** K/601/1314

**QCF level:** 5

**Credit value:** 15

### ● Aim

This unit provides learners with the opportunity to develop an understanding of trigonometric functions and the skills needed to apply advanced mathematical techniques to solve complex engineering problems.

### ● Unit abstract

This unit will enhance learners' capabilities in respect of trigonometry, algebra, calculus and statistics. Trigonometric functions are explored largely as a foundation for their application to the understanding of waves. Additional techniques, including matrices and numerical methods, are introduced so learners are able to solve linear and non-linear algebraic equations. Skills in the correct use and application of calculus are enhanced by introducing learners to partial differentiation and the application and solution of differential equations. This is developed by exploring the techniques used in integration, and the application of these techniques to the calculation of areas and volumes. Learners will develop skills in data gathering and analysis by considering the common forms of distribution. Learners will also gain an understanding of how mathematics is used to communicate results and support decision making.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the use of trigonometric functions
- 2 Be able to solve algebraic equations representing engineering problems
- 3 Be able to apply calculus to engineering problems
- 4 Be able to apply differential equations to engineering problems
- 5 Be able to apply statistical techniques to engineering problems.

## Unit content

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### 1 Understand the use of trigonometric functions

*Trigonometric functions:* graphs; sum waves; identities

*Graph:* of the form  $R\sin(\omega t + a)$ ;  $\sin x$ ;  $\cos x$ ;  $\tan x$ ;  $\sin 2x$ ;  $\cos 2x$ ; properties (amplitude, phase, frequency, period)

*Sum waves:* e.g.  $(a\sin x + b\cos x)$

*Trigonometric identities:* e.g. expansions of  $\sin 2x$ ,  $\cos 2x$  etc

### 2 Be able to solve algebraic equations representing engineering problems

*Algebraic equations:* linear; non-linear; identification of unknowns, derivation of model equations

*Linear algebraic equations:* matrix form of simultaneous linear equations; solution of linear simultaneous equations, inverse matrices, Gaussian elimination

*Non-linear algebraic equations:* bisection; Newton-Raphson method

### 3 Be able to apply calculus to engineering problems

*Calculus:* partial differentiation; integration; by parts, substitution and partial fractions

*Engineering problems:* stationary points; areas and volumes

*Stationary points:* location and classification of stationary points; functions of one and two variables

*Areas and volumes:* calculation using definite integrals

### 4 Be able to apply differential equations to engineering problems

*Differential equations:* modelling using differential equations; solutions (e.g. analytical solutions of linear constant coefficient differential equations, initial and boundary conditions, numerical solutions of differential equations, Euler's method); use of appropriate software

*Engineering problems:* as appropriate to learner pathway (mechanical systems, electrical systems, fluid systems, thermodynamic systems, control systems, statics, dynamics, growth and decay), use of mathematical software

### 5 Be able to apply statistical techniques to engineering problems

*Statistical techniques:* sampling; linear regression (including line of best fit); confidence intervals; discrete and continuous distributions (binomial, Poisson, normal)

*Engineering problems:* as appropriate to learner pathway (material testing, quality control, forecasting, decision making)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the use of trigonometric functions	1.1 sketch graphs for trigonometric functions of the form $R\sin(\omega t + a)$ 1.2 analyse the sum of waves at the same frequency 1.3 evaluate problems using trigonometric identities
LO2  Be able to solve algebraic equations representing engineering problems	2.1 construct algebraic equations to represent engineering problems 2.2 solve simultaneous linear equations 2.3 solve non-linear equations
LO3  Be able to apply calculus to engineering problems	3.1 determine partial derivatives of functions 3.2 classify stationary points of functions with one and two variables 3.3 determine integrals 3.4 calculate areas and volumes using definite integrals
LO4  Be able to apply differential equations to engineering problems	4.1 select appropriate differential equation models 4.2 solve problems using initial and boundary value conditions 4.3 solve differential equations numerically using mathematical software
LO5  Be able to apply statistical techniques to engineering problems	5.1 determine lines of best fit 5.2 analyse probability distributions for discrete and continuous data 5.3 solve engineering problems using standard statistical distributions

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 3: Applied Mathematics for Construction and the Built Environment*
- *Unit 27: Site Surveying Procedures for Construction and the Built Environment*
- *Unit 34: Structural Analysis and Design*
- *Unit 39: Transportation for Construction and the Built Environment*
- *Unit 58: Application of Scientific Principles to Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to a suitable electronic graphical calculator and also need access to appropriate computer facilities, software and library resources.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## Unit 37: Advanced Civil Engineering

**Unit code:** T/601/1316

**QCF level:** 5

**Credit value:** 15

### ● Aim

This unit enables learners to understand the methods and techniques used for specialised civil engineering projects and develop skills in solving problems arising from construction and civil engineering activities.

### ● Unit abstract

This unit provides learners with an understanding of specialised methods and techniques used in complex civil engineering activities. There is a strong theoretical understanding underpinning the study of this unit, and there will be considerable emphasis on learners understanding the selection of appropriate methods and resources through a variety of realistic case studies.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the methods and techniques used in tunnelling activities
- 2 Understand the methods and techniques used in hydraulic structures
- 3 Understand the methods and techniques used in marine works
- 4 Understand the methods and techniques used in highway construction and railway works
- 5 Be able to solve problems arising from complex civil engineering activities.

## Unit content

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### 1 Understand the methods and techniques used in tunnelling activities

*Tunnelling activities:* ground conditions e.g. hard rock, soft ground; ground support; cut and cover tunnelling; pipejacking; mini-tunnelling; construction of shafts

### 2 Understand the methods and techniques used in hydraulic structures

Constructing hydraulic structures: materials used e.g. earth, rockfill, concrete; ancillary works; canal and river works

### 3 Understand the methods and techniques used in marine works

*Constructing marine works:* cofferdams; caissons; sea walls; harbour works; coastal protection activities

### 4 Understand the methods and techniques used in highway construction and railway works

*Constructing and maintaining carriageway works:* rigid pavements; flexible pavements; railway works (provision of new track and ancillary structures)

### 5 Be able to solve problems arising from complex civil engineering activities

*Factors affecting solutions to civil engineering problems:* proper regard to health, safety and welfare; environmental issues; quality matters; technical and economic considerations; importance of resource plan, planning and programming; contingency plans; amendments as necessary

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the methods and techniques used in tunnelling activities	1.1 explain construction methods for tunnelling  1.2 illustrate appropriate methods used in tunnels and shafts
LO2  Understand the methods and techniques used in hydraulic structures	2.1 explain construction methods for hydraulic structures  2.2 illustrate appropriate methods used in hydraulic structures
LO3  Understand the methods and techniques used in marine works	3.1 explain construction methods for marine works  3.2 illustrate appropriate methods used in marine works
LO4  Understand the methods and techniques used in highway construction and railway works	4.1 explain construction methods for highway and railway works  4.2 illustrate appropriate methods used in highway construction and railway works
LO5  Be able to solve problems arising from complex civil engineering activities	5.1 design appropriate solutions for complex civil engineering activities  5.2 produce a resource plan for civil engineering activities

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 4: Management Principles and Application for Construction and the Built Environment*
- *Unit 13: Environmental Impact of Construction*
- *Unit 15: Production Management for Construction*
- *Unit 27: Site Surveying Procedures for Construction and the Built Environment*
- *Unit 33: Civil Engineering Technology*
- *Unit 38: Hydraulic Principles and Applications.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits to two different civil engineering works. To ensure site visits are successful tutors should brief learners on the of scope of works, health, safety and welfare requirements and associated problems with tunnelling, marine, highways or complex civil engineering works. Tutors should outline the aims and objectives of the visits and encourage learners to review the site visits and compare construction techniques used on site works. Tutors should organise presentations by visiting speakers, for example contractors to contextualise site visits. Tutors should use real-life case studies, based on site visits, for example, tunnelling and temporary works associated with earthworks and earthwork removal, and/or management of complex marine or highway civil engineering projects, including relevant health, safety and welfare requirements. Tutors should encourage learners to produce written solutions supported by oral presentations.

## Unit 38: Hydraulic Principles and Applications

**Unit code:** J/601/1319

**QCF level:** 5

**Credit value:** 15

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### ● Aim

This unit provides learners with an opportunity to develop the skills required to solve hydrostatic and flow problems, select appropriate pumps and undertake experiments in hydraulics.

### ● Unit abstract

This unit focuses on the forces in fluids, predominantly water, both at rest and in motion. Learners will develop the skills needed to use measuring instrumentation under laboratory conditions and will have an opportunity to record, and analyse data, and present the results in an appropriate format. Learners will carry out calculations to analyse hydrostatic forces in relation to civil engineering projects. This unit explores fluid kinetics, and its application to the design of pipelines and channels. Learners will develop an appreciation of hydraulic machinery to enable them to understand pump and pipeline system problems. Learners will also investigate the use of hydraulic structures to measure and control the flow of fluids in channels.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to solve engineering hydrostatic problems
- 2 Be able to solve engineering flow problems
- 3 Be able to match pumps to the demands of a specific system
- 4 Be able to undertake hydraulic experimental procedures.

## Unit content

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### 1 Be able to solve engineering hydrostatic problems

*Pressure measuring devices:* manometers; other instruments (used to measure fluid pressure and pressure differentials)

*Hydrostatic forces:* magnitude and location of hydrostatic forces acting on submerged bodies (plane and curved surfaces, vertical and inclined surfaces)

### 2 Be able to solve engineering flow problems

*Engineering flow problems:* flow classification; analytical principles; closed conduit flow; uniform open channel flow; flow measurement in open channels

*Flow classification:* laminar and turbulent flow; uniform and non-uniform flow; steady and unsteady flow

*Analytical principles:* continuity; conservation of energy (Bernoulli's equation); forces due to rate of change of momentum

*Closed conduit flow:* frictional heat loss in pipes and pipe systems; minor (form) head losses; roughness and variation of friction factor

*Uniform open channel flow:* Chezy and Manning velocity equations; normal and critical depths; specific energy and specific force; super-critical flow; the hydraulic jump

*Flow measurement in open channels:* velocity area methods; gauging structures e.g. broad crested weir, venturi flume

### 3 Be able to match pumps to the demands of a specific system

*Pump matching:* energy and hydraulic gradients in pump-pipeline systems; pump performance and characteristic curves; pump selection to operate in a given system; pumps in series and parallel

*Specific systems:* hydrodynamic machines; classification of pumps and turbines (radial, axial, reaction)

### 4 Be able to undertake hydraulic experimental procedures

*Experimental procedures:* determination and investigation of hydrostatic forces; pressure measurement; velocity and flow measurement (pipes and open channels); energy losses (pipe systems); hydraulic jumps; pump characteristics

## Learning outcomes and assessment criteria

<b>Learning outcomes</b> <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b> <b>The learner can:</b>
L01 Be able to solve engineering hydrostatic problems	1.1 explain the construction and application of pressure measuring devices 1.2 carry out calculations to determine the magnitude and position of hydrostatic forces
L02 Be able to solve engineering flow problems	2.1 carry out calculations for pipeline flow problems 2.2 carry out calculations for open channel flow problems
L03 Be able to match pumps to the demands of a specific system	3.1 carry out calculations to match pump(s) to the requirements of a specific system
L04 Be able to undertake hydraulic experimental procedures	4.1 carry out laboratory investigations into hydraulic behaviour 4.2 produce reports on the findings of hydraulic laboratory investigations

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 3: Applied Mathematics Methods for Construction and the Built Environment*
- *Unit 36: Applied Mathematics for Complex Engineering Problems*
- *Unit 37: Advanced Civil Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Laboratory facilities are essential for learners to undertake experimental work on a hydraulic bench/flume, and develop competence in using measuring instruments to record, analyse and present results.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## Unit 39: Transportation for Construction and the Built Environment

**Unit code:** J/601/1322

**QCF level:** 5

**Credit value:** 15

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### ● Aim

This unit provides learners with an opportunity to understand the principles required to justify transportation projects and develop the skills needed to produce final design solutions for transportation projects.

### ● Unit abstract

This unit brings together the necessary understanding and skills which will underpin any project in the transportation sector of the built environment. It focuses on the need to use data to justify the allocation of financial resources to transportation projects. Learners will prepare a project brief based on their analysis of transport data. Learners will develop their understanding of design principles by presenting overall design concepts and refining the design options to develop final detailed designs. Learners will also consider the design and subsequent construction of transportation projects taking environmental factors into account.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand how to analyse data to justify projects
- 2 Be able to prepare project briefs based on the analysis of data
- 3 Be able to utilise basic project information to present overall design concepts
- 4 Be able to refine design options to develop final detailed designs
- 5 Understand the importance of an environmental impact study.

## Unit content

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### 1 Understand how to analyse data to justify projects

*Sources:* local; national; validity and appropriateness

*Use data sources:* selection of appropriate data sources; determination of range of analysis; collection and collation of data (clear and accurate); analysis of data; determination of results (accurate, reliable and indicative)

*Justifying choices made:* using results of analysis; highlighting key outcomes

### 2 Be able to prepare project briefs based on the analysis of data

*Key functions and performance:* critical benefits of the project e.g. economic, environmental, social; sustainability strategy; policies

*Justify brief:* data analysis; brief to include critical elements e.g. economic, social, environmental, sustainable; procurement processes; tendering

*Further investigation:* identify factors which may require further analysis e.g. policy, regulatory

*Project brief:* total scope of the project (requirements, structures and activities); sectors e.g. construction, civil engineering, building services; services provided by each sector; project teams; role of professionals within project teams

### 3 Be able to utilise basic project information to present overall design concepts

*Design requirements:* key elements; specific problems; confirmation of requirements of the project

*Assembly of data:* project brief (policy, strategy, local, national, regulatory requirements)

*Design scope:* design concept; compare concept to brief; identify how the design is to be undertaken (internally or externally through consultants)

*Project requirements:* local needs; strategy; policy; services; existing conditions; facilities; environment

*Timescale and costs:* standard programming software; overall project programme; land purchase; planning consents; construction phase; cost comparisons; industry-standard indices; cost escalation provisions

**4 Be able to refine design options to develop final detailed designs**

*Design methods:* selection of techniques for detailed designs; relevant codes of practice; industry standards

*Design process:* identification of specific problems; proposals to resolve problems; initial design concept; final design outline; determination of design complexity; resource plan for completion; requirement for specialist input; selection of formats for drawings and schedules; calculations; design checks (accuracy, consistency, compliance with design requirements)

*Design outputs:* calculations; drawings; schedules; schematic views; drawings; recording and annotation of all outputs; quality assurance

**5 Understand the importance of an environmental impact study**

*Project assessment:* examination of design; methods of construction; materials; sources; changes to existing use; disposals; analysis; review; effects on community e.g. social, economic, ecological; land use; contamination of land; carbon use; flood risk management; safety and accessibility

*Recommendations:* effectiveness of alternatives (compare, evaluate, justify)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand how to analyse data to justify projects	1.1 select suitable sources of transportation data 1.2 assess the feasibility of potential transportation projects using data sources 1.3 justify the choice of transportation projects
LO2  Be able to prepare project briefs based on the analysis of data	2.1 discuss the key functions and performance requirements for projects 2.2 justify the brief against the results of the data analysis 2.3 examine factors within projects which may require further investigation 2.4 prepare project briefs
LO3  Be able to utilise basic project information to present overall design concepts	3.1 present design proposals that meet the requirements of the brief 3.2 identify specific problems 3.3 estimate the capital cost of a project 3.4 develop an overall programme for the completion of projects
LO4  Be able to refine design options to develop final detailed designs	4.1 present the most appropriate method of producing final design details 4.2 carry out refinement of initial design concepts 4.3 produce design details using current codes of practice 4.4 produce drawings and schedules
LO5  Understand the importance of an environmental impact study	5.1 assess project proposals, detailed designs and methods of construction in relation to environmental factors 5.2 review measures to reduce the environmental impact

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 1: Design Principles and Application for Construction and the Built Environment*
- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 3: Applied Mathematics for Construction and the Built Environment*
- *Unit 13: Environmental Impact of Construction*
- *Unit 36: Applied Mathematics for Complex Engineering Problems*
- *Unit 61: Project Design, Implementation and Evaluation.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to extracts from the appropriate design standards, both national and local, IT facilities and design and modelling computer software for demonstration purposes.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise presentations by visiting speakers, for example design consultants on how to scope and develop a project brief and/or Environment Agency representatives on current requirements in project development.



## Unit 40: Thermofluids and Acoustic Criteria for Building Services Engineering

**Unit code:** R/601/1324

**QCF level:** 5

**Credit value:** 15

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- **Aim**

This unit provides learners with the opportunity to develop an understanding of the principles of thermofluids. Learners will also develop the skills needed to analyse formulae and design acoustic environments.

- **Unit abstract**

The purpose of this unit is to extend learner understanding of the analysis and application of fluid flow, heat transfer and acoustics in the design of building services installations. This unit examines thermodynamic laws and process cycles which are pertinent to the systems and equipment used in building services engineering.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand the principles of heat and vapour transfer in building services systems
- 2 Understand the performance of heat exchangers and refrigeration plants
- 3 Be able to apply dimensional analysis to formulae
- 4 Be able to design acceptable acoustic environments to control noise.

## Unit content

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### 1 Understand the principles of heat and vapour transfer in building services systems

*Heat transfer:* kinetic theory; modes of heat transfer; suitability for building services equipment; applications in building services; conduction; free and forced convection; temperature parameters e.g. mean, bulk, Arithmetic Mean Temperature Difference (AMTD), Log Mean Temperature Difference (LMTD); application of dimensionless groups e.g. Grashoff, Nusselt, Reynolds, Prandtl; heat transfer coefficients; heat flux for heated and cooled surfaces; radiation; surface characteristics (reflectivity, transmissivity, absorptivity, emissivity); electromagnetic radiation (waveform, amplitude, frequency, wavelength); black body emissions (in terms of wavelength and absolute temperature); emission from black, grey and selective surfaces; use of form factors to determine radiant heat exchange; application of radiant heat transfer principles to building services heat transfer equipment; discomfort (due to asymmetric radiation, plane radiant temperature, vector radiant temperature); solar radiation; solar constant; implications of solar intensity on surfaces

*Vapour transfer:* Fick's Law; diffusion, permeability and vapour resistivity; determination of moisture transfer (through composite structures); formation of condensation; implications of vapour mass transfer for building services applications

### 2 Understand the performance of heat exchangers and refrigeration plants

*Heat exchangers:* types; classification (shell and tube, shell and coil, tube in tube, plate); design; construction; characteristics; applications

*Principles of heat exchangers:* fluid flow paths; pressure drop limitations; film and overall thermal transmittance through heat exchanger boundary walls (solid boundary and boundary layers); resistances; factors that affect effectiveness and loss of performance; rate of heat exchange (primary fluid flow, secondary fluid flow, return temperatures varying in parallel flow and counterflow); performance-using effectiveness; capacity ratio; number of transfer units (NTU); LMTD for parallel flow and counterflow; performance of heat exchangers for evaporating and condensing fluids (single and two-phase fluid condition); heat exchange in cross flow

*Refrigeration plant:* types; classification; design; construction; characteristics; applications; use, application and comparison of vapour, gas and power cycles appropriate to industry, building services and refrigeration applications; compression and expansion devices; analysis of performance characteristics (different types of compressor used in refrigeration systems)

*Principles of refrigeration plant:* construction of vapour compression diagrams for heating and cooling; use of T-S and p-H diagrams to construct refrigeration cycles; thermodynamic processes in refrigeration cycles, heat pumps and heat engines; Carnot cycle; performance analysis of refrigeration/heat pumps in cooling and heating modes (by use of formulae, tables and charts for gases and vapours); mass flow rates; input power, capacity; efficiency and temperature; coefficient of performance; theoretical and actual cycle arrangements; ideal and actual pressure-volume diagrams (for reciprocating and roto-dynamic compression devices); isothermal, adiabatic and polytropic compression and expansion curves; first law of thermodynamics

### 3 Be able to apply dimensional analysis to formulae

*Dimensional analysis:* units and dimensions; dimensional analysis; fundamental and empirical formulae

*Units and dimensions:* identification of units and dimensions in commonly used terms and parameters e.g. force, energy, mass flow, volume flow, acceleration, density, viscosity, specific heat capacity, specific enthalpy, cubical expansion, thermal conductivity, heat flux, rotation, heat transfer coefficient, velocity and area; checking formation of rational formulae; identification of dimensions of constants (rational formulae used in building services applications)

*Application of dimensional analysis:* geometric and dynamical similarity; derivation of appropriate rational and empirical formulae from known variables e.g. pump/fan laws, D'Arcy's equation for turbulent flow, equations for heat transfer by free convection and forced convection; application of dimensional analysis to the solution of problems in building services applications (Reynolds Number, Grashof Number, Nusselt Number, Prandtl Number)

*Formulae:*  $P = h\rho g$  (Pa);  $h = 4fLu^2/2gd$  (m of fluid);  $h = fLQ^2/3d^5$  (m of fluid);  $Q = C(dP)^{0.5}$  ( $m^3/s$ ) where  $C = 2/\rho(m - 1)^{0.5} a_1$ ;  $TE = Z_1 + P_1/\rho g + u_1^2/2g$  (m of fluid)

### 4 Be able to design acceptable acoustic environments to control noise

*Acoustic environments:* noise ratings, noise criteria curves; application in acoustic design; privacy criteria; concept of speech intelligibility; statutory and local regulations and criteria (internal and external environments); evaluation of sound and vibration effects on the environment in a building; design criteria in a building environment; design solutions for acceptable acoustic environments

*Control of noise:* attenuation characteristics of materials, components and systems; acoustic enclosures; noise control design solutions (pipework, ductwork, grilles, diffusers, prime movers and compressors)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the principles of heat and vapour transfer in building services systems	1.1 explain the principles of conductive, convective and radiant heat transfer within buildings and through structural elements  1.2 discuss vapour transfer through structural elements  1.3 analyse building services installations in relation to the principles of heat transfer  1.4 analyse the formation of condensate in relation to the principles of vapour transfer
LO2  Understand the performance of heat exchangers and refrigeration plants	2.1 compare different types of heat exchanger in relation to design and application  2.2 analyse the performance of heat exchangers  2.3 compare different types of refrigeration plant in relation to design, application and performance  2.4 analyse the performance of different types of refrigeration plant
LO3  Be able to apply dimensional analysis to formulae	3.1 identify dimensions, units and dimensionless groups  3.2 solve problems in building services using dimensional analysis
LO4  Be able to design acceptable acoustic environments to control noise	4.1 discuss acoustic design criteria  4.2 evaluate the impact of noise and vibration on occupants of the internal environment  4.3 follow recognised guidelines to design effective acoustic environments for building services applications

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 41: Air Conditioning for Industrial and Commercial Buildings*
- *Unit 42: Low Pressure Hot Water Heating for Non-domestic Buildings*
- *Unit 44: Air Conditioning for Complex Industrial and Commercial Buildings*
- *Unit 45: Heating Systems for Industrial and Specialist Applications.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Risk assessments must be produced and complied with for all practical activities, including site visits to building services installations and design offices. Laboratory facilities are required for learners to investigate the properties of heat transfer mechanisms, refrigeration cycles/plant and acoustic criteria.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to building services installations and/or design offices. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example design consultants, materials scientists and/or environmental consultants. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 41: Air Conditioning for Industrial and Commercial Buildings

**Unit code:** H/601/1330

**QCF level:** 4

**Credit value:** 15

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### ● Aim

This unit provides learners with an opportunity to develop the skills needed to select and design suitable ventilation and air conditioning systems for industrial and commercial buildings.

### ● Unit abstract

This unit will develop learner skills in applying the principles of design and operation of air conditioning equipment and installations. Learners will have an opportunity to experience the process of completing air conditioning designs in complex industrial and commercial applications. This unit will also enable learners to interpret the air conditioning requirements of buildings, develop practical air conditioning schemes for a range of environments, and evaluate the effectiveness of alternative schemes.

### ● Learning outcomes

#### On successful completion of this unit a learner will:

- 1 Be able to carry out appraisals of the ventilation and air conditioning requirements for industrial and commercial buildings
- 2 Be able to determine cooling loads for buildings and peak summertime temperatures for spaces without air conditioning
- 3 Be able to produce designs to satisfy the ventilation and air conditioning needs of industrial and commercial buildings
- 4 Be able to select cooling plant and equipment for air conditioning systems.

## Unit content

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### 1 Be able to carry out appraisals of the ventilation and air conditioning requirements for industrial and commercial buildings

*Appraisals:* client and building operational requirements; possible strategies

*Client and building operational requirements:* ventilation and air conditioning design standards; publications for industrial and commercial buildings; balance between client needs, commercial constraints, health and safety requirements, aesthetic issues and energy efficiency considerations

*Possible strategies:* mechanical air conditioning or ventilation systems; use of natural ventilation (for cooling); interrelationship of ventilation and air conditioning with other mechanical and electrical building services

### 2 Be able to determine cooling loads for buildings and peak summertime temperatures for spaces without air conditioning

*Cooling loads due to solar radiation:* solar geometry and terminology; direct and diffuse solar radiation; calculation of solar irradiance on vertical, horizontal and pitched surfaces; transmission of solar radiation (through glass and building structures)

*Total cooling load and cooling plant capacity:* factors contributing to cooling plant capacity (air conditioned building); assessment of total heat gains to the interior; selection and verification of parameters (determining realistic casual gains); effect of building construction and orientation (thermal inertia and cooling load); use of tables, reference data and computer software to determine cooling loads for rooms, zones and buildings

*Strategies for reducing cooling loads:* effect of shadows and shading; impact of alternative design temperature indices; method of cooling loads

*Peak summertime temperatures:* assessment of peak summertime temperatures (anticipated in the absence of air conditioning); use of tables, reference data and computer software

### 3 Be able to produce designs to satisfy the ventilation and air conditioning needs of industrial and commercial buildings

*Ventilation systems:* application of natural and mechanical ventilation systems; mixed flow and displacement ventilation systems; fume and dust extraction systems; combination of ventilation and commercial air conditioning systems

*Air conditioning systems:* properties, characteristics, psychometric cycles and selection of 'all air,' air, water and packaged refrigerant air conditioning systems (single duct, terminal re-heat, variable air volume (VAV) multi-zone, fan-coil, perimeter induction, chilled ceilings/beam, variable refrigerant volume (VRV), other single and multi-zone packaged refrigeration systems); choice of air conditioning systems to meet buildings' needs

*Ventilation and air conditioning design:* control systems for air conditioning systems; sizing and selection of plant, ductwork and pipework; use of manufacturers' data and software selection; design implications of space; maintenance and commissioning requirements; capital and operating costs; comparisons between centralised and packaged equipment

*Commissioning and testing requirements:* application of current standards and procedures (for commissioning air conditioning and refrigeration systems); instruments and procedures (measurement of volumetric flow, temperature, humidity, pressure and noise); commissioning schedules and documentation

### 4 Be able to select cooling plant and equipment for air conditioning systems

*Selection of plant and equipment:* vapour compression refrigeration cycles; cooling plant and associated equipment; refrigerants

*Vapour compression refrigeration cycles:* construction; major components of refrigeration heat pump installations and commercial air conditioning systems (operation characteristics and features); lubrication requirements and principles

*Cooling plant and associated equipment:* equipment and networks; use of tables, charts, computer software and manufacturers' data; basic control systems (refrigeration and heat pump systems)

*Refrigerants:* properties; characteristics; thermodynamic performance; health, safety and welfare implications; environmental implications of commercially available refrigerants; legislation and standards (for use, handling and disposal of refrigerants and plant); compatibility of refrigerants with lubrication oils; criteria for selection; procedures for charging and evacuating systems

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to carry out appraisals of the ventilation and air conditioning requirements for industrial and commercial buildings	1.1 establish client and building requirements for ventilation and air conditioning  1.2 present alternative strategies for providing ventilation and air conditioning systems
LO2  Be able to determine cooling loads for buildings and peak summertime temperatures for spaces without air conditioning	2.1 determine cooling loads due to solar radiation  2.2 identify factors that contribute to total cooling load and cooling plant capacity  2.3 formulate strategies for reducing cooling loads for buildings  2.4 determine peak summertime temperatures for non-air conditioned buildings
LO3  Be able to produce designs to satisfy the ventilation and air conditioning needs of industrial and commercial buildings	3.1 compare ventilation systems for industrial and commercial buildings  3.2 demonstrate appropriate air conditioning solutions  3.3 design appropriate ventilation and air conditioning systems  3.4 produce guidelines for commissioning and testing requirements
LO4  Be able to select cooling plant and equipment for air conditioning systems	4.1 explain the role of the major components involved in the vapour compression refrigeration cycle  4.2 outline the characteristics and environmental implications of refrigerants used in a cooling plant  4.3 design a cooling plant and associated equipment

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 40: Thermofluids and Acoustic Criteria for Building Services Engineering*
- *Unit 42: Low Pressure Hot Water Heating for Non-domestic Buildings*
- *Unit 44: Air Conditioning for Complex Industrial and Commercial Buildings*
- *Unit 45: Heating Systems for Industrial and Specialist Applications*
- *Unit 58: Application of Scientific Principles to Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to a wide range of publications, reference data, manufacturers' product information, computer facilities and air conditioning design software.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits and conduct preparatory briefings. Tutors should use real-life case studies, based on site visits, to demonstrate the application of air conditioning in industrial and commercial buildings.



## Unit 42: Low Pressure Hot Water Heating for Non-domestic Buildings

**Unit code:** F/601/1335

**QCF level:** 4

**Credit value:** 15

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### ● Aim

This unit provides learners with an opportunity to develop the skills to analyse the need for, and design and specification of, low pressure hot water (LPHW) heating installations for non-domestic buildings.

### ● Unit abstract

Effective, energy efficient and controllable heating installations, sympathetic to the form and function of the building, are expected in today's energy conscious world. Learners will explore the legislation, standards and design guides associated with heating installations and apply these in producing design solutions for industrial, public and commercial buildings. Learners will have the opportunity to establish heating strategies, design briefs and perform calculations required to determine the heating loads for these buildings. Learners will produce design drawings and perform calculations necessary to size, select and specify the pipework, plant and equipment associated with these heating installations. This unit focuses on the application of the principles, standards and legislation associated with the design, control, testing and commissioning of the boiler plant or other heat sources for LPHW heating.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to analyse the need for heating installations and develop design briefs
- 2 Be able to determine space heating loads and energy requirements for heating systems
- 3 Be able to apply legislation and standards to the design of heating systems for non-domestic buildings
- 4 Be able to apply principles, standards and legislation to the selection, specification and commissioning of primary heat sources.

## Unit content

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### 1 Be able to analyse the need for heating installations and develop design briefs

*Client and building heating requirements:* establish the scope of a design brief (client and building operational requirements), provision of heating for non-domestic buildings e.g. balance between client needs, legislative requirements, commercial constraints, building form, structure, configuration and spatial arrangement, range and scope of other mechanical and electrical building services, health, safety and welfare considerations, aesthetic and energy strategies and efficiency considerations

*Design briefs:* constraints and publications (that influence the design of heating installations in industrial and commercial buildings) e.g. statutory requirements, standards, guides and other relevant publications; production of heating installation design briefs

### 2 Be able to determine space heating loads and energy requirements for heating systems

*Thermal comfort:* factors affecting thermal comfort; thermal indices; thermal comfort design parameters; other factors affecting thermal comfort e.g. temperature variations within a space, air and radiant temperature differences, effect of local radiation on comfort, local discomfort and asymmetry; use of predicted mean vote and predicted dissatisfaction

*Steady state heat transfer in buildings:* selection of design data; steady state energy transfer networks; calculation of steady state heat losses to maintain operative comfort (using various types of emitter and the resulting space temperatures)

*Non-steady state heat transfer in buildings:* transient heat transfer factors and equations; calculation of response and heating plant correction factors (for systems with intermittent operation); admittance values; heating loads for systems (with highly intermittent operation)

*Total heating loads and heating plant capacity:* heating plant capacity for buildings; assessment of total heat losses and heating plant output; comparisons with heating benchmarks, energy efficiency targets and standards; minimising heat loads; computer software to determine heating loads for rooms, zones and building

### 3 Be able to apply legislation and standards to the design of heating systems for non-domestic buildings

*Heat emitters:* direct and indirect fired radiant, convection and mixed output heat emitters (selection criteria and performance); configuration, operating temperatures and emission rates for underfloor heating and heated ceilings; natural and forced convection emitters, controls of heat emitters

*Design of heating systems:* layout; control arrangements for heating installations; design of plant rooms (for heat generation plant); space requirements for installation, maintenance and commissioning; controls for heat generation plant; boiler configuration (to achieve total heating load); integration of heating requirements (with ventilation, air conditioning and other services installations); accommodation and control of expansion (water and pipework); support and suspension systems (for plant and pipework); sizing, specification and selection of plant, equipment and distribution network; effect of distribution network on total installed load; use of manufacturer's data, sizing and selection software; design implications (space, maintenance and commissioning requirements, capital and operating costs)

*Commissioning and testing requirements for heating installations:* current standards and procedures (for the commissioning of water circulation heating systems); instruments and procedures (for the measurement of flow, temperature and pressure); commissioning schedules and documentation

**4 Be able to apply principles, standards and legislation to the selection, specification and commissioning of primary heat sources**

*Principles, standards and legislation associated with:* fuels; chemistry of combustion; firing equipment; boilers and primary heat sources; boilerroom ventilation, draught and flue requirements

*Fuels:* properties; characteristics, performance; environmental implications of commercially available solid (including biomass), liquid and gaseous fuels; health, safety and welfare implications; legislation and standards

*Chemistry of combustion:* principles of combustion; stoichiometric air fuel ratios; flue gas analysis arising from stoichiometric combustion; need for and effect of excess air, instrumentation for flue gas analysis; determining air fuel ratios and combustion efficiency (flue gas analysis); combustion standards

*Firing equipment:* operational characteristics and features (of burners found in non-domestic boilers and hot water generation plant); control and safety monitoring systems (for burners); air/fuel adjustment and burner commissioning requirements

*Boilers and primary heat sources:* commercial LPHW boiler and air and ground source heat pumps (construction, operation characteristics and features); control arrangements (for single and multiple boiler/heat pump installations); fuel consumption and operational efficiency; testing and commissioning

*Boilerroom ventilation, draught and flue requirements:* legislation and standards (flues/chimneys and boiler plant ventilation); natural and mechanical draught in boiler plant (principles and applications); single and multiple boiler installations (principles, construction, materials and applications of flue systems); condensate in flues; design and installation of flue systems (for single and multiple boiler installations using various fuels)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to analyse the need for heating installations and develop design briefs	1.1 analyse client and building heating requirements 1.2 evaluate alternative strategies for providing space heating 1.3 discuss legislative requirements, design standards and publications that influence the design of heating installations 1.4 produce design briefs for heating installations
LO2  Be able to determine space heating loads and energy requirements for heating systems	2.1 evaluate the factors that contribute to human thermal comfort and the use of comfort indices 2.2 justify heating installation design parameters and standards 2.3 perform calculations to determine heating loads for buildings requiring steady state, intermittent and highly intermittent heating 2.4 follow guidelines to achieve a reduction in heating loads
LO3  Be able to apply legislation and standards to the design of heating systems for non-domestic buildings	3.1 justify strategies for the selection of heat emitters 3.2 design heating and installations including their control strategies and plant room arrangements 3.3 perform the calculations necessary to size, select and specify pipework, plant and equipment for heating installations and primary heat sources 3.4 follow guidelines to develop commissioning schedules for heating installations

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO4  Be able to apply principles, standards and legislation to the selection, specification and commissioning of primary heat sources	4.1 describe physical, supply and combustion properties of common fuels  4.2 perform calculations to determine air fuel ratios and resulting flue gas compositions for stoichiometric combustion  4.3 perform calculations to determine operating efficiencies for boilers  4.4 discuss the construction, operation, and features of commonly used LPHW primary heat sources  4.5 illustrate boiler installation and control arrangements for single and multiple boiler/heat pump installations  4.6 produce combustion air and flue/chimney design solutions for single and multiple commercial boilers

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 10: Building Services Design, Installation and Maintenance in Construction*
- *Unit 40: Thermofluids and Acoustic Criteria for Building Services Engineering*
- *Unit 44: Air Conditioning for Complex Industrial and Commercial Buildings*
- *Unit 46: Piped Distribution Services for Non-domestic Buildings*
- *Unit 58: Application of Scientific Principles to Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to boiler, heat pump and burner manufacturers. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example commissioning engineers on the principles, practices and standards for the commissioning of heating installations and commissioning/testing of boilers and firing equipment. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 43: Electricity and Lighting for Building Services Engineering

**Unit code:** R/601/1341

**QCF level:** 4

**Credit value:** 15

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### ● Aim

This unit provides learners with an opportunity to develop the skills needed to design electrical power installations, lighting installations and fire protection systems, in compliance with relevant legislation and standards.

### ● Unit abstract

This unit develops the skills needed to design simple electrical and lighting installations in compliance with relevant legislation and standards. Learners will explore general and emergency lighting installations, the distribution of electrical power, the legislation that underpins the design of electrical installations, the specification of fire protection systems, and the use of motors and control installations in mechanical plant. Learners will have the opportunity to design lighting installations, select cable sizes and types, specify methods of electrical distribution, specify overcurrent protection devices, produce fire detection design solutions and installation requirements for building services control panels. The focus of this unit is on the design and installation of mechanical building services installations in industrial, public and commercial buildings.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to design simple lighting installations
- 2 Be able to specify the cables and methods used in the distribution of electricity
- 3 Be able to apply legislation and standards to the design of electrical installations
- 4 Be able to apply legislation and standards to the design of fire protection systems
- 5 Be able to specify motors and control installations for use in mechanical services plant.

## Unit content

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### 1 Be able to design simple lighting installations

*Lighting installations:* general lighting; emergency lighting; design

*General lighting:* luminaire output; control; energy efficiency; sustainability issues; legislation and industrial standards

*Emergency lighting:* maintained; non-maintained; level of lighting; positioning; escape routes; maintenance and testing requirements; legislation and industrial standards

*Design:* lighting terms and units; essentials of good quality lighting; illuminance (selection of appropriate levels); glare and control of glare; characteristics and application of lamps in common use; photometry data; lumen method; efficacy of light sources and luminaires; colour rendering; light loss factor; maintenance factor; legislation and industrial standards

### 2 Be able to specify the cables and methods used in the distribution of electricity

*Distribution of electricity:* industrial, public and commercial buildings; types of load; alternative forms of supply; uninterruptible power supplies (UPS); power factor correction; components of distribution systems

*Types of load:* essential; critical; non-essential

*Alternative power supply:* single and multi-set installations; automatic start arrangements; synchronisation (with other sets or with public supply); prime movers; fuel; efficiency; legislation and regulations; suitability; cost effectiveness

*Uninterruptible power supplies (UPS):* central; local; single-phase; three-phase; static switch and/or by-pass

*Electrical distribution systems:* rising mains; sub-main; bus-bar; trunking; conduit; false floor systems; ducting; types and sizes of cables; category of circuits; industrial, public and commercial buildings

### 3 Be able to apply legislation and standards to the design of electrical installations

*Design of electrical installations:* IEE and statutory regulations; fundamental requirements for safety; overcurrent protection; cable ratings

*Legislation and standards:* The Electrical Supply Regulations 1988; The Health and Safety at Work etc. Act 1974; The Electricity at Work Regulations 1989; The Construction (Design and Management) Regulations 2007; The Electromagnetic Compatibility Regulations 2005

*Safety requirements:* principles of earthing; protective conductors; bonding; supplementary bonding; circuit protective conductor; determination of size; residual current devices

*Overcurrent protection:* overload devices; short circuit and overload protection; discrimination

*Cable ratings:* method of installation; correction factors; cable ratings for mechanical loads

### 4 Be able to apply legislation and standards to the design of fire protection systems

*Legislation and standards:* fire detection and alarm equipment; manual and automatic systems; detection devices; siting; spacing of detectors; sounders; effect of building materials on levels of attenuation e.g. doors, windows, walls, floors, ceilings, partitions; links with mechanical plant; cables and power supplies; methods of fire stopping; health and safety legislation and procedures

### 5 Be able to specify motors and control installations for use in mechanical services plant

*Factors affecting the design of control installations:* principles of DC motors; principles of AC motors; selection and rating of motors; aspects of control installations

*AC motors:* induction/synchronous motor principles and characteristics; speed and torque characteristics; starting methods; inverter; soft-start; direct on line (DOL); star; delta; speed control

*DC motors:* electromagnetic forces; series and shunt motors; speed and torque characteristics; starting methods; speed control; efficiency

*Selection and rating of motors:* enclosures; classes; ratings; theoretical ratings

*Control installations:* plant and control schematics and circuit diagrams; control strategies; flow and logic diagrams; block wiring diagrams; control and wiring schedules; control panels and field wiring diagrams; relay logic; electrical protection; typical voltages; segregation of voltages; electrical and mechanical interlocks

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to design simple lighting installations	1.1 justify the selection of lamps and luminaries 1.2 evaluate lighting installation designs in terms of efficacy and energy compliance 1.3 design supply circuits, lighting layouts and control systems 1.4 design simple lighting installations
LO2  Be able to specify the cables and methods used in the distribution of electricity	2.1 evaluate the different types of load and alternative power supplies 2.2 analyse the applications, characteristics and features of UPS systems 2.3 justify electrical distribution systems used in non-residential buildings 2.4 specify methods of electrical distribution and types and sizes of cable
LO3  Be able to apply legislation and standards to the design of electrical installations	3.1 review legislation and standards relevant to electrical installations 3.2 justify safety principles, procedures and equipment used in electrical installations 3.3 produce specifications for overcurrent protection devices 3.4 perform calculations for assessing electrical load and cable sizes using electrical tables
LO4  Be able to apply legislation and standards to the design of fire protection systems	4.1 review legislation and standards relevant to electrical fire protection 4.2 evaluate standard methods of fire stopping 4.3 determine cables suitable for installation purposes 4.4 design fire protection systems for industrial and/or commercial buildings

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO5  Be able to specify motors and control installations for use in mechanical services plant	5.1 compare the operating characteristics of AC and DC motors  5.2 justify the use of DC and AC motors in specific building services installations  5.3 interpret schematic wiring diagrams for building services installation control panels  5.4 produce designs and installation requirements for building services installation control panels

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 51: Lighting Applications for Industrial and Commercial Buildings*
- *Unit 52: Power Supplies for Building Services Engineering*
- *Unit 53: Electrical Protection and Transportation Installations for Non-domestic Buildings.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to a wide range of publications, reference data, manufacturers' products/information, and design and computer facilities.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to the design offices of major building services contractors. To ensure site visits are successful tutors should outline the aims and objectives of the visits and conduct preparatory briefings. Tutors should use real-life case studies to demonstrate electricity and lighting designs and installations in industrial and commercial buildings.

## Unit 44: Air Conditioning for Complex Industrial and Commercial Buildings

**Unit code:** K/601/1345

**QCF level:** 5

**Credit value:** 15

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- **Aim**

This unit provides learners with an opportunity to develop the skills needed to determine energy requirements, and design ventilation and air conditioning systems, for large, complex, multi-zone buildings.

- **Unit abstract**

In this unit learners will develop skills in applying the principles of air conditioning and will complete air conditioning designs for large, complex, multi-zone buildings. This unit enables learners to interpret the air conditioning and ventilation requirements of buildings, develop practical air conditioning schemes for a range of environments and evaluate the effectiveness of alternative schemes.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Be able to determine the energy requirements of buildings from primary data
- 2 Be able to design ventilation systems for complex industrial and commercial buildings
- 3 Be able to design multi-zone air conditioning systems for complex industrial and commercial buildings
- 4 Be able to design pipe and ductwork distribution systems.

## Unit content

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### 1 Be able to determine the energy requirements of buildings from primary data

*Primary data:* seasonal climatic variations; meteorological data; operating characteristics of buildings and systems; future needs

*Seasonal climatic variations:* temperature; humidity; wind; solar radiation; precipitation

*Meteorological data:* annual wind graphs, rainfall data, driving rain index

*Operating characteristics of buildings and systems:* building geometry; volume to external envelope ratio; occupation times; system criticality; zoning requirements; heat gain and loss data; occupancy; lighting; machinery; fabric; solar; infiltration/exfiltration

*Future needs:* expansion, diversification, flexibility, change of use

### 2 Be able to design ventilation systems for complex industrial and commercial buildings

*Design issues:* stack pressure; passive stack ventilation; wind pressure; orientation; atrium design

*Ventilation requirements:* natural ventilation (for comfort, removal of water vapour and contaminants, control of fire and smoke)

*Commissioning requirements:* setting systems to work; commissioning procedures; testing

### 3 Be able to design multi-zone air conditioning systems for complex industrial and commercial buildings

*Design issues:* heat recovery and waste minimisation; filtration of contaminants; control system requirements; simulation of building and system performance; building usage and occupancy; use of industry-standard software applications

*Large-scale air conditioning systems:* high velocity/high pressure; central plant; single duct; dual duct; induction convection; perimeter induction convection; constant volume; variable air volume; chilled beam; stand-alone modular units

### 4 Be able to design pipe and ductwork distribution systems

*Design issues:* pipes and ductwork; operating characteristics; safety issues

*Safety issues:* for air flow systems (fire, smoke exhaust, contamination, control of bacteria)

*Operating characteristics of air flow systems:* ducting design; fan characteristics; sound and selection, sound attenuation; air distribution in spaces; grill position; air requirements

*Pipes and ductwork:* types of distribution systems; duct shape and materials; integration into building design; constraints for refurbished buildings; fire protection; sound attenuation

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to determine the energy requirements of buildings from primary data	1.1 explain seasonal climatic variations in terms of published meteorological data  1.2 demonstrate how building and system operating characteristics, and future needs, affect energy requirements
LO2  Be able to design ventilation systems for complex industrial and commercial buildings	2.1 evaluate the ventilation requirements of complex buildings  2.2 design natural ventilation systems  2.3 produce manuals of commissioning and testing procedures for ventilating systems
LO3  Be able to design multi-zone air conditioning systems for complex industrial and commercial buildings	3.1 outline the characteristics of air conditioning design  3.2 develop system designs for large-scale air conditioning installations  3.3 carry out design simulations
LO4  Be able to design pipe and ductwork distribution systems	4.1 explain the safety requirements for air flow systems  4.2 analyse the operating characteristics of air flow systems  4.3 design a pipe and duct air flow layout

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 40: Thermofluids and Acoustic Criteria for Building Services Engineering*
- *Unit 41: Air Conditioning for Industrial and Commercial Buildings*
- *Unit 42: Low Pressure Hot Water Heating for Non-domestic Buildings*
- *Unit 45: Heating Systems for Industrial and Specialist Applications.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

The following resources are required in order to deliver this unit: design facilities, IT facilities and software packages (for modelling), graphic and pictorial presentation, building services design and simulation (for decision making).

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits and conduct preparatory briefings. Tutors should use real-life case studies to demonstrate the application of air conditioning in complex industrial and commercial buildings.

## Unit 45: Heating Systems for Industrial and Specialist Applications

**Unit code:** A/601/1351

**QCF level:** 5

**Credit value** 15

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### Aim

This unit provides learners with an opportunity to develop skills in designing and specifying heating systems for large, complex, industrial buildings and other highly specialist applications.

### Unit abstract

This unit provides learners with the opportunity to apply design procedures for the more specialised heating systems typically found in large-scale industrial and other complex buildings. Learners will explore the principles, standards and design procedures required to produce design solutions for steam and high pressure hot water (HPHW) heating installations. Learners will consider how these systems may be used to provide process heating in addition to space heating requirements. Learners will also be given the opportunity to consider other specialist applications, including the use of district heating schemes as an alternative to local heat sources, and the design of electrical heating installations.

### ● Learning outcomes

#### On successful completion of this unit a learner will:

- 1 Be able to design steam, space and process heating systems
- 2 Be able to design HPHW space and process heating systems
- 3 Be able to design and justify group and district heating schemes
- 4 Be able to apply principles and standards to select and design a primary energy source plant for heating installations
- 5 Be able to design electrical heating systems for buildings.

## Unit content

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### 1 Be able to design steam, space and process heating systems

*Properties and generation of steam:* steam tables; heat content and thermal properties (pressurised water, wet, dry saturated and superheated steam)

*Steam system, plant and equipment:* layout and plant arrangements for low pressure steam systems (space heating and process work applications); types, operation, use and operational characteristics of plant and equipment used in steam systems e.g. steam traps, relay points, pressure reducing valves, condensate and feed pumps

*Design of steam systems:* determining steam flow rates at heat exchangers and resultant steam generation rates; design of steam systems (space heating and process work); design of systems incorporating flash steam recovery; indirect use of steam for space heating via steam to water heat exchangers; sizing, specification and selection of plant, equipment and steam distribution and condensate return networks

### 2 Be able to design HPHW space and process heating systems

*HPHW application:* operational features and application of HPHW systems; comparisons with low pressure hot water (LPHW) and steam systems; advantages, disadvantages, and applications of HPHW, LPHW and steam systems; conversion from HPHW to LPHW

*Pressurisation systems:* application, operational methodology, characteristics and safety features of alternative methods of pressurisation; calculations associated with and the analysis of safe working temperatures and pressures (proposed systems with various pump locations); selection and application of anti-flash margins

*Design of HPHW system:* control arrangements for HPHW plant; determining expansion volumes; sizing, specification and selection of heat emitters/exchangers plant; pipe distribution networks, plant and equipment for HPHW installations

### 3 Be able to design and justify group and district heating schemes

*Feasibility:* group and district heating schemes e.g. capital and running costs, thermal efficiency, CO<sub>2</sub> and NO<sub>x</sub> emissions; standard and alternative primary heat sources/fuels e.g. waste incineration, combined heat and power (CHP) schemes, geothermal sources; social and economic considerations (for local authorities and consumers)

*Distribution:* distribution methodologies; operating temperatures; design of distribution networks and distribution ducting; plant for district heating schemes

*Utilisation and metering:* provision of heating and hot water (to and within consumer's premises); consumer charging and energy metering

**4 Be able to apply principles and standards to select and design a primary energy source plant for heating installations**

*Features and plant arrangements for boilers and CHP installations:* plant requirements and configurations for saturated and superheated steam and HPHW systems; operation of steam superheaters; scope, economics and engineering viability

*Performance of boilers and CHP installations:* thermal efficiency of steam, HPHW boiler and CHP plant; annual energy consumption, losses and emissions for plant; blowdown rates; feed pump requirement

*Feed water treatment:* boiler feed water treatment (steam and HPHW plant)

**5 Be able to design electrical heating systems for buildings**

*Electrical heating systems:* application and operation of electrical space heating equipment e.g. immersion heaters, electrode boilers, thermal storage, trace heating tape, quartz/luminous heaters, non-storage heaters, embedded resistance cables; building constructional details (resistance cable installations)

*Energy requirements:* active store; daily design energy requirement and charge acceptance in storage heating

*Pressurised electrothermal storage systems:* plant size and power requirements; methods of temperature control and time scheduling

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to design steam, space and process heating systems	1.1 perform calculations to determine the thermal properties of steam supplies 1.2 explain how the characteristics of steam plant and equipment influence their selection and application 1.3 design steam installations for space heating and process work 1.4 analyse the potential for using flash steam recovery and integrating it within primary steam systems 1.5 perform calculations for the design and specification of steam distribution and condensate return networks
LO2  Be able to design HPHW space and process heating systems	2.1 compare the features, advantages, disadvantages and applications of HPHW with steam and LPHW systems 2.2 explain how the operational methodology of HPHW pressurisation systems influences their selection and application 2.3 design HPHW heating installations 2.4 perform calculations for the selection and specification of HPHW plant and equipment
LO3  Be able to design and justify group and district heating schemes	3.1 compare the features, advantages, disadvantages and use of group/district heating schemes with individual heating plants 3.2 review the primary heat sources and fuels available for district heating 3.3 justify the use of district/group heating schemes 3.4 design group and district heating installations

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO4  Be able to apply principles and standards to select and design a primary energy source plant for heating installations	4.1 analyse the features of boilers, CHP installations and their associated plant  4.2 perform efficiency and performance calculations for boilers, CHP installations and their associated plant  4.3 describe the methods of feed water treatment for steam and HPHW plant  4.4 design boiler and CHP plant arrangements for steam and HPHW installations
LO5  Be able to design electrical heating systems for buildings	5.1 explain the operation, application and control of electrical heating systems  5.2 perform calculations to determine the energy requirements for electrical storage heating systems  5.3 perform calculations to design and specify a plant for pressurised systems of electrothermal storage

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 10: Building Services Design, Installation and Maintenance in Construction*
- *Unit 40: Thermofluids and Acoustic Criteria for Building Services Engineering*
- *Unit 42: Low Pressure Hot Water Heating for Non-domestic Buildings*
- *Unit 44: Air Conditioning for Complex Industrial and Commercial Buildings.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Throughout this unit the term 'high pressure hot water' (HPHW) is used to signify those heating systems where the pressure in the installation is raised in order to support water temperatures above atmospheric boiling point. It is recognised that the terms 'high temperature hot water' (HTHW) and 'high pressure hot water' (HPHW) are frequently interchanged to describe the same systems. To avoid confusion, high pressure hot water or HPHW is used throughout this unit, but tutors may use whichever convention they prefer. In the same way, 'medium pressure hot water' (MPHW) or 'medium temperature hot water' (MTHW) is frequently used to define those systems where the pressure within the system is such that, only temperatures moderately above atmospheric boiling point can be used. To avoid unnecessary confusion and duplication, this unit uses the term high pressure hot water to include both medium and high pressure systems.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## **Employer engagement and vocational contexts**

Tutors should organise site visits, for example to steam equipment manufacturers, steam heating installations and/or CHP installations. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example feed water treatment engineers on the principles, practices and standards for feed water treatment. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 46: Piped Distribution Services for Non-domestic Buildings

**Unit code:** R/601/1355

**QCF level:** 4

**Credit value:** 15

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### ● Aim

This unit enables learners to develop skills in designing cold and hot water, mechanical firefighting and suppression, and fuel, industrial and medical gas installations for non-domestic buildings.

### ● Unit abstract

This unit focuses on installations that are heavily influenced by the legislative requirements associated with public health issues, fire safety, and risk of explosion from gas installations. Learners will explore the legislation, standards and design guides associated with these installations and apply them in the production of design solutions for complex industrial and commercial buildings. Learners will also have the opportunity to establish strategies, produce design drawings and perform calculations necessary to size, select and specify the pipework, plant and equipment associated with these installations.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to produce design briefs for piped distribution installations
- 2 Be able to apply legislation and standards to the design of cold and hot water supplies
- 3 Be able to apply legislation and standards to the design of mechanical firefighting and suppression installations
- 4 Be able to apply legislation and standards to the design of fuel, industrial and medical gas installations.

## Unit content

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### 1 Be able to produce design briefs for piped distribution installations

*Design for piped distribution services:* client and building requirements; design briefs

*Client and building requirements:* analysis and interpretation of requirements; alternative strategies for provision of installations e.g. balance between client needs, legislative requirements and commercial constraints; health, safety and welfare considerations; aesthetic considerations; energy efficiency considerations

*Design briefs:* constraints on design; legislation; design standards; firefighting and fire protection systems in industrial and commercial buildings; statutory requirements; standards; guides; production of design briefs for industrial and commercial buildings

### 2 Be able to apply legislation and standards to the design of cold and hot water supplies

*Design of cold water storage and distribution systems:* cold water supply legislation; standards; codes of practice; design guides; water properties; analysis of water; water quality standards (general and specialist applications); water treatment methods; equipment for use within buildings; cold water storage capacities; fill rates system layouts, control and valve arrangements (from available mains pressure, gravity sources, boosted sources); booster systems and pumping systems; pressure reduction and control; sizing and specification of cold water distribution networks; required plant and equipment; cold water installations; commissioning and routine maintenance

*Design of hot water systems:* hot water supply legislation; standards; codes of practice; design guides; capital and operating costs (storage and non-storage, central and point of use systems); system layouts; control and valve arrangements for hot water installations e.g. vented and unvented storage, solar and high recovery rate systems; sizing and specification of hot water generation and storage plant and equipment; distribution and secondary return networks; commissioning and routine maintenance

### 3 **Be able to apply legislation and standards to the design of mechanical firefighting and suppression installations**

*Fire:* dynamics of fire; assessment of fire risk factors; firefighting and suppression systems

*Fire dynamics:* terminology; fire and smoke behaviour e.g. ignition, fire growth, fire parameters, flash over, limiting fire development, smoke hazards, smoke plumes, smoke filling

*Assessment of fire risk factors:* legislation; standards; codes of practice; risk assessments; building designation factors; fire precaution standards; classification by purpose groups; means of escape; behaviour of people in fire situations; occupancy types; fire compartments; travel distances and times; development of fire safety strategies from risk assessments

*Firefighting and suppression systems:* legislation, standards, codes of practice and design guides; application to portable extinguishers, dry and wet risers, hose reels, sprinklers, foam, gaseous and water mist installations; integration with fire and smoke detection and ventilation systems; design and sizing of mechanical firefighting and suppression installations; testing and maintenance procedures

### 4 **Be able to apply legislation and standards to the design of fuel, industrial and medical gas installations**

*Fuel gas installations:* properties and usage of fuel gases; required gas flow rates; systems layouts, control and valve arrangements for mains and liquefied petroleum gas (LPG) systems; legislation, standards, codes of practice and design guides; sizing and specification of gas distribution networks, plant and equipment for non-domestic applications; procedures for the commissioning, testing and purging of fuel gas installations

*Industrial and medical gas installations:* properties and usage of medical gases, vacuums and industrial gases (compressed air, industrial oxygen, carbon dioxide and acetylene); layout, control and valve arrangements for medical and industrial gas installations; legislation, standards, codes of practice and design guides; application to sizing and specification of medical and industrial gas distribution networks, plant and equipment

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
<p>LO1</p> <p>Be able to produce design briefs for piped distribution installations</p>	<p>1.1 analyse client and building requirements for mechanical distribution services, firefighting and suppression installations</p> <p>1.2 evaluate alternative strategies for the provision of piped distribution services and fire protection suppression installations</p> <p>1.3 review legislative requirements and design standards for piped distribution services and fire protection suppression installations</p> <p>1.4 produce design briefs for piped distribution services and fire protection suppression installations</p>
<p>LO2</p> <p>Be able to apply legislation and standards to the design of cold and hot water supplies</p>	<p>2.1 review legislation and design standards for hot and cold water installations</p> <p>2.2 explain testing and commissioning requirements for cold and hot water storage and distribution systems</p> <p>2.3 design cold and hot water installations for complex non-domestic buildings</p> <p>2.4 perform calculations to size, select and specify pipework, plant and equipment for cold water installations</p> <p>2.5 perform calculations to size, select and specify pipework, plant and equipment for hot water installations</p>
<p>LO3</p> <p>Be able to apply legislation and standards to the design of mechanical firefighting and suppression installations</p>	<p>3.1 explain the development of fire and smoke</p> <p>3.2 justify firefighting and suppression strategies</p> <p>3.3 review legislation and design standards for firefighting and suppression installations</p> <p>3.4 design mechanical firefighting and suppression installations</p> <p>3.5 perform calculations to size, select and specify pipework, plant and equipment for mechanical firefighting and suppression installations</p>

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO4  Be able to apply legislation and standards to the design of fuel, industrial and medical gas installations	4.1 evaluate the properties of common fuel, industrial and medical gases  4.2 review legislation and design standards for fuel, industrial and medical gases, vacuums and compressed air installations  4.3 design fuel, industrial and medical gas, vacuum and compressed air installations for buildings  4.4 perform calculations to size, select and specify pipework, plant and equipment sizes for fuel gas installations  4.5 produce schedules for the commissioning, testing and purging of fuel gas installations

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 10: Building Services Design, Installation and Maintenance in Construction*
- *Unit 42: Low Pressure Hot Water Heating for Non-domestic Buildings*
- *Unit 45: Heating Systems for Industrial and Specialist Applications.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to solar heated water installations and/or medical and industrial gas installations. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example water treatment engineers on the operational, commissioning and maintenance procedures, fire engineers on fire dynamics, fire risk assessment and fire strategies in buildings, installation engineers on specialist fixed gas, foam firefighting and misting systems and/or installation engineers on medical and industrial gas installations. Tutors should use real-life case studies, for example complex cold water supply and plant selection exercises, complex hot water supply and plant selection exercises, firefighting strategies for different applications and/or fuel gas testing and purging exercises.

## Unit 47: Energy Utilisation and Efficiency for Building Services Engineering

**Unit code:** F/601/1366

**QCF level:** 5

**Credit value:** 15

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### ● Aim

This unit enables learners to understand how energy utilisation in buildings impacts on the environment, and develop the skills needed to audit energy requirements and improve the energy efficiency of buildings.

### ● Unit abstract

The purpose of this unit is to provide learners with an understanding of the environmental impact of energy utilisation in buildings and the implications of energy efficiency and sustainability. Learners will investigate how environmental and economic gains can be achieved by reducing waste and maximising energy efficiency. As concern over global environmental issues increases, the role of the building services engineer in the design and operation of buildings becomes even more important. This unit is recommended for learners seeking to explore the opportunities that exist for improving the energy efficiency of buildings.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the environmental impact of energy utilisation in buildings
- 2 Understand the sustainability of alternative energy sources and water supplies for buildings
- 3 Be able to appraise the energy efficiency of building services installations
- 4 Be able to undertake energy audits for buildings and building services installations
- 5 Understand heat recovery and energy minimisation methods.

## Unit content

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### 1 Understand the environmental impact of energy utilisation in buildings

*Environmental impact:* global consequences of excessive energy utilisation; combustion of finite sources of fossil fuels; impact of emissions on climate and environment (global warming; acid rain; air pollution; water pollution)

*Energy utilisation:* energy generation and distribution (principles, fundamentals, technology); need to promote energy conservation; international environmental agreements and protocols e.g. Kyoto agreement, Copenhagen 2009, UK climate change programme; role of building services engineers in meeting agreed environmental objectives

### 2 Understand the sustainability of alternative energy sources and water supplies for buildings

*Sustainability:* interrelationship of environmental, economic and social issues relating to the generation and utilisation of energy and water

*Alternative energy sources:* renewable energy sources (hydroelectric, wind, bio-fuels, waste incineration, active and passive solar energy schemes, aquatherm energy); use of (space heating, cooling, heating domestic water); combined heat and power (CHP) systems

*Alternative water supplies:* water recovery systems; grey water schemes; design of alternative supplies

### 3 Be able to appraise the energy efficiency of building services installations

*Energy efficiency:* indicators; principles; fundamentals (energy utilisation, performance, estimated running costs)

*Appraisal and improvement of energy efficiency:* orientation; design; insulation

### 4 Be able to undertake energy audits for buildings and building services installations

*Energy audits:* purpose of audits; benefits of audits; different types of approach; common strategies; identification of audit needs within organisations, buildings and services installations

*Findings of energy audits:* collection of data; interpretation of data; consideration of improvements to energy utilisation efficiency; provision of advice to building managers

## 5 Understand heat recovery and energy minimisation methods

*Heat recovery:* use of heat recovery techniques to improve system and building energy efficiency; techniques and principles for central air ventilation systems e.g. plate heat exchangers, run-around coils, thermal wheels, re-circulation, heat pipe, air to water recovery techniques, refrigeration; opportunities for combining heat recovery from CHP with absorption refrigeration chillers

*Energy minimisation:* application of available technologies; energy conservation principles and techniques; incorporation into building engineering systems; importance of commissioning, handover procedures and maintenance; appraisal and selection of high efficiency plant and equipment e.g. condensing boilers, combination boilers, low nitrogen oxide (NO<sub>x</sub>) boilers, variable volume pumps, variable volume ventilation plant, instantaneous gas fired hot water storage (HWS) heaters; heating and cooling load reduction (by use of improved controls, daylight and movement sensors, application of low energy and high frequency techniques); improving system performance e.g. building management systems, application of free cooling strategies (enthalpy control), night time cooling techniques

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the environmental impact of energy utilisation in buildings	1.1 explain how energy is generated and distributed 1.2 explain how emissions from the combustion of fossil fuels impact on the global environment 1.3 justify the importance of energy efficiency and environmental conservation
LO2  Understand the sustainability of alternative energy sources and water supplies for buildings	2.1 discuss sustainability issues applicable to the provision of energy and water supplies 2.2 compare alternative methods of supplying energy to buildings in terms of efficacy and cost 2.3 compare alternative methods of supplying water to buildings in terms of efficacy and cost
LO3  Be able to appraise the energy efficiency of building services installations	3.1 compare methods of reducing energy requirements 3.2 carry out energy efficiency appraisals using energy performance indicators
LO4  Be able to undertake energy audits for buildings and building services installations	4.1 justify the benefits of undertaking energy audits 4.2 carry out energy audits 4.3 present the findings of energy audits
LO5  Understand heat recovery and energy minimisation methods	5.1 compare heat recovery methods and energy minimisation techniques 5.2 assess the impact of plant size in terms of energy efficiency 5.3 evaluate standard heat recovery plant and equipment in terms of performance in use 5.4 discuss how building management systems reduce energy utilisation and improve system performance

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 13: Environmental Impact of Construction*
- *Unit 54: Building Management Systems for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example representatives from the Carbon Trust or similar organisations. Tutors should encourage learners to carry out an energy efficiency appraisal for a proposed building services installation and/or undertake an energy audit of an existing building.



## **Unit 48: Refrigeration Technology for Construction and the Built Environment**

**Unit code:** R/601/1372

**QCF level:** 5

**Credit value:** 15

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- **Aim**

This unit enables learners to develop skills to evaluate the technology involved in the energy efficient design and operation of commercial systems used in construction and the built environment.

- **Unit abstract**

This unit will introduce learners to the principles of vapour compression refrigeration systems and the technology involved in the commercial systems used in construction and the built environment. Pressure-enthalpy charts will be used to evaluate the performance of refrigerants, to enable learners to select a refrigerant and evaluate systems and components within refrigeration systems. System design will enable learners to evaluate systems and components and appreciate the effect of varying operating conditions on overall performance. Learners will also gain an appreciation of how to design systems to a specification and will develop the skills needed to produce energy efficient designs for commercial refrigeration systems.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand primary and secondary refrigerants
- 2 Understand the performance of single-stage and multi-stage vapour compression systems
- 3 Understand the design and performance of refrigeration systems
- 4 Be able to create energy efficient designs for commercial refrigeration systems.

## Unit content

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### 1 Understand primary and secondary refrigerants

*Refrigerants:* function of a refrigerant (primary and secondary refrigeration systems)

*Terminology and classification:* classification of refrigerants using recognised standards e.g. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Institute of Refrigeration (IOR), other national standards

*Properties of refrigerants:* eutectic points; oil and refrigerant relationships; pressure enthalpy charts; thermodynamic tables

### 2 Understand the performance of single-stage and multi-stage vapour compression systems

*Single-stage vapour compression cycle:* function of compressor, condenser, evaporator and throttling device

*Refrigeration cycle:* Carnot cycle; volumetric and isentropic efficiency; ideal and actual refrigeration cycles; coefficients of performance

*Multi-stage vapour compression systems:* high and low stage compressor duties; intermediate pressure/temperature; inter-cooling methods

### 3 Understand the design and performance of refrigeration systems

*Design and performance criteria:* design standards; effect of condenser and evaporator temperature/pressure variation on capacity and input power; range and approach; ambient temperatures; heat gain calculations

*Controls:* safety; capacity; refrigerant and evaporator flow; defrosting; building management systems; commissioning and operation

*Defrost:* methods; technology; high humidity environments; condensate lines; effect of frosting on evaporators

### 4 Be able to create energy efficient designs for commercial refrigeration systems

*Components:* selection of compressor; condenser; evaporator; throttling device; refrigerant; pipe sizing; design guidelines

*Systems:* coldrooms; chillers; heat pumps; secondary refrigerant systems; heat recovery methods; operation; commissioning

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand primary and secondary refrigerants	1.1 explain the classification and terminology of refrigerants  1.2 compare oil and refrigerant properties  1.3 evaluate the properties of refrigerants in terms of performance in use
LO2  Understand the performance of single-stage and multi-stage vapour compression systems	2.1 explain the function of components within single-stage refrigeration systems  2.2 evaluate ideal and actual refrigeration cycles  2.3 compare single and multi-stage vapour compression systems
LO3  Understand the design and performance of refrigeration systems	3.1 evaluate design criteria and their impact on the selection and operation of refrigeration systems  3.2 examine the operation of controls to improve efficiency and safety  3.3 compare the efficiency of defrosting arrangements
LO4  Be able to create energy efficient designs for commercial refrigeration systems	4.1 create component and system specifications for refrigeration systems

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 55: Refrigeration Applications for Construction and the Built Environment*
- *Unit 56: Refrigeration Design for Construction and the Built Environment.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to a wide range of publications, reference data and manufacturers' information, IT facilities and appropriate software. Learners also require access to commissioning equipment and/or simulated refrigeration rigs or live systems. Laboratory facilities will be needed to assess system variations due to compressor, condenser and evaporator cycle fluctuations.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example representatives from Danfoss Controls and/or Co-op Engineering. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.

## **Unit 49: Electrical and Electronic Control Principles for Building Services Engineering**

**Unit code:** K/601/1376

**QCF level:** 4

**Credit value:** 15

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- **Aim**

This unit provides learners with the opportunity to develop an understanding of information transmission signals and develop skills to design plant control systems and data distribution networks for non-domestic buildings.

- **Unit abstract**

The purpose of this unit is to develop learner understanding of the information transmission systems involved in plant control and data distribution associated with high technology buildings. Learners will also develop skills in designing plant control systems and data distribution networks for non-domestic buildings.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Be able to design plant control systems for non-domestic buildings
- 2 Understand information transmission systems
- 3 Be able to design data distribution networks for non-domestic buildings.

## Unit content

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### 1 Be able to design plant control systems for non-domestic buildings

*Control principles:* benefits of control systems; open loop and closed loop systems; time lags; transfer functions; system response to step-change and transients; system stability and tuning

*Control actions:* control law; control mode (proportional, integral and derivative); digital, logic and cascade control; artificial intelligence; choice of control mode; the effects of dead-band, damping, gain and proportional-band

*Control sensors:* sensing elements, transducers, transmitters, transponders; sensor types for pressure, velocity/flow, temperature, level, humidity, gas presence/quality, flame, smoke, light, thermal radiation; sensor selection in terms of accuracy and speed of response; calibration requirements; siting of sensing elements

*Control actuators:* applications of electrical types for linear, rotary and positional movements

*Control devices:* applications of electrically operating valves and dampers for control purposes; valve and damper authority; application of variable speed drives for fan, pump and compressor motors, application of lighting controls

### 2 Understand information transmission systems

*Transmission of signals:* analogue, digital and optical signal transmission systems; effects of modulation; signal attenuation; series and parallel data transmission protocols; synchronous and asynchronous data transmission; time division multiplexing (TDM); frequency division (FDM); combined TDM and FDM; frequency; wavelength; amplifiers; operational amplifiers; attenuators; analogue to digital conversion and vice versa; use of analogue and digital measuring instruments

### 3 Be able to design data distribution networks for non-domestic buildings

*Distribution of data:* horizontal and vertical distribution; installation categories; cable types including fibre optic; data installations within buildings; siting of servers; cable lengths; earthing systems; earth leakage currents

*Network hardware:* use of servers, repeaters, hubs, bridges, switches and routers; power supplies over the Ethernet

*Network configurations:* connection of networks using bus, tree, ring, star, mesh and wireless connections; network types including local area (LAN), campus area (CAN), metropolitan area (MAN), global area (GAN); use of internet and intranet systems

*Data distribution networks:* effects on data systems of electrostatic interference, radiation and vibration; effects of heat; requirements of the electromagnetic compatibility (EMC) directive; methods used to reduce interference

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to design plant control systems for non-domestic buildings	1.1 describe the operation of closed loop control systems  1.2 discuss the effects of a step-change signal on control systems  1.3 apply individual and system transfer functions to control systems  1.4 discuss the effect damping has on the operation of plant control systems  1.5 design plant control systems for applications in non-domestic buildings
LO2  Understand information transmission systems	2.1 explain how signals convey information  2.2 analyse information systems  2.3 explain the effects of amplifiers and attenuators on signal transmission  2.4 evaluate the effects of poor synchronisation on data recovery
LO3  Be able to design data distribution networks for non-domestic buildings	3.1 evaluate data network design strategies for non-domestic buildings  3.2 explain the effects of interference on data transmission  3.3 explain how interference can be minimised  3.4 design data distribution networks for non-domestic buildings

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 50: Electrical Installation for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

## Unit 50: Electrical Installation for Building Services Engineering

**Unit code:** M/601/1380

**QCF level:** 4

**Credit value:** 15

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### ● Aim

This unit enables learners to develop an understanding of DC/AC motors and rectification systems for controlling electric plant and equipment, and develop the skills needed to solve DC/AC network problems.

### ● Unit abstract

This unit will develop learner understanding of the underlying principles in the design and commissioning of low voltage electrical distribution systems and the application of current standards and legislation. This unit also provides an opportunity for learners to experience the process of completing electrical designs for complex non-domestic applications. Learners will explore the requirements of buildings in electrical terms, develop practical schemes for a range of environments and evaluate the effectiveness of alternative schemes.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to solve DC and AC network circuit problems
- 2 Be able to apply current standards and legislation to building electrical systems
- 3 Understand DC and AC motors
- 4 Understand rectification systems for controlling electric plant and equipment.

## Unit content

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### 1 Be able to solve DC and AC network circuit problems

*Circuit principles and theorems:* Thevenin's theorem (DC); Norton's theorem (DC); maximum power transfer theorem; star/delta transformation; single-phase resistance, inductance and capacitance (R, L and C) circuits in series and parallel; use of the j-operator, quadrature and polar forms; admittance; conductance; susceptance; three-phase star/delta networks; balanced and unbalanced loads; power measurement and power factor control; effects of resonance in power transmission

### 2 Be able to apply current standards and legislation to building electrical systems

*Low-voltage(LV) switchgear and distribution:* principles of LV distribution in buildings; LV switchgear and isolators; load centres; power distribution using horizontal and vertical methods; coordination/crossing of services; false floor systems; rising mains; sub-mains

*Design constraints:* environmental e.g. noise, thermal, vibration, health and safety issues and their relationship to the design process; designing for health and safety (The Construction (Design and Management) Regulations 2007)

*Designer's discretion:* assessment of load; principles of diversity; use of W.m<sup>2</sup> method; extending disconnection times; selection of protective devices; motor circuits using direct on line or star-delta starting

*Safety requirements:* application of current BS7671 requirements for protection of circuits, equipment, personnel and livestock

*Cables:* wiring containment and support systems; bus-bar trunking; trunking; conduit; tray; basket; uni-strut; selection of cables and wiring types/sizes for required purpose and to comply with current-carrying capacity and volt-drop constraints; sizing of cables including motor circuits, thermal effects, grouping of cables of different cross-sectional area; load characteristics

### 3 Understand DC and AC motors

*Motor theory:* DC and AC motor principles; DC series/shunt motors; speed/torque characteristics; induction/synchronous/wound-rotor motor principles and characteristics; starting methods e.g. inverters, soft-start, direct on line starter (DOL), star delta; speed control

*Motor applications:* use of DC and AC motors; motor selection; motor housings; ventilation methods; IP ratings; nameplate ratings

### 4 Understand rectification systems for controlling electric plant and equipment

*Principles of rectification:* half-wave and full-wave diode rectifier circuits; single and three phase; smoothing circuits; thyristor and applications; phase control and integral cycle control

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to solve DC and AC network circuit problems	1.1 use maximum power transfer theorem and Thevenin's and Norton's models to solve practical problems  1.2 calculate the parameters of AC equivalent circuits using transformation theorems  1.3 apply circuit theory techniques to solve AC circuit problems  1.4 analyse the application and benefits of power factor control  1.5 apply complex quantities techniques to solve complex power and AC circuit problems
LO2  Be able to apply current standards and legislation to building electrical systems	2.1 evaluate the appropriateness of designs in relation to environmental, access and health, safety and welfare issues  2.2 analyse how design constraints for a given building affect the choice of electrical distribution  2.3 apply 'designer's discretion' when producing electrical designs for buildings  2.4 evaluate the appropriateness of electrical designs in terms of complying with current standards and legislation  2.5 determine optimum cable sizes for groups of cables with different cross-sectional areas and load characteristics
LO3  Understand DC and AC motors	3.1 examine DC series and shunt motor applications  3.2 explain how to control the speed of DC series motors using thyristor control  3.3 calculate the theoretical ratings of motors for a given duty  3.4 explain starting methods and speed control for AC motors  3.5 evaluate the suitability of AC motors for building services applications

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO4  Understand rectification systems for controlling electric plant and equipment	4.1 describe the operation of half-wave and full-wave rectification systems  4.2 explain the effect of using controlled rectifiers in AC circuits  4.3 examine the application of rectification in the control of electrical plant and equipment

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 49: Electrical and Electronic Control Principles for Building Services Engineering*
- *Unit 52: Power Supplies for Building Services Engineering*
- *Unit 53: Electrical Protection and Transportation Installations for Non-domestic Buildings.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.



## Unit 51: Lighting Applications for Industrial and Commercial Buildings

**Unit code:** J/601/1384

**QCF level:** 4

**Credit value:** 15

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- **Aim**

This unit provides learners with the opportunity to develop an understanding of lighting applications for industrial and commercial buildings and the skills needed to produce design solutions for lighting systems.

- **Unit abstract**

The purpose of this unit is to develop learner understanding of the principles that underpin the design, installation and operation of natural and artificial lighting systems. Learners will develop the skills needed to design lighting solutions for complex industrial and commercial applications. Learners will interpret the interior, exterior and emergency lighting requirements of buildings. Learners will also have the opportunity to explore the design of practical lighting schemes for a range of environments in industrial and commercial buildings, and evaluate the effectiveness of alternative schemes.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand the lighting requirements of industrial and commercial buildings
- 2 Understand the characteristics of lighting equipment and the visual effects of lighting
- 3 Be able to design interior and exterior lighting schemes for industrial and commercial buildings
- 4 Be able to produce a design for an emergency lighting system.

## Unit content

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### 1 Understand the lighting requirements of industrial and commercial buildings

*Lighting requirements:* operational requirements; design standards

*Operational requirements:* client and building operational requirements; balance between client, commercial, aesthetic and energy efficiency considerations; aesthetic and ergonomic requirements (specialised lighting situations)

*Design standards:* publications (industrial and commercial buildings); interrelationship between lighting and other mechanical and electrical building services

### 2 Understand the characteristics of lighting equipment and the visual effects of lighting

*Fundamental principles of lighting:* terminology; units; inverse square law; cosine law; colour temperature; light spectrum; natural daylight; luminous efficacy

*Characteristics of lighting equipment:* characteristics of light sources (light spectrum, natural daylight, luminous efficacy, colour temperature); characteristics of luminaires (standards, markings, lamp types and classifications, identification codes, lamp characteristics); luminaires for hostile and hazardous environments; polar curves and other photometric data; use of illuminance ratio charts; switching and dimming; lamp life; luminous flux; maintenance; lamp control gear

*Visual effects of lighting:* lighting levels; glare; illumination for task performance; appearance; colour rendering; revealing form; display lighting; light modulation

### 3 Be able to design interior and exterior lighting schemes for industrial and commercial buildings

*Design of interior and exterior lighting schemes:* design issues; general lighting schemes; specialised lighting schemes

*Design issues:* client and building requirements; commercial viability; performance; economics; appropriateness of proposed lighting schemes

*General lighting schemes:* multi-storey buildings; commercial buildings; wide variety of environments and requirements; layout; specification and control (interior and exterior lighting); car parks and walkway lighting; integration of lighting with other services installations; inverse square law; lumen method of design; glare

*Specialised lighting schemes:* general; localised and local lighting schemes; complex commercial situations in real buildings; wide variety of environments and lighting effects e.g. art galleries, museums, operating theatres, retail displays, theatres, concert halls, conference lighting; spot and flood lights; up-lighters; colour correction; enhancement lighting; integration of artificial lighting with natural daylight; permanent supplementary artificial lighting of interiors (PSALI); calculations of point-to-point illuminance levels; computer-aided design (CAD) software

4 **Be able to produce a design for an emergency lighting system**

*Design issues:* specification and design; maintenance and testing

*Specification and design:* current legislation and standards for emergency lighting; industrial and commercial building functions (escape lighting, standby lighting, external escape lighting); lighting levels; location of lighting; speed of operation

*Maintenance and testing:* requirements; documentation; responsibilities; coordination of emergency lighting schemes with other services and emergency systems

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the lighting requirements of industrial and commercial buildings	1.1 evaluate client and building operational requirements  1.2 justify lighting design standards
LO2  Understand the characteristics of lighting equipment and the visual effects of lighting	2.1 explain the fundamental principles of lighting design  2.2 review the visual effects of lighting in relation to task performance and quality of appearance  2.3 select appropriate luminaires for given purposes  2.4 compare the characteristics of different light sources
LO3  Be able to design interior and exterior lighting schemes for industrial and commercial buildings	3.1 follow guidelines to design a general lighting system  3.2. produce designs and specifications for a specialised lighting system  3.3 carry out an audit of the performance in use of lighting installations
LO4  Be able to produce a design for an emergency lighting system	4.1 produce designs and specifications for an emergency lighting system for industrial or commercial buildings  4.2 write a maintenance and testing schedule handbook for emergency lighting systems

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 43: Electricity and Lighting for Building Services Engineering*
- *Unit 49: Electrical and Electronic Control Principles for Building Services Engineering*
- *Unit 52: Power Supplies for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to a wide range of publications, reference data, manufacturers' products/information and design and computer facilities. Learners will also need access to simulated installations and sample equipment to support their learning.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits and conduct preparatory briefings. Tutors should use real-life case studies, for example typical lighting applications in and around industrial and commercial buildings.



## Unit 52: Power Supplies for Building Services Engineering

**Unit code:** D/601/1388

**QCF level:** 5

**Credit value:** 15

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### ● Aim

This unit enables learners to develop an understanding of the principles of AC power supply and the skills required to provide high voltage (HV) supplies to complex industrial and commercial buildings.

### ● Unit abstract

This unit provides learners with the understanding and skills needed to apply the principles and practices of HV supplies to complex industrial and commercial buildings. Learners will investigate how circuit theorems and complex quantities are used to analyse AC power supply networks. Learners will explore the principles underpinning the use of transformers and the various applications of transformers. This unit also considers the issues associated with fault currents, HV distribution systems and abnormal loads and learners will develop the skills needed to quantify each of the above in terms of providing safe and effective HV power supplies.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the use of circuit theorems and complex quantities in AC power supplies
- 2 Understand the principles and applications of transformers in power transmission and distribution
- 3 Be able to determine fault currents in power supply networks
- 4 Be able to design HV distribution systems
- 5 Be able to determine the effect of abnormal loads on power supply systems.

## Unit content

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### 1 Understand the use of circuit theorems and complex quantities in AC power supplies

*Circuit theorems:* Thevenin's theorem; Norton's theorem; application to transmission lines; T and  $\Pi$  networks; analyse power supply networks

*Complex quantities:* equipment represented as complex quantities; analysis of such quantities

### 2 Understand the principles and applications of transformers in power transmission and distribution

*Transformer principles:* electromagnetic induction; laws of induction; transformer theory; phasor diagrams; equivalent circuits; referred values

*Transformer applications:* transformer tests; efficiency and regulation statistics; parallel operation and group references; metering and protection

### 3 Be able to determine fault currents in power supply networks

*Fault analysis:* types of faults; percentage and per unit (pu) values; determination of fault levels; determination of short circuit currents; network configurations; network analysis for fault levels

### 4 Be able to design HV distribution systems

*HV distribution systems:* networks (radial, ring, interconnected mesh); types of HV switchgear (RMU, oil, vacuum, SF6); protection systems; relay settings and grading; HV fuses; HV switchgear ratings; protection systems and relays; earthing of power systems; component lists; specifications for design

### 5 Be able to determine the effect of abnormal loads on power supply systems

*Abnormal load analysis:* load assessment; maximum power demand; load management; large motor loads (furnaces, welding); voltage interference; harmonics; energy usage; supply design constraints; negotiation of energy contracts and tariffs

*Managing the effect of abnormal loads:* strategies and mechanisms, supporting methods and calculations; supply contracts and tariffs regarding energy use in large buildings

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the use of circuit theorems and complex quantities in AC power supplies	1.1 analyse power supply networks using circuit theorems  1.2 analyse power supply networks using complex quantities to represent items of power equipment
LO2  Understand the principles and applications of transformers in power transmission and distribution	2.1 explain how transformer theory can be used to solve transformer problems  2.2 analyse transformer test results to determine efficiency and regulation statistics  2.3 justify the use of instrument transformers for metering and protection
LO3  Be able to determine fault currents in power supply networks	3.1 analyse fault currents in power supply networks  3.2 perform calculations to determine fault levels and short circuit currents in power supply networks  3.3 specify appropriate HV switchgear and protection equipment for power supply networks
LO4  Be able to design HV distribution systems	4.1 evaluate the suitability and commercial viability of HV power supplies for complex installations with large loads  4.2 determine switchgear, transformer and protection requirements for HV distribution systems  4.3 produce component lists and specifications to support the design of HV distribution systems
LO5  Be able to determine the effect of abnormal loads on power supply systems	5.1 evaluate loads and power requirements for large buildings  5.2 determine strategies and mechanisms for the management of abnormal loads  5.3 make recommendations for supply contracts and tariffs in relation to energy use in large buildings

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 43: Electricity and Lighting for Building Services Engineering*
- *Unit 50: Electrical Installation for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to a wide range of publications, reference data, and manufacturers' products/information, and design and computer facilities.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to power installations, power stations and/or large buildings with complex electrical installations. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example building services engineers, electrical engineers and/or qualified installation personnel. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.

## Unit 53: Electrical Protection and Transportation Installations for Non-domestic Buildings

**Unit code:** H/601/1392

**QCF level:** 5

**Credit value:** 15

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### ● Aim

This unit provides learners with an opportunity to develop the understanding and skills required to design and specify electrical protection and transportation installations.

### ● Unit abstract

This unit focuses on the principles that underpin the design and specification of electrical protection and transportation installations for non-domestic buildings. Learners will investigate the selection and specification of overcurrent protection devices and explore the design and specification of lightning protection, standby power supplies, fire/smoke detection and alarm systems, and transportation installations. Learners will apply the associated legislation, standards and design guides for electricity, fire and public safety. Learners will also have the opportunity to establish strategies, produce design drawings and perform the calculations needed to size, select and specify the various items of plant and equipment required for electrical protection and transportation installations.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to design lightning protection installations for non-domestic buildings
- 2 Understand the application of principles and standards to circuit protection
- 3 Be able to design standby power and uninterruptible power supplies (UPS) for non-domestic buildings
- 4 Be able to design vertical and horizontal transportation installations for non-domestic buildings
- 5 Be able to design and specify fire detection and alarm systems.

## Unit content

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### 1 Be able to design lightning protection installations for non-domestic buildings

*Design issues:* implications of lightning strikes on buildings; factors that determine susceptibility to lightning strikes; lightning strike risk assessments

*Lightning protection installations:* system components; air termination network; down conductors; earth termination networks; bonding; side flashing protection; protection of electrical and data equipment within buildings; bonding of electrical and lightning protection systems; cable routes and equipment location

### 2 Understand the application of principles and standards to circuit protection

*Circuit protection:* principles; legislation and standards; overcurrent and short circuit protection; protection for variable loads; determination of fault currents; protection against fault currents; discrimination between protective devices e.g. fuses, miniature circuit breakers (MCBs) and moulded case circuit breakers (MCCBs); operating time ranges and tripping characteristics (thermal, magnetic and electronic protection devices); construction and desirable characteristics of common types of fuses (heavy current and electronic circuits); use of manufacturers' data for the selection of fuses, MCBs, and MCCBs

### 3 Be able to design standby power and uninterruptible power supplies (UPS) for non-domestic buildings

*Standby power supplies:* identification of essential, critical and non-essential loads; single and multi-generator set installations; automatic start-up arrangements; synchronisation with other sets and with the public supply; supply protection e.g. overcurrent, reverse-power, voltage, frequency, check-synchroniser; prime mover fuels and efficiency; effect of generator impedance on fault levels; overcurrent and earth fault protection

*Uninterruptible power supplies (UPS):* purpose and role of UPS; types, operation, configuration, characteristic and applications of UPS systems; single-phase to single-phase, three phase to three-phase and three-phase to single-phase systems; static switch/by-pass; voltage and current waveforms; total harmonic distortion; batteries (types and criteria for selection)

#### 4 **Be able to design vertical and horizontal transportation installations for non-domestic buildings**

*Transportation in buildings requirements:* lift functions e.g. firefighting, evacuation lifts for disabled persons, passenger, observation, goods and services; lift operations and control e.g. attendant, single automatic pushbutton control, collective, duplex, dispatch

*Vertical systems:* lift components; roping arrangements (above well, below well, compensating); winding systems (geared and gearless, electric traction drives, lift drives and controls); hydraulic lifting arrangements e.g. cylinder arrangements, power units, control and oil cooling; speed control; over-speed governors; safety devices; services in lift wells

*Horizontal systems:* escalators and walkways; safety devices e.g. discharge capacity, fire control, guards at intersections, angle of inclination; drive systems

*Design of lift provision:* location of lifts; grouping; quality of service e.g. arrival rate, estimation of population, daily occupancy, building type and height; passenger waiting time; passenger demand e.g. handling capacity, traffic profiles, up-peak, round trip time, calculation of handling capacity

#### 5 **Be able to design and specify fire detection and alarm systems**

*Fire detection and alarm:* manual and automatic systems; fire detection devices (siting and spacing of detectors, alarm sounders, initiation of other safety measures); cables and power supplies; equipment for wireless systems

*Design:* proposals for multi-storey commercial and public buildings; different environments and hazards; evaluation of performance of proposed fire detection and alarm installations

*Specification:* standards and legislative requirements; categories of alarm and detection systems; types of fire detection systems (break-glass, manual call point systems)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to design lightning protection installations for non-domestic buildings	1.1 assess the probability of lightning strikes and risks for non-domestic buildings  1.2 design lightning protection installations for non-domestic buildings
LO2  Understand the application of principles and standards to circuit protection	2.1 compare the operational characteristics of overcurrent circuit protection devices  2.2 justify the selection of suitable forms of circuit protection
LO3  Be able to design standby power and uninterruptible power supplies (UPS) for non-domestic buildings	3.1 analyse electrical installation loads for standby power supplies  3.2 compare standby power and UPS installations for non-domestic buildings  3.3 design standby power and UPS installations for non-domestic buildings
LO4  Be able to design vertical and horizontal transportation installations for non-domestic buildings	4.1 analyse client needs and building performance requirements for transportation installations  4.2 compare different types of transportation installations  4.3 design transportation installations for non-domestic buildings
LO5  Be able to design and specify fire detection and alarm systems	5.1 evaluate the legislation and standards that apply to fire detection and alarm installations  5.2 compare different types of fire detection and alarm equipment  5.3 design and specify fire detection and alarm installations

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 10: Building Services Design, Installation and Maintenance in Construction*
- *Unit 43: Electricity and Lighting for Building Services Engineering*
- *Unit 46: Piped Distribution Services for Non-domestic Buildings*
- *Unit 50: Electrical Installation for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to protection installations, standby power supply installations and/or lift installations. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example representatives from standby power supply manufacturers, UPS manufacturers, lift manufacturers, fire alarm equipment manufacturers and/or fire officers. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 54: Building Management Systems for Building Services Engineering

**Unit code:** M/601/1394

**QCF level:** 4

**Credit value:** 15

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### ● Aim

This unit enables learners to develop an understanding of building management systems (BMS) in relation to management and control requirements of buildings and develop skills to specify and install effective BMS.

### ● Unit abstract

This unit allows learners to explore the characteristics of BMS installations and consider how these systems can be used to manage and control the mechanical and electrical services of buildings and promote internal environmental comfort and energy efficiency. Learners will investigate the use of BMS hardware to achieve the aims of BMS strategies and examine the associated installation and operational issues. Learners will also develop the skills needed to analyse and produce designs for BMS installations, and investigate the use of BMS reports and data to inform planned preventative maintenance (PPM) strategies and optimise the performance of BMS installations.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the management and control requirements of buildings
- 2 Understand the control functions of BMS hardware
- 3 Be able to design BMS installations
- 4 Be able to use BMS reports and data to optimise the performance of BMS installations.

## Unit content

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### 1 Understand the management and control requirements of buildings

*Building requirements:* management and control; power generation and load management; fire detection; maintenance; characteristics of BMS

*Management and control:* environmental control requirements of buildings (heating, natural ventilation, mechanical ventilation, air conditioning); lighting control requirements; lamps and luminaires; different strategies for different buildings

*Power generation and load management:* control of power generation; maximum demand; power factors; load management techniques (for modern industrial and commercial buildings)

*Fire detection:* access control and security systems; lift and escalator controls; integration of fire detection, building access and building security systems

*Maintenance:* requirements of plant and systems; maintenance (type and frequency); monitoring energy sources and energy consumption within buildings; realistic energy target criteria; financial implications of using BMS; benefits of BMS (compared to conventional control strategies)

*Characteristics of BMS:* terminology; functions performed; analogue and digital control; environmental monitoring; plant switching; data (monitoring, logging, reporting); types and configuration of BMS; role of BMS within intelligent buildings

### 2 Understand the control functions of BMS hardware

*Control functions:* identification of control requirements; configurations and techniques to achieve optimisation; compensation; sequencing; plant switching; cascade control; night time cooling

*BMS fixed hardware:* types e.g. analogue and digital condition sensors, actuators and metering devices, BMS control panel components; power supplies and conditions; operation characteristics and application (switching and protection equipment); wiring requirements; techniques and installation specification; earthing requirements; wiring configurations (LAN, WAN, networks, LON-Works, BACNET); system integration; intelligent processors

### 3 Be able to design BMS installations

BMS installations: design; software

Design: services installation proposals (application of control logic); planning control strategies; panel locations; production of controls installation, schematic drawings and logic drawings; control symbols and annotation of drawings; production of control points count schedules; specification of outstations and intelligent controllers (from manufacturers' information); production of BMS equipment schedules and specifications

Software: logic drawings to identify node numbers and functions; programmes for hardware control strategies; commissioning requirements; procedures and documentation

#### 4 Be able to use BMS reports and data to optimise the performance of BMS installations

*BMS reports:* installed equipment (system logic, settings, operating conditions); methods and techniques used to monitor and adjust BMS settings e.g. time schedules, set points, via both central and local BMS equipment; building and system performance reports (techniques for interrogating BMS installations)

*BMS data:* PPM programmes; extraction of plant running times; monitoring plant breakdown; alarm strategies; integration of BMS data into PPM regimes

*BMS optimisation techniques:* monitoring physical energy usage; exception reports, data analysis and alarm strategies; reduce energy resource demands (interpretation of BMS reports); BMS data (selection of energy tariffs, monitor plant efficiency performance and life expectancy, load shedding, plant switching strategies, optimisation of plant and building energy performance)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the management and control requirements of buildings	1.1 describe the functions of buildings that can be managed using BMS  1.2 evaluate the functions performed by BMS installations and components  1.3 justify the decision to use a BMS installation within a given building
LO2  Understand the control functions of BMS hardware	2.1 explain the control functions performed by BMS hardware  2.2 evaluate the operation of fixed hardware components associated with BMS installations  2.3 justify the techniques used to install BMS fixed hardware and wiring
LO3  Be able to design BMS installations	3.1 apply control logic to design BMS installations  3.2 produce control points count schedules, controls installation, schematic drawings and logic drawings  3.3 produce BMS component and equipment lists, schedules and specifications for given installations  3.4 carry out BMS software procedures to achieve required control strategies  3.5 produce commissioning schedules for BMS installations
LO4  Be able to use BMS reports and data to optimise the performance of BMS installations	4.1 analyse BMS installations to obtain performance reports  4.2 analyse BMS settings to modify and adjust BMS installations  4.3 produce planned preventative maintenance strategies using BMS reports and data  4.4 produce energy management optimisation strategies using BMS reports and data

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 10: Building Services Design, Installation and Maintenance in Construction*
- *Unit 28: IT Applications for Construction*
- *Unit 35: The Use of Information and Communication Technology for Construction and the Built Environment*
- *Unit 47: Energy Utilisation and Efficiency for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

It is strongly recommended that learners have access to real or simulated BMS installations and software. Learners will require access to a wide range of publications, reference data, manufacturers' products/information, and computer facilities and BMS software.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to complex buildings with BMS, manufacturers' premises and/or software companies. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example building services engineers, building systems managers or facilities managers and/or qualified installation personnel. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 55: Refrigeration Applications for Construction and the Built Environment

**Unit code:** F/601/1397

**QCF level:** 5

**Credit value:** 15

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- **Aim**

This unit provides learners with the opportunity to develop an understanding of refrigeration applications associated with the construction and built environment sector.

- **Unit abstract**

This unit explores the refrigeration applications in the food, medical, technological and leisure sectors. Learners will develop an understanding of the methods and processes that depend on refrigeration and how this impacts on the quality of stored food, dairy produce, brewing and ice making for industrial and commercial applications.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand the factors affecting the quality of stored food
- 2 Understand the processing and transportation requirements for food products
- 3 Understand the methods used to manufacture ice for food and leisure applications
- 4 Understand the refrigeration methods used in medical and technological applications.

## Unit content

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### 1 Understand the factors affecting the quality of stored food

*Food quality:* microbiology; destruction agents; respiration

*Storage requirements:* frozen and chilled produce; temperature; humidity; air velocity; controlled atmospheric storage; alternative preservation methods

### 2 Understand the processing and transportation requirements for food products

*Processing:* dairy products; brewing; wine making; fruit juices; bakery processes

*Transportation:* cold chain; dry ice; refrigeration methods; controlled atmospheres

### 3 Understand the methods used to manufacture ice for food and leisure applications

*Ice production:* cube; plate; slice; block; tube ice

*Ice rinks:* design; sport and recreational skating; rink floors; dehumidification equipment

### 4 Understand the refrigeration methods used in medical and technological applications

*Medical:* fast freezing and thawing of living tissues; preservation; medication

*Technological:* civil engineering; scrap metals; chemical; material manufacturing

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the factors affecting the quality of stored food	1.1 examine the microbiology of food 1.2 discuss the agents that destroy food 1.3 compare the conditions of food storage
LO2  Understand the processing and transportation requirements for food products	2.1 examine the processing requirements of food products 2.2 discuss the requirements for food transportation
LO3  Understand the methods used to manufacture ice for food and leisure applications	3.1 evaluate methods of ice production 3.2 justify the refrigeration design of ice rinks 3.3 examine the construction of ice rink floors
LO4  Understand the refrigeration methods used in medical and technological applications	4.1 analyse the preservation criteria for tissue and medication 4.2 evaluate clinical and research applications of refrigeration 4.3 evaluate the use of refrigeration for technological applications

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 48: Refrigeration Technology for Construction and the Built Environment*
- *Unit 56: Refrigeration Design for Construction and the Built Environment.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to commissioning equipment and either simulated refrigeration rigs or live systems. Laboratory facilities are also required to assess system variations due to compressor, condenser and evaporator cycle fluctuations.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits as part of delivery for this unit. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers associated with site visits. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.

## **Unit 56: Refrigeration Design for Construction and the Built Environment**

**Unit code:** L/601/1399

**QCF level:** 5

**Credit value:** 15

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### ● **Unit aim**

This unit provides learners with the opportunity to develop an understanding of system design criteria and the skills needed to select equipment and design energy efficient industrial refrigeration systems.

### ● **Unit abstract**

This unit introduces learners to the techniques used to select industrial refrigeration equipment and the refrigeration systems used in the construction and built environment sector. Learners will produce equipment design specifications and evaluate refrigeration systems and components. This will allow learners to appreciate the variety of solutions that are available. Learners will also gain an appreciation of designing systems to a specification and will develop the skills needed to produce energy efficient solutions for industrial refrigeration systems.

### ● **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand refrigeration system design criteria
- 2 Be able to select equipment using manufacturers' data
- 3 Be able to create energy efficient designs for industrial refrigeration systems.

## Unit content

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### 1 Understand refrigeration system design criteria

*Design criteria:* ambient conditions; site; product; construction and design regulations; environmental regulations; health and safety regulations

*Plant layout:* pipe arrangements; layout of plant rooms; positioning of equipment

*Cold rooms:* floor construction; underfloor heating; vapour barriers; pressure equalisation vents; pull down schedules

### 2 Be able to select equipment using manufacturers' data

*System design:* heat load calculations; direct expansion and flooded systems; oil return; equipment balancing; multi-temperature systems; multi-stage

*Selection of equipment:* pipe sizing; oil separators; refrigerants; refrigerant circulation pumps; cooling towers; evaporative condensers; heat exchangers; receivers; controls

*Alternative refrigeration systems:* absorption refrigeration; secondary refrigeration systems

### 3 Be able to create energy efficient designs for industrial refrigeration systems

*Components:* design standards; compressor; condenser; evaporator; controls; refrigerant; oil system; receivers; commissioning schedules and documentation

*Controls:* control strategy; part load operation

*Cost control:* strategies; budgeting

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand refrigeration system design criteria	1.1 evaluate the design criteria for refrigeration applications  1.2 assess the criteria for plant room layouts and equipment positioning  1.3 analyse cold room construction and underfloor heating requirements
LO2  Be able to select equipment using manufacturers' data	2.1 carry out calculations for heat gains and system capacities  2.2 produce equipment design specifications  2.3 plan refrigeration solutions using alternatives to vapour compression systems
LO3  Be able to create energy efficient designs for industrial refrigeration systems	3.1 create component, system and control specifications for refrigeration systems  3.2 produce cost control strategies and procedures for refrigeration applications

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 48: Refrigeration Technology for Construction and the Built Environment*
- *Unit 55: Refrigeration Applications for Construction and the Built Environment.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to a wide range of publications, reference data and manufacturers' information, IT facilities and appropriate software to support their learning. Laboratory facilities are also required to assess system variations due to compressor, condenser and evaporator cycle fluctuations.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to local cold stores. To ensure site visits are successful tutors should outline the aims and objectives of the visits and conduct preparatory briefings. Tutors should organise presentations by visiting speakers, for example representatives from Danfoss Controls and/or Sabroe Compressors. Tutors should use real-life case studies, based on visiting speakers, for part of the assessment for this unit.

## Unit 57: Project Management for Building Services Engineering

**Unit code:** T/601/1400

**QCF level:** 5

**Credit value:** 15

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### ● Aim

This unit enables learners to develop an understanding of contract management principles, and their application within building services engineering, together with the skills needed to produce tenders and estimates.

### ● Unit abstract

This unit is designed to develop learner skills in applying the techniques and procedures of building services engineering project management. Learners will understand how to establish clear project objectives and explore the management skills and processes required to achieve those objectives. Learners will study the implications of the different methods of procurement and produce tenders and estimates for building services installations. Learners will consider the implications of management structures, and the role and significance of effective teamwork and communication. Learners will also explore the standard forms of contract used within the sector, and develop skills in applying project management techniques to forecast and plan resources.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the objectives, processes and skills of project management
- 2 Be able to apply procedures and processes to the procurement of contracts and the production of tenders and estimates
- 3 Understand management structures, team relationships and communication methods involved in project management
- 4 Understand the implications, requirements and obligations of the standard forms of contract
- 5 Be able to apply the techniques and procedures of project management.

## Unit content

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### 1 Understand the objectives, processes and skills of project management

*Objectives and processes of project management:* definition of project management; identification of client objectives; interpreting project briefs; establishing project objectives e.g. prestige, profitability, expectations and quality

*Building services project cycles:* project conception to post-handover phase

*Processes and skills in resource management:* management processes e.g. forecasting, planning, organising, motivating, controlling, coordinating and communicating; identification of management skills e.g. interpersonal skills, delegation, negotiation, decision making, planning and clarity of thinking

*Improvement strategies:* quality criteria; performance and quality improvement objectives

### 2 Be able to apply procedures and processes to the procurement of contracts and the production of tenders and estimates

*Project procurement and delivery:* procuring building services projects (sequence and processes); traditional and alternative methods of procurement (for building services engineering projects of various sizes)

*Profitability:* cost factors that make up profit within a contract and their impact on profitability; cost benefit analysis techniques; cost allocation; factors which affect profitability e.g. materials procurement, contract terms, contract conditions, human resources, relationships, time and quality

*Estimating and tendering:* cost predictions; cost and quality analysis; estimates and tenders (techniques, processes and procedures); cost factors within contract bids

### 3 Understand management structures, team relationships and communication methods involved in project management

*Management structures:* features of alternative management and project team structures; building services project management and delivery teams (individual and collective roles and responsibilities); relationships and role of clients

*Team relationships:* features of teamworking; roles within teams; team relationships; leadership; decision-making techniques; team membership; stages of team formation; equal opportunities within teams

*Communication:* effective formal and informal communication structures; personal communication skills; management of information; meetings; reporting

**4 Understand the implications, requirements and obligations of the standard forms of contract**

*Features of a contract:* what constitutes a contract; forms of contract; parties to a contract (implications and responsibilities)

*Standard forms of contract:* main and sub-contracts; standard contracts (building services engineering sector); standard contract clauses (requirements and obligations); vocabulary of contracts; non-standard and onerous contract conditions (identification and implications); implications of warranties and insurances; commercial and financial risks

**5 Be able to apply the techniques and procedures of project management**

*Management forecasting:* sources and management (current and historic information and data); forecasting techniques; potential error and risk analysis

*Planning and programming:* techniques; for scheduling and programming material (diagrams and charts), equipment, financial and human resources

*Project progress and control:* techniques and procedures (control, monitor and report progress e.g. completed work, work in progress, costs, claims for variations, delays, disruption, and cash control procedures)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the objectives, processes and skills of project management	1.1 define the objectives of a project and their significance in meeting the client’s needs  1.2 analyse the processes and skills needed to manage contract resources successfully  1.3 justify the need for a continuous quality improvement strategy
LO2  Be able to apply procedures and processes to the procurement of contracts and the production of tenders and estimates	2.1 analyse the methods of procurement used for building services engineering projects  2.2 evaluate the cost factors within a contract bid  2.3 explain the sensitivity of profitability to variations in cost factors  2.4 produce estimates and tenders for building services engineering installation projects
LO3  Understand management structures, team relationships and communication methods involved in project management	3.1 compare features, roles and responsibilities of alternative management and project team structures  3.2 discuss leadership and teamworking within building services engineering projects  3.3 examine effective formal and informal communication skills within the context of project management
LO4  Understand the implications, requirements and obligations of the standard forms of contract	4.1 explain the features of legal contracts and the implications for the parties involved  4.2 compare the standard forms of contract commonly used for building services engineering projects  4.3 analyse the rights, obligations and legal responsibilities within standard contract clauses  4.4 discuss the implications of non-standard and onerous contract conditions

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
L05  Be able to apply the techniques and procedures of project management	5.1 explain the forecasting techniques used in the management of contracts  5.2 plan and programme of human, material and financial resources  5.3 apply techniques and procedures to monitor and report contract progress  5.4 plan actions arising from progress measurement information

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 4: Management Principles and Application for Construction and the Built Environment*
- *Unit 9: Law and Contract for Construction and the Built Environment*
- *Unit 11: Contractual Procedures and Procurement for Construction and the Built Environment*
- *Unit 14: Economics for Construction and the Built Environment*
- *Unit 15: Production Management for Construction*
- *Unit 16: Measuring, Tendering and Estimating for Construction and the Built Environment*
- *Unit 17: Project Management for Construction and the Built Environment*
- *Unit 21: Specification and Contract Documentation for Construction.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to current information from the building services engineering industry regarding the use and development of practical project management.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits so learners can observe management structures and site meetings. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example on tendering and estimating software and databases, planning and programming techniques and/or project/cost control techniques. Tutors should use real-life case studies for part of the assessment for this unit. For example relating to, management processes, project cycles, methods of procurement, management structures and/or forms of contract within projects.

## Unit 58: Application of Scientific Principles to Building Services Engineering

**Unit code:** F/601/1402

**QCF level:** 4

**Credit value:** 15

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### ● Aim

This unit develops an understanding of the elements of control systems, AC networks and the skills needed to determine heat energy transfer rates, energy losses and effects of sound and vibration.

### ● Unit abstract

This unit will develop learners' understanding of the scientific principles and concepts used in a wide range of building services engineering applications and it provides a basis for studying the more specialised building service applications. Learners will explore the fundamental principles of heat transfer, fluid flow, acoustics, electrical networks and controls systems. Learners will investigate the principles that underpin heat transfer modes and transmission through insulated surfaces and will apply these principles in a building services engineering context. Learners will explore the various forms of fluid flow and determine energy losses in fluid flow systems. Learners will also explore the effects of sound and vibration, such as the consequences of sound power generated by elements of building services, and will further develop their understanding of the performance of electrical networks and control systems.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to determine heat energy transfer rates
- 2 Be able to determine energy losses in fluid flow
- 3 Understand the principles of single-phase AC electrical networks
- 4 Be able to determine the effects of sound and vibration
- 5 Understand elements of control systems and their performance.

## Unit content

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### 1 Be able to determine heat energy transfer rates

*Heat energy transfer rates:* principles of heat transfer; thermal comfort; associated calculations

*Principles of heat transfer:* conduction; convection; radiation; evaporation; natural and forced convection coefficients; Stefan's constant; black and grey body radiation; one dimensional heat conduction (in single and multi-leaf plane, cylindrical and spherical surfaces); heat transfer through insulated surfaces; insulation thickness and economics; temperature gradients; risk of interstitial condensation

*Thermal comfort:* physiological and psychological factors; thermal indices and their use in the design of building services systems; methods of predicting and assessing thermal comfort; reliability of design criteria

*Associated calculations:* heat transfer rates by conduction through composite, complex and thermally bridged structures; heat conduction rates using star and delta thermal resistance networks

### 2 Be able to determine energy losses in fluid flow

*Fluid flow:* laminar and turbulent flow; boundary separation and transition; Reynolds' number; uniform and steady flow; continuity of flow; conservation of energy in a moving fluid; Bernoulli's equation; volume and mass transfer; measurement of fluid flow rates (using venture meter, orifice plate and pitot-static tubes)

*Energy losses:* frictional losses in pipe and duct networks (loss due to fittings and shock); frictional coefficients; velocity pressure factors; static regain in expansion pieces; gravitational flow in flooded and partially flooded conduits (guttering, channels, drainage pipes and soil/waste stacks); formulae (Manning, Crimp and Bruge, Darcy-Weisback, Chezy)

### 3 Understand the principles of single-phase AC electrical networks

*Principles of single-phase AC electrical networks:* non-resonant circuits; resonant circuits; power factor correction

*Non-resonant circuits:* series, parallel and complex networks; resistance; capacitance; inductance; reactance and impedance; potential difference; current flow in non-resonant single-phase AC circuits; power factor; true, reactive and apparent power; heating and magnetic effects of electric currents

*Resonant circuits:* definition of circuit resonance; circuit conditions at resonance (circuits containing coil and capacitor in series or parallel, resonant frequency, dynamic frequency)

*Power factor correction:* capacitance required to improve overall power factor of an inductive load; benefits of power factor correction

**4 Be able to determine the effects of sound and vibration**

*Effects of sound and vibration:* transmission and propagation of sound; measurement of sound; room acoustics

*Transmission and propagation of sound:* sound power; frequency spectra for external and internal noise sources; propagation of acoustic energy; sound insulation; sound attenuation

*Measurement of sound:* decibel scales; equivalent continuous noise levels; sound power levels (SPL); sound intensity levels (SIL); sound power produced by building services installations

*Room acoustics:* background and total sound levels; reverberation time; sound absorption; anti-vibration mountings

**5 Understand elements of control systems and their performance**

*Concepts:* load, lag and deviation

*Elements and systems:* sensing elements; controllers; actuators; analogue and digital control; control modes (on-off, step, floating, proportional, integral and combined)

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to determine heat energy transfer rates	1.1 discuss the principles of heat transfer 1.2 discuss the reliability of design criteria for maintaining thermal comfort 1.3 determine the risk of interstitial condensation in multi-leaf plane structures 1.4 determine heat energy transfer rates by conduction, convection and radiation
LO2  Be able to determine energy losses in fluid flow	2.1 discuss the principles of fluid flow 2.2 examine Bernoulli's equation for conserving energy in a moving fluid 2.3 determine volume and mass transfer rates 2.4 determine frictional coefficients for turbulent flow 2.5 determine frictional heat losses in pipe and duct networks
LO3  Understand the principles of single-phase AC electrical networks	3.1 explain the practical applications of non-resonant AC circuits 3.2 analyse circuit conditions at resonance 3.3 discuss the benefits of power factor correction 3.4 evaluate the methods used for power factor correction
LO4  Be able to determine the effects of sound and vibration	4.1 discuss the transmission and propagation of sound 4.2 calculate sound power from performance data 4.3 determine reverberation times 4.4 determine the performance characteristics of anti-vibration mountings
LO5  Understand elements of control systems and their performance	5.1 explain the concepts used in control systems 5.2 explain the construction and operation of sensing elements 5.3 compare response characteristics for various mode systems with different loads

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 2: Science and Materials for Construction and the Built Environment*
- *Unit 36: Applied Mathematics for Complex Engineering Problems*
- *Unit 40: Thermofluids and Acoustic Criteria for Building Services Engineering*
- *Unit 41: Air Conditioning for Industrial and Commercial Buildings*
- *Unit 42: Low Pressure Hot Water Heating for Non-domestic Buildings*
- *Unit 48: Refrigeration Technology for Construction and the Built Environment*
- *Unit 50: Electrical Installation for Building Services Engineering.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to IT facilities to benefit from using spreadsheets in problem-solving exercises.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Tutors should organise site visits, for example to scientific exhibitions on new materials and controls systems. To ensure site visits are successful tutors should outline the aims and objectives of the visits, conduct preparatory briefings and encourage learners to review the site visits once completed. Tutors should organise presentations by visiting speakers, for example design/commissioning engineers on current industrial practices and role of services science. Tutors should use real-life case studies, based on site visits, for part of the assessment for this unit.



## Unit 59: Employability Skills

**Unit code:** A/601/0992

**QCF level:** 5

**Credit value:** 15

### ● Aim

This unit provides learners with the opportunity to acquire honed employability skills required for effective employment.

### ● Unit abstract

Learners at all levels of education and experience require honed employability skills as a prerequisite for entering the job market. This unit gives learners an opportunity to assess and develop an understanding of their own responsibilities and performance in, or when entering, the workplace. Learners will consider the skills required for general employment such as interpersonal and transferable skills, and the dynamics of working with others in teams or groups including leadership and communication skills. This unit also deals with the everyday work requirement of problem solving which includes the identification or specification of the 'problem', strategies for its solution and the evaluation of the results through reflective practices.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to determine own responsibilities and performance
- 2 Be able to develop interpersonal and transferable skills
- 3 Understand the dynamics of working with others
- 4 Be able to develop strategies for problem solving.

## Unit content

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### 1 Be able to determine own responsibilities and performance

*Own responsibilities:* personal responsibility; direct and indirect relationships and adaptability, decision-making processes and skills; ability to learn and develop within the work role; employment legislation, ethics, employment rights and responsibilities

*Performance objectives:* setting and monitoring performance objectives

*Individual appraisal systems:* uses of performance appraisals e.g. salary levels and bonus payments, promotion, strengths and weaknesses, training needs; communication; appraisal criteria e.g. production data, personnel data, judgemental data; rating methods e.g. ranking, paired comparison, checklist, management by objectives

*Motivation and performance:* application and appraisal of motivational theories and techniques; rewards and incentives; role of manager; self-motivational factors

### 2 Be able to develop interpersonal and transferable skills

*Effective communication:* verbal and non-verbal e.g. awareness and use of body language, openness and responsiveness, formal and informal feedback to and from colleagues; ICT as an effective communication medium; team meetings

*Interpersonal skills:* personal effectiveness; working with others; use of initiative; negotiating skills; assertiveness skills; social skills

*Time management:* prioritising workload; setting work objectives; making and keeping appointments; working steadily rather than erratically; making time for learning; reliable estimate of task time

*Problem solving:* problem analysis; researching changes in the workplace; generating solutions; choosing a solution

### 3 Understand the dynamics of working with others

*Working with others:* nature and dynamics of team and group work; informal and formal settings, purpose of teams and groups e.g. long-term corporate objectives and strategies; problem solving; short-term development projects; flexibility/adaptability; ability to function as team player

*Teams and team building:* selecting team members e.g. specialist roles, skills, mix of styles and/or approaches; identification of teamwork and group roles; stages in team development e.g. team building, identity, loyalty, commitment to shared beliefs, team health evaluation; action planning; monitoring and feedback; coaching skills; ethics; effective leadership skills e.g. setting direction, setting standards, motivating, innovating, responding, communicating effectively; reliability; consistency

#### 4 Be able to develop strategies for problem solving

*Specification of the problem:* definition of the problem; analysis and clarification

*Identification of possible outcomes:* identification and assessment of various alternative outcomes

*Tools and methods:* problem-solving methods and tools

*Plan and implement:* sources of information; solution methodologies; selection and implementation of the best corrective action e.g. timescale, stages, resources, critical path analysis

*Evaluation:* evaluation of whether the problem was solved or not; measurement of solution against specification and desired outcomes; sustainability

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to determine own responsibilities and performance	1.1 develop a set of own responsibilities and performance objectives  1.2 evaluate own effectiveness against defined objectives  1.3 make recommendations for improvement  1.4 review how motivational techniques can be used to improve quality of performance
LO2  Be able to develop interpersonal and transferable skills	2.1 develop solutions to work-based problems  2.2 communicate in a variety of styles and appropriate manner at various levels  2.3 identify effective time management strategies
LO3  Understand the dynamics of working with others	3.1 explain the roles people play in a team and how they can work together to achieve shared goals  3.2 analyse team dynamics  3.3 suggest alternative ways to complete tasks and achieve team goals
LO4  Be able to develop strategies for problem solving	4.1 evaluate tools and methods for developing solutions to problems  4.2 develop an appropriate strategy for resolving a particular problem  4.3 evaluate the potential impact on the business of implementing the strategy

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 5: Group Project in the Construction Industry*
- *Unit 30: Work-based Learning and Assessment in Construction and the Built Environment*
- *Unit 31: Work-based Training and Development in Construction and the Built Environment*
- *Unit 60: Personal and Professional Development*
- *Unit 62: Research Project.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners will need access to a range of work-related exemplars for example appraisal and development systems, team health checks, job descriptions, action plans and communication strategies. Case studies based on relevant sectors, workshops, career talks and work-based mentors are also useful in the teaching and learning aspect of this unit. Learners can generate assessment evidence through a range of possible activities including individual work placements, project management, research reports, development of case studies and the process of working with others for example employee-supervisor roles, teamwork, group work and everyday communication within the workplace.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.



## Unit 60: Personal and Professional Development

**Unit code:** T/601/0943

**QCF level:** 5

**Credit value:** 15

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- **Aim**

This unit aims to help the learner become an effective and confident self-directed employee. This helps the learner become confident in managing own personal and professional skills to achieve personal and career goals.

- **Unit abstract**

This unit is designed to enable learners to assess and develop a range of professional and personal skills in order to promote their future personal and career development. It also aims to develop learners' ability to organise, manage and practise a range of approaches, in order to improve their performance as self-directed learners in preparation for work or further career development. The emphasis is on the needs of the individual within the context of how the development of self-management corresponds with effective team management to meet objectives. Learners will be able to improve their own learning, be involved in teamwork and be more capable of problem solving through the use of case studies, role play and real-life activities.

- **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Understand how self-managed learning can enhance lifelong development
- 2 Be able to take responsibility for own personal and professional development
- 3 Be able to implement and continually review own personal and professional development plan
- 4 Be able to demonstrate acquired interpersonal and transferable skills.

## Unit content

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### 1 Understand how self-managed learning can enhance lifelong development

*Self-managed learning:* self-initiation of learning processes; clear goal setting e.g. aims and requirements, personal orientation achievement goals, dates for achievement, self-reflection

*Learning styles:* personal preferences; activist; pragmatist; theorist; reflector e.g. reflexive modernisation theory; Kolb's learning cycle

*Approaches:* learning through research; learning from others e.g. mentoring/coaching, seminars, conferences, secondments, interviews, use of the internet, social networks, use of bulletin boards, newsgroups

*Effective learning:* skills of personal assessment; planning, organisation and evaluation

*Lifelong learning:* self-directed learning; continuing professional development; linking higher education with industry, further education, Recognition of Prior Learning, Apprenticeships, Credit Accumulation and Transfer Schemes

*Assessment of learning:* improved ability range in relation to personal learning; evidence of improved levels of skill; feedback from others; learning achievements and disappointments

### 2 Be able to take responsibility for own personal and professional development

*Self-appraisal:* skills audit (personal profile using appropriate self-assessment tools); evaluating self-management; personal and interpersonal skills; leadership skills

*Development plan:* current performance; future needs; opportunities and threats to career progression; aims and objectives; achievement dates; review dates; learning programmes and/or activities; action plans; personal development plans

*Portfolio building:* developing and maintaining a personal portfolio

*Transcripts:* maintaining and presenting transcripts including curriculum vitae

### 3 Be able to implement and continually review own personal and professional development plan

*Learning styles and strategies:* type of styles; awareness of own personal style; impact of personal style; interactions with others

*Learning from others:* formal learning and training; observation; mentoring; supervision; tutorials; informal networks; team members; line managers; other professionals

*Evaluation of progress:* setting and recording of aims and objectives; setting targets; responding to feedback; re-setting aims and targets; establishing and recognising strengths and weaknesses; directions for change; cycles of activity (monitoring, reflecting, planning)

**4 Be able to demonstrate acquired interpersonal and transferable skills**

*Transferable skills:* personal effectiveness e.g. ability to communicate effectively at all levels, initiative, self-discipline, reliability, creativity, problem solving

*Verbal and non-verbal communication:* effective listening; respect for opinions of others; negotiation; persuasion; presentation skills; assertiveness; use of ICT

*Delivery formats:* ability to deliver transferable skills using a variety of formats

*Working with others:* team player; flexibility/adaptability; social skills

*Time management:* prioritising workloads; setting work objectives; using time effectively; making and keeping appointments; reliable estimates of task time

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand how self-managed learning can enhance lifelong development	1.1 evaluate approaches to self-managed learning 1.2 propose ways in which lifelong learning in personal and professional contexts could be encouraged 1.3 evaluate the benefits of self-managed learning to the individual and organisation
LO2  Be able to take responsibility for own personal and professional development	2.1 evaluate own current skills and competencies against professional standards and organisational objectives 2.2 identify own development needs and the activities required to meet them 2.3 identify development opportunities to meet current and future defined needs 2.4 devise a personal and professional development plan based on identified needs
LO3  Be able to implement and continually review own personal and professional development plan	3.1 discuss the processes and activities required to implement the development plan 3.2 undertake and document development activities as planned 3.3 reflect critically on own learning against original aims and objectives set in the development plan 3.4 update the development plan based on feedback and evaluation
LO4  Be able to demonstrate acquired interpersonal and transferable skills	4.1 select solutions to work-based problems 4.2 communicate in a variety of styles and appropriate manner at various levels 4.3 evaluate and use effective time management strategies

## Guidance

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### Links

This unit links with the following units from the Management Standards Centre National Occupational Standards:

- A2: Manage your own resources and professional development
- A3: Develop your personal networks
- D2: Develop productive working relationships with colleagues and stakeholders
- D9: Build and manage teams
- D12: Participate in meetings
- E11: Communicate information and knowledge.

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 30: Work-based Learning and Assessment in Construction and the Built Environment*
- *Unit 31: Work-based Training and Development in Construction and the Built Environment*
- *Unit 59: Employability Skills*
- *Unit 62: Research Project.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

A personal development portfolio or progress file must be put together for all information and personal records 'owned' by the learner, including the planning and monitoring of progress towards the achievement of personal objectives. This could be web based, paper based or another format.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.



## Unit 61: Project Design, Implementation and Evaluation

**Unit code:** L/601/0995

**QCF level:** 5

**Credit value:** 20

### ● Aim

To develop learners' skills of independent enquiry by undertaking a sustained investigation of direct relevance to their vocational, academic and professional development.

### ● Unit abstract

This unit provides opportunities to develop skills in decision making, problem solving and communication, integrated with the knowledge, understanding and skills developed in many of the other units within the programme, in order for learners to complete a realistic project. Learners will select, plan, implement and evaluate a project and present the final outcomes, in terms of the process and the product. Learners will also develop the ability to work individually and/or with others, within defined timescales and given constraints, to produce acceptable and viable solutions to an agreed brief. If this is a group project, each member of the team must be clear about their responsibilities at the start of the project and tutors must ensure that everyone is accountable for each aspect of the work and makes a contribution to the end result. Learners must work under the supervision of programme tutors or work-based managers.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to formulate a project
- 2 Be able to implement the project within agreed procedures and to specification
- 3 Be able to evaluate the project outcomes
- 4 Be able to present the project outcomes.

## Unit content

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### 1 Be able to formulate a project

*Project selection:* researching and reviewing areas of interest; literature review; methods of evaluating feasibility of projects, initial critical analysis of outline specification, selection of project option, initiating project-based logbook and/or diary, estimating costs and resource implications, identifying goals and limitations; value of project, rationale for selection, agree roles and allocating responsibilities (individually with tutor/supervisor and within project group if appropriate)

*Project specifications:* developing and structuring a list of requirements relevant to project specifications e.g. costs, timescales, scale of operation, standards, legislation, ethics, sustainability, quality, fitness for purpose, business data, resource implications

*Procedures:* planning and monitoring methods; operating methods; lines of communication; risk analysis; structure of groups and collaborative working e.g. learner groups or roles and responsibilities within a work-based project, targets and aims

*Project plan:* production of a plan for the project including timescales, deliverables, milestones, quality assurance systems and quality plans; monitoring progress

### 2 Be able to implement the project within agreed procedures and to specification

*Implement:* proper use of resources; working within agreed timescale; use of appropriate techniques for generating solutions; monitoring development against the agreed project plan; maintaining and adapting project plan where appropriate

*Record:* systematic recording of relevant outcomes of all aspects and stages of the project to agreed standards

### 3 Be able to evaluate the project outcomes

*Evaluation techniques:* detailed analysis of results; conclusions and recommendations; critical analysis against the project specification and planned procedures; use of appropriate evaluation techniques; application of project evaluation and review techniques (PERT); opportunities for further studies and developments

*Interpretation:* use of appropriate techniques to justify project progress and outcomes in relation to the original agreed project specification

*Further consideration:* significance of project; application of project results; implications; limitations of the project; improvements; recommendations for further consideration

### 4 Be able to present the project outcomes

*Record of procedures and results:* relevant documentation for all aspects and stages of the project

*Format:* professional delivery format appropriate to the audience; use of appropriate media

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to formulate a project	1.1 formulate and record possible outline project specifications  1.2 identify the factors that contribute to the process of project selection  1.3 produce a specification for the agreed project  1.4 produce an appropriate project plan for the agreed project
LO2  Be able to implement the project within agreed procedures and to specification	2.1 match resources efficiently to the project  2.2 undertake the proposed project in accordance with the agreed specification  2.3 organise, analyse and interpret relevant outcomes
LO3  Be able to evaluate the project outcomes	3.1 use appropriate project evaluation techniques  3.2 interpret and analyse the results in terms of the original project specification  3.3 make recommendations and justify areas for further consideration
LO4  Be able to present the project outcomes	4.1 produce a record of all project procedures used  4.2 use an agreed format and appropriate media to present the outcomes of the project to an audience

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 5: Group Project in the Construction Industry*
- *Unit 30: Work-based Learning and Assessment in Construction and the Built Environment*
- *Unit 31: Work-based Training and Development in Construction and the Built Environment*
- *Unit 39: Transportation for Construction and the Built Environment*
- *Unit 62: Research Project.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

The required resources will vary significantly with the nature of the project. Identification of the required equipment and materials, and the establishment of their availability, is a vital part of the planning phase. Learners will require access to a wide variety of physical resources and data sources relevant to the project. Tutors should ensure that learners do not embark on work that they cannot complete successfully because of a lack of access to the required resources.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

It is recommended that centres establish relationships with appropriate organisations in order to bring realism and relevance to learner projects.

## Unit 62: Research Project

**Unit code:** K/601/0941

**QCF level:** 5

**Credit value:** 20

### ● Aim

To develop learners' skills of independent enquiry and critical analysis by undertaking a sustained research investigation of direct relevance to their Higher Education programme and professional development.

### ● Unit abstract

This unit is designed to enable learners to gain confidence in using research techniques and methods. It addresses the elements that make up formal research including the proposal, a variety of research methodologies, action planning, carrying out the research and presenting the findings. To complete this unit satisfactorily, learners must understand the theory that underpins formal research. The research itself will depend on learners, the context of their area of learning, their focus of interest and the anticipated outcomes. This unit draws together a range of other areas of content from within the programme of study to form a holistic piece of work that will make a positive contribution to the learner's area of interest. Learners should seek approval from their tutors before starting their research project.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand how to formulate a research specification
- 2 Be able to implement the research project within agreed procedures and to specification
- 3 Be able to evaluate the research outcomes
- 4 Be able to present the research outcomes.

## Unit content

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### 1 Understand how to formulate a research specification

*Research formulation:* aims and objectives; rationale for selection; methodology for data collection and analysis; literature review; critique of references from primary sources e.g. questionnaires, surveys, interviews; secondary sources e.g. books, journals, internet; scope and limitations; resource implications

*Hypothesis:* definition; suitability; skills and knowledge to be gained; aims and objectives; terms of reference; duration; ethical issues

*Action plan:* rationale for research question or hypothesis; milestones; task dates; review dates; monitoring/reviewing process; strategy

*Research design:* type of research e.g. qualitative, quantitative, systematic, original; methodology; resources; statistical analyses; validity; reliability; control of variables

### 2 Be able to implement the research project within agreed procedures and to specification

*Implement:* according to research design and method; test research hypotheses; considering test validity; reliability

*Data collection:* selection of appropriate tools for data collection; types e.g. qualitative and quantitative; systematic recording; methodological problems e.g. bias, variables, control of variables, validity, reliability

*Data analysis and interpretation:* qualitative and quantitative data analysis (interpreting transcripts); coding techniques; specialist software; statistical tables; comparison of variable; trends; forecasting

### 3 Be able to evaluate the research outcomes

*Evaluation of outcomes:* overview of the success or failure of the research project (planning, aims and objectives, evidence and findings, validity, reliability, benefits, difficulties, conclusions)

*Future consideration:* significance of research investigation; application of research results; implications; limitations of the investigation; improvements; recommendations for the future, areas for future research

### 4 Be able to present the research outcomes

*Format:* professional delivery format appropriate to the audience; use of appropriate media

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand how to formulate a research specification	1.1 formulate and record possible research project outline specifications  1.2 identify the factors that contribute to the process of research project selection  1.3 undertake a critical review of key references  1.4 produce a research project specification  1.5 provide an appropriate plan and procedures for the agreed research specification
LO2  Be able to implement the research project within agreed procedures and to specification	2.1 match resources efficiently to the research question or hypothesis  2.2 undertake the proposed research investigation in accordance with the agreed specification and procedures  2.3 record and collate relevant data where appropriate
LO3  Be able to evaluate the research outcomes	3.1 use appropriate research evaluation techniques  3.2 interpret and analyse the results in terms of the original research specification  3.3 make recommendations and justify areas for further consideration
LO4  Be able to present the research outcomes	4.1 use an agreed format and appropriate media to present the outcomes of the research to an audience

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 61: Project Design, Implementation and Evaluation*
- *Unit 63: Work-based Experience.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Tutors will need to establish the availability of resources to support independent study before learners proceed with their proposals.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

It is recommended that centres establish relationships with appropriate organisations in order to bring realism and relevance to the project.

## Unit 63: Work-based Experience

**Unit code:** D/601/0998

**QCF level:** 5

**Credit value:** 15

### ● Aim

This unit aims to enable learners to experience the scope and depth of learning which may take place in a work-based context by planning, monitoring and evaluating the work experience.

### ● Unit abstract

A significant amount of learning can be achieved by carrying out practical activities in a workplace. Learning may be enhanced by taking a more formal approach to work-based activities by planning, carrying out the activities and reflecting on the benefits of the activities to the organisation and learners. This unit is designed to allow flexibility of study for part-time and full-time learners. It is expected that learners will be supervised in the workplace in addition to the supervision provided by their tutor. Learners will have the opportunity, with the support of their supervisors, to negotiate and perform activities that will allow them to meet the assessment criteria for this unit. Learners will recognise the scope of what they have achieved by recording evidence generated from carrying out the activities. Learners can also maximise the benefit gained from studying this unit by reflection on, and evaluation of, the work they undertake.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Be able to negotiate industry experience
- 2 Understand the specific requirements of the placement
- 3 Be able to undertake work experience as identified
- 4 Be able to monitor and evaluate own performance and learning.

## Unit content

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### 1 Be able to negotiate industry experience

*Suitable organisation and location:* establishments for placement e.g. industry-related work for a client brief at the centre, existing work environment, different departments within current employer's business

*Negotiation:* methods of contacting organisations; methods of undertaking negotiations

*Nature of duties:* types e.g. routine duties and tasks, project work, development of new procedures and protocols

*Supervisors:* roles and responsibilities of academic and industrial mentors

*Expectations of learning:* aims e.g. proficiency in new tasks and procedures, time management, problem-solving skills, reflection, discussion of progress with others, teamwork

*Business constraints:* consideration of possible limitations e.g. need to be fully trained, adherence to quality systems, health and safety considerations, supervision time, workload, customer satisfaction, limited staffing, cost of materials

### 2 Understand the specific requirements of the placement

*Tasks:* details of activities e.g. specific hourly, daily, weekly routine and non-routine tasks; breakdown of a project into stages; new procedures and protocols

*Prioritisation:* reasons for rationalising the order of tasks; methods of prioritising work

*Plan for the work experience:* methods used to develop detailed plans with a schedule of tasks; proposed dates for reviews; expected input from supervisors

*Benefits to organisation and learner:* advantages to organisation e.g. allowing more routine tasks to be carried out, allowing procedures and techniques to be developed, increasing responsiveness, identifying cost saving measures; advantages to learner e.g. understanding how a business operates, understanding importance of teamwork, learning new techniques, development of problem-solving and time management skills

### 3 Be able to undertake work experience as identified

*Carrying out planned activities:* realisation e.g. carrying out tasks and project work according to relevant legislation, training and codes of practice; developing new procedures and protocols

*Recording activities in the appropriate manner:* systematic and appropriate recording of relevant activities e.g. logbook, diary, portfolio, spreadsheets, databases; list of resources

*Revising initial plans as required:* methods used to review activities at the appropriate time to see if they meet requirements, making alterations as needed

**4 Be able to monitor and evaluate own performance and learning**

*Evaluation of the quality of the work undertaken:* meeting industry standards and evaluating own performance against original proposal; comments/testimony from supervisors

*Account of learning during work experience:* details of experience gained e.g. new procedures, interpersonal skills, time management, problem solving, teamwork; details of evidence e.g. portfolio of evidence, scientific report, management report

*Recommendations on how the learning experience could have been enhanced:* alternative ideas e.g. different location, different brief, different time period, more/less support, better time management, better preparation

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Be able to negotiate industry experience	1.1 research and evaluate suitable organisations that could provide industry experience  1.2 negotiate with work and academic supervisors a proposal for the work experience  1.3 recognise the business constraints on the work experience offered
LO2  Understand the specific requirements of the placement	2.1 agree and prioritise the tasks and responsibilities involved in the work experience  2.2 produce a plan for the work experience  2.3 analyse the benefits of the proposed activities to the business and the learner
LO3  Be able to undertake work experience as identified	3.1 fulfil specified requirements of placement conforming to all related codes of practice  3.2 produce systematic records of work undertaken  3.3 revise the initial plan as required  3.4 make suggestions for improvement and review these with appropriate supervisor
LO4  Be able to monitor and evaluate own performance and learning	4.1 monitor progress against original proposal  4.2 evaluate the quality of own performance  4.3 analyse the learning which has taken place during the work experience using suitable reflections  4.4 make recommendations on how the experience could have been enhanced

## Guidance

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### Links

This unit links with the following units from the Management Standards Centre National Occupational Standards:

- A1: Manage your own resources
- D1: Develop productive working relationships with colleagues
- E8: Manage physical resources
- F1: Manage a project.

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 30: Work-based Learning and Assessment in Construction and the Built Environment*
- *Unit 31: Work-based Training and Development in Construction and the Built Environment*
- *Unit 59: Employability Skills*
- *Unit 60: Personal and Professional Development*
- *Unit 62: Research Project.*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Given the work-based nature of this unit, the majority of resources will need to be available to learners in the workplace. The work will be planned so it is achievable within the resource constraints of the employer. Therefore, knowledge of company structures, daily routines and expectations is essential. Tutor support and guidance are also essential throughout the delivery of this unit.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.



## Unit 64: Railway Track Engineering

**Unit code:** R/503/4530

**QCF level:** 5

**Credit value:** 15

### ● Aim

This unit provides learners with an introduction to some specific engineering techniques and methods used in railway construction and maintenance. It gives an insight into the development and maintenance of the railway system and the interaction between the railway provider; train operating companies and Government.

### ● Unit abstract

In this unit learners will acquire knowledge of the responsibilities of key bodies, such as the Rail Safety and Standards Board relating to the health and safety aspects of rail engineering and the terminology and functions of track construction, including plain track, switches and crossings. They will demonstrate an understanding of methods utilised in the construction of railway earthworks, drainage and track; of track-bed inspection and maintenance.

### ● Learning outcomes

**On successful completion of this unit a learner will:**

- 1 Understand the development of the current UK Railway track system and that of its stakeholders
- 2 Understand the responsibilities of key bodies relating to health, safety and welfare on the UK Railway system with respect to track engineering
- 3 Be able to determine suitable methods for earthworks construction within a Rail context
- 4 Understand track construction techniques, materials, switches and crossings
- 5 Understand methods of track bed inspection and maintenance.

## Unit content

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### 1 Understand the development of the current UK Railway track system and that of its stakeholders

*Causes of growth and decline:* commercial imperatives; the Industrial Revolution; technical innovation and invention; competition; resistance; speed of change and development; rail companies; nationalisation; privatisation

*Current structure:* commercial rail operators – freight and passenger; Network Rail; London Underground Ltd.; Office of Rail Regulation

*Current Issues:* continental links; Channel Tunnel Rail Link (CTRL); efficiency/customer satisfaction; Crossrail; HS2; plans for the future

### 2 Understand the responsibilities of key bodies relating to health, safety and welfare on the UK Railway system with respect to track engineering

*Key bodies:* Rail Safety and Standards Board; Office of Rail Regulation; Health and Safety Executive; Network Rail; Contractors; Train Operating Companies

*Obligations and liabilities:* Track work; Codes of Practice; Individual and Corporate responsibility; Group Standards

### 3 Be able to determine suitable methods for earthworks construction within a Rail context

*Principles of earthmoving:* embankments; cuttings; tunnels; soil characteristics; compaction, stability and erosion control

*Earthworks support and drainage:* Retaining structures – insitu, precast, gabion and reinforced earth; sheet piling; surface and ground water control; drainage of structures; plant and equipment for excavating, lifting, transporting, compacting

### 4 Understand track construction techniques, materials, switches and crossings

*Components:* Rails and rail types; track fastenings, joints, baseplates, pads, sleepers and rail supports, road/rail interfaces; ballast

*New track:* Preparation of new and existing track-bed; laying, shaping and compaction of ballast; laying in new sleepers; rail laying

*Switches and crossings:* Functions; types; terminology; on-site and off-site fabrication; geometry and layout; plant and equipment for plain track, switches and crossings

*Design and alignment:* Longitudinal alignment; horizontal curves; limitations; cant and cant deficiency; transitional curves and spirals; vertical curves and gradients

## 5 Understand methods of track bed inspection and maintenance

*Requirements:* Standard maintenance activities; routine maintenance planning; track assessment and inspection

*Processes:* Stripping existing track; ballast preparation, cleaning, placing, reballasting and compaction; replacing old/loose sleepers; laying new sleepers; plant and equipment for ballast treatment and track laying

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO1  Understand the development of the current UK Railway track system and that of its stakeholders	1.1 Assess the causes of growth and decline of the UK Railway track system.  1.2 Explain the structure of the current UK Railway track system.  1.3 Analyse issues affecting the development of the current UK Railway track system.
LO2  Understand the responsibilities of key bodies relating to health, safety and welfare on the UK Railway network with respect to track engineering	2.1 Explain the responsibilities of key bodies with regard to health, safety and welfare on the rail network in respect of track engineering.  2.2 Discuss the obligations and liabilities of the Train Operating Companies and track contractors in the UK relating to health, safety and welfare.
LO3  Be able to determine suitable methods for earthworks construction within a Rail context	3.1 Critically compare construction methods used for embankments, cuttings and tunnels  3.2 Determine suitable methods for stabilising soils following earthworks  3.3 Evaluate suitable structures to contain and retain earthworks together with related surface and ground water control systems
LO4  Understand track construction techniques, materials, switches and crossings	4.1 Determine the various components required to assemble and construct track so that it is ready for use  4.2 Explain the preparation, laying and ballasting processes for new track  4.3 Explain the processes involved in the design, fabrication and installation of switches and crossings  4.4 Explain the geometrical requirements for longitudinal alignment in the track
LO5  Understand methods of track bed inspection and maintenance	5.1 Explain the requirements of track inspection, assessment and maintenance  5.2 Explain processes involved in track inspection, assessment and maintenance  5.3 Explain processes involved in track, sleeper and ballast replacement

## Guidance

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### Links

This unit links with other BTEC HN Construction and the Built Environment units, for example:

- *Unit 6: Health, Safety and Welfare for Construction and the Built Environment*
- *Unit 27: Site Surveying Procedures for Construction and the Built Environment*
- *Unit 33: Civil Engineering Technology*
- *Unit 37: Advanced Civil Engineering*

The content of this unit has been designed and mapped against the current CIC National Occupational Standards (see attached material) and the current NVQs at levels 4 and 5 (see attached material). Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

### Essential requirements

Learners require access to appropriate IT, library and internet resources, case study material and, where possible, examples of actual organisations in various sectors of the Rail industry.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there

should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.

### Employer engagement and vocational contexts

Whilst site visits would be useful for the delivery of this unit, access to trackside is not easily available due to the required permit and Personal Track Safety systems. However, locations where public access is available such as stations, would allow an examination of track and related installations within a safe context. Visiting speakers from rail companies would enhance the delivery process.



## **Unit 65: Building Information Modelling for Construction and the Built Environment**

**Unit code:** M/508/5551

**QCF level:** 5

**Credit value:** 15

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### ● **Aim**

This unit provides learners with an understanding of the information delivery cycle in Building Information Modelling (BIM) and develops the skills necessary to understand how BIM is able to influence the efficiency of a construction project.

### ● **Unit abstract**

This unit is designed to develop understanding of the emerging technology of BIM in a construction environment. Learners will understand that BIM is a collaborative process wherein modelling technologies with an associated set of processes are used to produce, communicate and analyse building models. The learner will understand that building models can be characterised by building components that are represented by digital objects carrying computable parametric graphic and data attributes that identify themselves to software applications. Hence these building models are able to be manipulated in an intelligent fashion. The learner will also understand that collaboration is the key to the success of a BIM project, enabling it to achieve enhanced building performance and ensuring high quality at lower costs.

Learners will use a variety of three dimensional (3D) modelling software, clash detection software, specialist software and will develop skills to link the building model to analytical tools such as energy, efficiency and sustainability.

### ● **Learning outcomes**

**On successful completion of this unit a learner will:**

- 1 Know the functions and processes needed to manage the lifecycle of a built structure in a Building Information Modelling environment
- 2 Know how to produce data for built structures
- 3 Be able to prepare Building Information Models using industry standard software
- 4 Be able to extract data from prepared Building Information Models to satisfy a number of different requirements.

## Unit content

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### 1 Know the functions and processes needed to manage the lifecycle of a built structure in a Building Information Modelling environment

*Functions and processes:* current industry standards; Building Information Modelling maturity levels; asset information model; employer's information requirements; Building Information Modelling execution plan; master information delivery plan; scope of services stages; levels of model detail required in the Construction Industry Council (CIC) Scope of Services; the importance of soft landings; building assessment – maintain, refurbish, end of use

### 2 Know how to produce data for built structures

*Producing a data model:* two dimensional (2D) plans and three dimensional (3D) models; data exchange; single model access; information delivery – assessment and need; information delivery – procurement; information delivery – post-contract; information delivery – mobilisation; supply chain; production; common data environment; classification systems; producing Construction Operations Building Information Exchange (COBie) neutral spreadsheet information for multi-disciplinary teams; embedding BIM into industry standard Plans of Work

### 3 Be able to prepare Building Information Models using industry standard software

*Prepare a Building Information Model:* levels of model definition; object management; nested components and library information; clash rendition; specialist BIM tools for specific purposes; Computer-aided design (CAD) standards; specifications; bills of quantities; property and attribute handling; parametric modelling; BIM platforms

### 4 Be able to extract data from prepared Building Information Models to satisfy a number of different requirements

*Extract data from a prepared model:* creating specification information; costing schedule; bill of materials; analysing extracted data from a prepared model

## Learning outcomes and assessment criteria

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
<p>LO1</p> <p>Know the functions and processes needed to manage the lifecycle of a built structure in a Building Information Modelling environment</p>	<p>1.1 discuss the levels of BIM maturity and BIM's fundamental principles</p> <p>1.2 analyse the process of BIM generated models used throughout the lifecycle of a building/infrastructure and the provision of a single environment to store shared asset data</p> <p>1.3 discuss the information required at specific stages of a project and the related detail needed within the BIM data to meet these requirements</p> <p>1.4 evaluate the impact and importance of soft landings using currently Publicly Available Specification (PAS) standards and British Standards</p>
<p>LO2</p> <p>Know how to produce data for built structures</p>	<p>2.1 discuss the difference between two dimensional (2D) and three dimensional (3D) methods of displaying information</p> <p>2.2 evaluate structured facility information required for the commissioning operation in a recognised neutral spreadsheet format that can be used by a multi-disciplinary team</p> <p>2.3 discuss the common data environment as a single source of information for multi-disciplinary teams</p> <p>2.4 critically analyse the impact of integrating BIM into industry standard plans of work</p>

<b>Learning outcomes</b>  <b>On successful completion of this unit a learner will:</b>	<b>Assessment criteria for pass</b>  <b>The learner can:</b>
LO3  Be able to prepare Building Information Models using industry standard software	3.1 create building information in a BIM three dimensional (3D) model format  3.2 create BIM objects in a three dimensional (3D) model using specialist BIM tools software  3.3 create a minimum of five parametric objects in a three dimensional (3D) model using specialist software  3.4 solve a minimum of five clash rendition issues
LO4  Be able to extract data from prepared models to satisfy a number of different requirements	4.1 create specification information from extracted data  4.2 analyse the extracted data from a prepared model

## Guidance

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### Links

This unit links with other Pearson BTEC HN Construction and the Built Environment units, for example:

- Unit 1: Design Principles and Application for Construction and the Built Environment
- Unit 7: Construction and Maintenance of Buildings
- Unit 8: Technology of Complex Buildings
- Unit 10: Building Services Design, Installation and Maintenance in Construction
- Unit 12: Conversion and Adaptation of Buildings
- Unit 15: Production Management for Construction
- Unit 16: Measuring, Tendering and Estimating for Construction and the Built Environment
- Unit 24: Design Procedures for Construction
- Unit 29: Computer-aided Design for Construction.

The content of this unit has been designed and mapped against the current CIC National Occupational Standards and the current NVQs at levels 4 and 5. Completion of the learning outcomes will contribute knowledge, understanding and skills towards the evidence requirements of the NVQs.

- See *Annexe B* for summary of mapping information to NVQs.

This unit has also been mapped to illustrate the links to the NQF units.

- See *Annexe D* for summary of mapping information to NQF units.

### Essential requirements

Learners require access to industry standard software in the form of: three dimensional (3D) modelling software, clash rendition software, neutrally based spreadsheet software and suitable analysis software. The analysis tools are not prescriptive and will change and extend as the technology develops.

It is essential that a culture of health and safety is embedded in all the units to ensure that the learners understand the importance and relevance of health and safety issues. Therefore there should be clearly signposted aspects of current legislation and health, safety and welfare implications throughout the delivery and assessment of this unit.