

Unit 10: Surveying in Construction and Civil Engineering

Unit code:	J/600/0224
QCF Level 3:	BTEC Nationals
Credit value:	10
Guided learning hours:	60

● Aim and purpose

The aim of this unit is to enable learners to develop skills in linear and levelling surveys, measuring angles and setting out of small buildings.

● Unit introduction

Land surveying is concerned with the measurement of existing features of the natural and built environment and the presentation of data in a format suitable for architects and engineers to use in the design of construction projects. It plays an important role in the early stages of the design process, and has clear links with the setting out process.

Setting out is the process by which information is taken from construction design drawings to enable pegs, profiles or other marks to be set out to control construction work, and ensure that each element of the work is constructed in the correct position and to the correct level. In some senses setting out is the opposite of surveying, but the instruments and basic principles of measurement and accuracy are the same and people will often work in both disciplines.

This unit is practical, and learners will spend a significant amount of time carrying out fieldwork and producing drawings. There are also opportunities to use electronic instruments and CAD. Learners will need a reasonable standard of arithmetic and trigonometry in order to complete this unit successfully.

Learners will become familiar with basic surveying techniques, be able to carry out simple surveying tasks and present the data, and understand the roles of surveying and setting out in the construction process.

● Learning outcomes

On completion of this unit a learner should:

- 1 Be able to perform linear surveys to produce drawings
- 2 Be able to perform levelling surveys to produce drawings
- 3 Be able to measure angles and produce results from calculations
- 4 Be able to perform the setting out of small buildings.

Unit content

1 Be able to perform linear surveys to produce drawings

Terminology: framework; whole to part; well conditioned; taping; horizontal and slope distances; chainage; running measurements; perpendicular offsets; tie lines; check lines

Equipment: tapes; bands; rules; handheld lasers; ancillary equipment

Calculations: basic arithmetical operations

Drawings: internal or external survey plotted to scale

2 Be able to perform levelling surveys to produce drawings

Terminology: back sight; intermediate sight; fore sight; reduced level; datum; Ordnance Survey Bench Mark; Temporary Bench Mark; height of collimation; rise and fall; fly levelling

Equipment: automatic levels; tilting levels; water levels; rotating lasers; barcode instruments

Calculations: basic arithmetical operations, simple trigonometry

Drawings: spot heights on plans; sections

3 Be able to measure angles and produce results from calculations

Terminology: whole circle bearings; azimuth; horizontal angle; zenith angle; angles of inclination

Equipment: optical square; theodolites

Calculations: addition and subtraction of angles; sine, cosine, tangent; Pythagoras; sine rule; cosine rule

4 Be able to perform the setting out of small buildings

Terminology: plan measurement; check measurement; baseline; profile

Equipment: theodolites; site square; tapes; ancillary equipment

Techniques: set out pegs and profiles to control construction of a small house; constraints on positioning; application of arithmetic and simple trigonometry

Assessment and grading criteria

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

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P1 identify linear surveying terminology		
P2 carry out linear surveys, using appropriate equipment, to produce accurate drawings [IE1, IE2, IE4, CT1, CT5, TW1, TW3, TW4, RL6, SM2, SM3]		
P3 identify levelling surveying terminology IE1, IE2, IE4, CT1, CT5, TW1, TW3, TW4, SM3]	M1 carry out levelling calculations using both height of collimation and rise and fall methods	D1 analyse the methods used for levelling surveys in terms of accuracy
P4 carry out levelling surveys, using appropriate equipment, to produce accurate drawings [IE1, IE2, IE4, IE6, CT1, CT5, TW1, TW3, TW4, SM2, SM3]		
P5 identify angular terminology	M2 use angular measurements and trigonometry to calculate heights and distances	D2 analyse the methods used to take angular measurements in terms of trigonometric accuracy
P6 carry out angular measurements, using appropriate equipment, and calculations [IE1, IE2, IE4, IE6, CT1, CT5, TW1, TW3, TW4, SM2, SM3]		

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P7 identify setting out terminology	M3 set out and check profiles for a small building.	D3 explain the constraints on the positioning of profiles.
P8 set out and check corner pegs for a small building using appropriate equipment and techniques. [IE1, IE2, IE4, CT1, CT5, TW1, TW3, TW4, SM3]		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills which are embedded in the assessment of this unit. By achieving the criteria, learners will have demonstrated effective application of the referenced elements of the skills.

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

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures and supervised practical work will predominate, but the use of personal and/or industrial experience should also be considered. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add to the relevance of the subject but, as mentioned above, this is essentially a practical unit and learners will learn more quickly by doing, rather than by listening.

The four learning outcomes are not linked to each other but there is a natural progression through simple linear surveys, levelling (showing the third dimension), angular measurements and setting out which requires the application of all three of the previous skills.

The unit is practical and provides opportunities for learners to carry out realistic surveying tasks and produce high quality results. The actual form of the tasks will depend on the specialisms of the group and the space and facilities available to the centre.

This unit is likely to be delivered early in the programme, particularly if learners are progressing on to more advanced surveying units.

Group activities are permissible, but tutors will need to ensure that individual learners have equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken before practical activities are taken. Centres are advised to read the *Delivery approach* section in the specification, and *Annexe H: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.

Outline learning plan

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

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

Topic and suggested assignments/activities and/assessment
Introduction to unit
Formal lecture on linear surveying terminology, equipment and instruments, drawings, recording measurements in standard form Demonstrations of linear surveying Visits to sites
Assignment 1: Linear Survey
Formal lecture on levelling surveying terminology, equipment and instruments, drawings, recording measurements in standard form Demonstrations of levelling surveying Visits to sites
Assignment 2: Levelling Survey
Formal lecture on measuring angles terminology, equipment and instruments, drawings, recording angles in standard form Demonstrations of measuring angles Visits to sites
Assignment 3: Measuring Angles
Formal lecture on setting out terminology, equipment and instruments, drawings, recording information in standard form Demonstrations of setting out Visits to sites
Assignment 4: Setting Out
Review of unit and assignment feedback

Assessment

Evidence for this unit may be gathered from a variety of sources, including reports and practical assignments.

There are many suitable forms of assessment that could be used and tutors are encouraged to consider and adopt these where appropriate. Some example assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used, suitable evidence would be observation records or witness statements. Guidance on their use is provided on the Edexcel website.

The structure of the unit suggests that the grading criteria could be addressed fully by using four assignments. The first of these would cover P1 and P2, the second would cover P3, P4, M1 and D1, the third would cover P5, P6, M2 and D2 and the fourth P7, P8, M3 and D3.

To achieve a pass grade learners must meet the eight pass criteria listed in the grading grid.

For P1 and P2, learners must identify linear surveying terminology and carry out linear surveys using appropriate equipment to produce accurate drawings. They must participate in this fieldwork, probably as part of a team, and produce a drawing to a reasonable standard of neatness and accuracy. This drawing should be produced using manual rather than computer-aided design (CAD) techniques in order to demonstrate the achievable accuracies and to avoid the problems of dealing with inaccurate survey measurements in CAD.

For P3 and P4, learners should identify levelling surveying terminology and carry out levelling surveys using appropriate equipment to produce accurate drawings. They must carry out sufficient practical levelling to become reasonably proficient, then carry out a realistic task and produce a section drawing to a reasonable standard of neatness and accuracy. It is acceptable for this drawing to be produced manually or by CAD.

For P5 and P6, learners must identify angular terminology and carry out angular measurements using appropriate equipment and calculations. They must be able to set up and use a theodolite to carry out a practical task requiring measurement of angles and calculations involving degrees, minutes and seconds.

For P7 and P8, learners must identify setting out terminology and set out and check corner pegs for a small building using appropriate equipment and techniques. They must participate in fieldwork to set out the corners of a small building and demonstrate their understanding either through questioning by the tutor or by production of a brief report.

To achieve a merit grade learners must meet all of the pass grade criteria **and** the three merit grade criteria.

For M1, learners must carry out levelling calculations using both height of collimation and rise and fall methods. They must demonstrate proficiency in both methods of levelling calculation and know the standard checks for each method.

For M2, learners must be able to use angular measurements and trigonometry to calculate heights and distances. They must use these principles to calculate inaccessible measurements both in horizontal and vertical planes.

For M3, learners must set out and check profiles for a small building. They must carry this out through fieldwork and demonstrate their understanding either through questioning by the tutor or by production of a brief report.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria **and** the three distinction grade criteria.

For D1, learners must analyse the methods used for levelling surveys in terms of accuracy. They must write a brief report showing an understanding of the methods used. They should recognise common errors and the relationship between the scale of the plan and measurement accuracy, and the availability and suitability of different equipment for performing levelling surveys.

For D2, learners must analyse the methods used in angular measurements in terms of trigonometric accuracy. They must understand the principles of good intersection of lines of sight and the effect of increasing distance on angular error.

For D3, learners must explain the constraints on the positioning of profiles. They must demonstrate understanding of the factors to be taken into account when positioning profiles on a working site.

Programme of suggested assignments

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

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2	Linear Survey	As a trainee surveyor, you have been asked to complete a linear survey on a new build construction site.	Complete set of data, calculations and drawings.
P3, P4, M1, D1	Levelling Survey	As a trainee surveyor, you have been asked to complete a levelling survey on a new build construction site.	Complete set of data, calculations and drawings.
P5, P6, M2, D2	Measuring Angles	As a trainee surveyor, you have been asked to measure angles on a new build construction site.	Complete set of data, calculations and drawings.
P7, P8, M3, D3	Setting Out	As a trainee surveyor, you have been asked to set out a building on a new build construction site.	Building set out accurately with all dimensions correct and all angles right angles. Tutor questions can be used to cover basic knowledge.

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

This unit forms part of the BTEC Construction and the Built Environment sector suite. This unit has particular links with the following unit titles in the Construction and the Built Environment suite:

Level 1	Level 2	Level 3
		Setting Out Processes in Construction and Civil Engineering
		Surveying Technology in Construction and Civil Engineering
		Topographic Surveying in Construction and Civil Engineering

For those learners not taking surveying any further this unit provides a sound understanding of the basic surveying and measurement techniques applicable to many areas of construction. It provides a basis for the more advanced units in surveying including *Unit 12: Setting Out Processes in Construction and Civil Engineering*, *Unit 27: Surveying Technology in Construction and Civil Engineering* and *Unit 28: Topographic Surveying in Construction and Civil Engineering*. It also provides a basis for progression on to study at Higher National and degree level in construction and civil engineering.

This unit links to the Edexcel Level 3 NVQ in Technical Design (Construction Environment), the Edexcel Level 3 NVQ in Construction, Plant and Equipment Supervision and the Edexcel Level 4 NVQ in Construction, Plant and Equipment Management.

The unit also links to the following Level 3 NOS:

- Construction Contracting Operations
- Spatial Data Management
- Transportation.

Essential resources

As a minimum, the instruments required include tape measures, automatic optical levels and digital theodolites, but learners should be made aware of the other instruments mentioned in the unit content and, wherever possible, should have the opportunity to use them. Suitable ancillary equipment such as staffs, tripods and ranging poles will also be required. There should be sufficient instruments available so that during fieldwork teams will be small. Centres will require access to areas of land with a range of topographic and built features where surveying practical work can be carried out safely. Health, safety and welfare issues must be considered at all times and risk assessments undertaken where necessary.

Employer engagement and vocational contexts

Support to enable centres to initiate and establish links to industry, and to networks arranging visits to industry and from property practitioners is given below:

- Learning and Skills Network – www.vocationallearning.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- The Royal Institution of Chartered Surveyors – www.rics.org
- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI University of Warwick) – www.warwick.ac.uk/wie/cei/

Indicative reading for learners

Textbooks

Tutors and learners should be aware that many standard surveying textbooks are at too high level or too theoretical for this unit.

Topliss S, Hurst M and Skarratt G – *BTEC Level 3 National Construction and the Built Environment Student Book* (Pearson, 2009) ISBN 9781846906565

Topliss S, Hurst M and Skarratt G – *BTEC Level 3 National Construction and the Built Environment Teaching Resource Pack* (Pearson, 2009) ISBN 9781846906558

Bannister A, Raymond S and Baker R – *Surveying, 7th Edition* (Prentice Hall, 1998) ISBN 0582302498

Irvine W and MacLennan F – *Surveying for Construction, 5th Edition* (McGraw-Hill, 2005) ISBN 0077111141

Muskett J – *Site Surveying, 2nd Edition* (Blackwell, 1995) ISBN 0632038489

Journals

Civil Engineering Surveyor – Institution of Civil Engineering Surveyors

Geomatics World – PV Publications

New Civil Engineer – Emap

RICS Business – RICS

RICS Construction Journal – RICS

RICS Land Journal – RICS

Websites

www.bconstructive.co.uk

www.ciob.org.uk

www.cskills.org

www.cstt.org.uk

www.ice.org.uk

www.ices.org.uk

www.rics.org

Your future in Constuction

Chartered Institute of Building

Construction Skills

Chartered Surveyors Training Trust

Institute of Civil Engineers

Institution of Civil Engineering Surveyors

The Royal Institution of Chartered Surveyors

Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS opportunities that have been included within the assessment criteria of this unit:

Skill	When learners are ...
Independent enquirers	<p>identifying questions to answer and problems to resolve, planning and carrying out research, appreciating the consequences of decisions, analysing and evaluating information and judging its relevance and value, as they:</p> <ul style="list-style-type: none"> • select equipment • carry out surveys and setting out exercises • perform calculations and check those calculations • produce drawings
Creative thinkers	<p>generating ideas and exploring possibilities, asking questions to extend their thinking, trying out alternatives or new solutions and following ideas through, as they:</p> <ul style="list-style-type: none"> • select equipment • carry out surveys and setting out exercises • perform calculations and check those calculations • produce drawings
Reflective learners	<p>communicating their learning in relevant ways for different audiences, as they:</p> <ul style="list-style-type: none"> • produce drawings • decide which checks to make
Team workers	<p>collaborating with others to work towards common goals, adapting their behaviour to suit different roles and situations including leadership roles, taking responsibility and showing confidence in themselves and their contribution, as they:</p> <ul style="list-style-type: none"> • work with others to carry out surveys and setting out exercises
Self-managers	<p>working towards goals, showing initiative, commitment and perseverance, organising time and resources and prioritising actions, as they:</p> <ul style="list-style-type: none"> • carry out surveys and setting out exercises • perform calculations and check those calculations • produce drawings.

● Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	using CAD systems to produce drawings
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	
Manage information storage to enable efficient retrieval	
Follow and understand the need for safety and security practices	
Troubleshoot	
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	using CAD systems to produce drawings
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> ● text and tables ● images ● numbers ● records 	producing reports and presentations for other learners, tutors and assessment purposes
Bring together information to suit content and purpose	
Present information in ways that are fit for purpose and audience	
ICT – Develop, present and communicate information	
Evaluate the selection and use of ICT tools and facilities used to present information	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	

Skill	When learners are ...
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	
Identify the situation or problem and the mathematical methods needed to tackle it	performing arithmetic and trigonometric calculations to analyse surveying data in preparation for the production of drawings
Select and apply a range of skills to find solutions	performing arithmetic and trigonometric calculations to analyse surveying data in preparation for the production of drawings
Use appropriate checking procedures and evaluate their effectiveness at each stage	performing arithmetic and trigonometric calculations to analyse surveying data in preparation for the production of drawings
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	
Draw conclusions and provide mathematical justifications	
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	