

Unit 10: Surveying in Construction and Civil Engineering

NQF Level 3: BTEC National

Guided learning hours: 60

Unit abstract

Land surveying is concerned with the measurement of existing features of the natural and built environment and the presentation of the data in a format suitable for use by architects and engineers 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 the construction design drawings, to enable pegs, profiles or other marks to be set so as to control construction works, and ensure that each element of the works 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.

People often work in both of these disciplines. The unit is a practical one, and learners will spend a significant amount of time carrying out fieldwork and producing drawings. There are also opportunities for using electronic instruments and CAD. Learners will require a reasonable standard of arithmetic and trigonometry for the successful completion of this unit but these

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

Learning outcomes

On completion of this unit a learner should:

- 1 Understand surveying terminology and be able to use the equipment and instruments typically used to perform linear surveys, record the measurements in a standard form and produce drawings
- 2 Be able to use the equipment and instruments typically used to perform levelling surveys, record the measurements in a standard form and produce drawings
- 3 Be able to use the equipment and instruments typically used to measure angles, record the measurements in a standard form and produce results from calculations
- 4 Be able to perform the setting out of small buildings.

Unit content

- 1 Understand surveying terminology and be able to use the equipment and instruments typically used to perform linear surveys, record the measurements in a standard form and 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; hand-held lasers; ancillary equipment

Drawings: internal or external survey plotted to scale

- 2 Be able to use the equipment and instruments typically used to perform levelling surveys, record the measurements in a standard form and 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

Drawings: spot heights on plans; sections

- 3 Be able to use the equipment and instruments typically used to measure angles, record the measurements in a standard form 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

Grading grid

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

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 carry out linear surveys and produce clear and accurate drawings		D1 analyse the methods used for linear survey in terms of accuracy
P2 carry out levelling surveys and produce clear and accurate drawings	M1 carry out levelling calculations using both height of collimation and rise and fall methods	
P3 carry out angular measurements and produce accurate results from calculations	M2 use angular measurements and trigonometry to calculate heights and distances	D2 analyse the methods used in angular measurements in terms of trigonometric accuracy
P4 set out and check corner pegs for a small building.	M3 set out and check profiles for a small building.	D3 explain the constraints on the positioning of profiles.

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 not be ignored. 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 a very practical one 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 units in surveying.

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

Health, safety and welfare issues are paramount and should be strictly reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken prior to practical activities. Centres are advised to read the *Delivery approach* section on page 24, and *Annexe G: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.

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 employed and tutors are encouraged to consider and adopt these where appropriate. Some examples of possible 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 the use of these is provided on the Edexcel website.

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

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

For P1, learners must carry out linear surveys and produce clear and 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. It is assumed that this drawing will be produced using manual techniques rather than by computer-aided design (CAD) in order to demonstrate the accuracies achievable and to avoid the problems of dealing with inaccurate survey measurements in CAD.

For P2, learners should carry out levelling surveys and produce clear and 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 either manually or by CAD.

For P3, learners must carry out angular measurements and produce accurate results from calculations. They must be able to set up and use a theodolite to carry out a practical task requiring measurement of angles and associated calculations involving degrees, minutes and seconds.

For P4, learners must set out and check corner pegs for a small building. They must participate in the fieldwork to set out the corners of a small building and be able to 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 calculation of levelling 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 do this through fieldwork and be able to 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 linear survey in terms of accuracy. They must write a brief report showing an understanding of the methods used. It is not necessary for learners to understand corrections for catenary, tension or temperature but they should recognise errors from slope measurements and poorly conditioned triangles, the relationship between the scale of the plan and measurement accuracy and the availability and suitability of different equipment for measuring distances.

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 the factors to be taken into account when positioning them on a working site.

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

The learning outcomes in this unit are closely linked with, for example, *Unit 5 Construction Technology and Design in Construction and Civil Engineering*. For those learners not taking surveying any further it provides a sound understanding of basic techniques of surveying and measurement 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 may have links to the Edexcel Level 3 Technical and Professional NVQs for Construction and the Built Environment. Updated information on this, and a summary mapping of the unit to the CIC Occupational Standards, is available from Edexcel. See *Annexe D: National Occupational Standards/mapping with NVQs*.

The unit provides opportunities to gain Level 3 key skills in application of number and working with others. Opportunities for satisfying requirements for Wider Curriculum Mapping are summarised in *Annexe F: Wider curriculum mapping*.

Essential resources

Since this unit is of a very practical nature, centres will require not only a suitable range and quantity of equipment but also suitable areas for carrying out realistic tasks in safety. 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 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 in number.

Centres will require access to areas of land with a range of topographic and built features where the 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.

Indicative reading for learners

Textbooks

Note: The tutor and learner should be aware that many standard surveying textbooks are at too high a level or are too theoretical for this unit.

Bannister A, Raymond S and Baker R – *Surveying, 7th Edition*
(Pearson Higher Education, 1998) ISBN 0582301498

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

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Application of number Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> carrying out angular measurements and producing accurate results from calculations analysing the methods used in angular measurements in terms of trigonometric accuracy. 	<p>N3.1 Plan an activity and get relevant information from relevant sources.</p> <p>N3.2 Use your information to carry out multi-stage calculations to do with:</p> <ul style="list-style-type: none"> a amounts or sizes b scales or proportion c handling statistics d using formulae. <p>N3.3 Interpret the results of your calculations, present your findings and justify your methods.</p>
Working with others Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> carrying out linear surveys and producing clear and accurate drawings carrying out levelling surveys and producing clear and accurate drawings carrying out angular measurements and producing accurate results from calculations setting out and checking corner pegs for a small building setting out and checking profiles for a small building. 	<p>WO3.1 Plan work with others.</p> <p>WO3.2 Work to develop co-operation and check progress towards your agreed objectives.</p> <p>WO3.3 Review work with others and agree ways of improving collaborative work in future.</p>