

Unit 28: Topographic Surveying in Construction and Civil Engineering

NQF Level 3: BTEC National

Guided learning hours: 60

Unit abstract

Topographic surveying is the measurement of existing features of the earth's surface and the presentation of the results. Knowledge of the size, shape and position of natural and manmade features is an essential element in the planning of a wide variety of projects.

Surveyors use a variety of instruments to carry out measurements, which are normally recorded electronically. Measurement data is transferred from the instrument to suitable software for processing and for production of the required drawings. Drawings in digital format can be sent to the client electronically, and are often input directly into their own software for analysis, planning or design of the project.

Surveying is a technologically-advanced discipline and is changing rapidly in terms of instrumentation and the presentation of results. This unit covers the essential techniques for fieldwork and for processing surveying data, and it also allows learners to gain an appreciation of emerging instruments and new forms of presentation.

The professional surveyor must be confident with the underlying mathematics involved in the processing of data, and calculations are therefore an important part of the unit. Learners should have an understanding of trigonometry and basic mathematical principles. The use of spreadsheets for calculations and software for producing drawings is also an important aspect of the unit.

Learning outcomes

On completion of this unit a learner should:

- 1 Be able to carry out control surveys to establish the coordinates of points using standard surveying procedures and calculations
- 2 Be able to carry out control surveys to establish the levels of points using standard surveying procedures and calculations
- 3 Be able to carry out the surveying of land or buildings and produce plans and other products using standard software
- 4 Understand the uses and advantages of emerging technology in control and topographic surveys.

Unit content

- 1 Be able to carry out control surveys to establish the coordinates of points using standard surveying procedures and calculations**

Procedures: traversing; free station

Calculations: polar and rectangular coordinates; adjustment of simple traverses

- 2 Be able to carry out control surveys to establish the levels of points using standard surveying procedures and calculations**

Procedures: fly levelling

Calculations: adjustment of simple levelling networks

- 3 Be able to carry out the surveying of land or buildings and produce plans and other products using standard software**

Land: topographic surveys including hard and soft detail and contours using total stations and standard software

Buildings: measured building surveys including internal and external plans using standard software

- 4 Understand the uses and advantages of emerging technology in control and topographic surveys**

Technologies: global positioning systems; automated total stations; laser scanning

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 describes 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 undertake control surveys and calculate coordinates of stations	M1 adjust simple traverse networks by standard methods	D1 assess the accuracy of simple control networks relative to standard measures and discuss their suitability for purpose
P2 undertake levelling surveys to establish vertical control	M2 adjust simple levelling networks by standard methods	
P3 undertake surveys of either land or buildings using standard survey instruments and produce plans using standard software		
P4 demonstrate an awareness of emerging technology in control and topographic surveying.	M3 specify appropriate instruments and techniques for topographic surveying tasks.	D2 assess the accuracy and effectiveness of new technologies compared to current methods for control and topographic surveying.

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet and/or library resources and the use of personal and/or industrial experience are all suitable. 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 plan control, levelling and topographic surveys. Learning outcomes 1 to 3 are essentially practical. Learning outcome 4 is of a less practical nature but it gives the learner the opportunity to investigate new technologies and relate their use to the practical work they have already carried out.

The unit requires that learners be able to carry out the standard surveying calculations using non-programmable calculators. However, once learners have demonstrated this ability, the use of spreadsheets to carry out repetitive calculations should be encouraged.

The unit provides learners with opportunities to carry out realistic surveying tasks and produce high quality results. This unit is likely to be delivered later in the programme, since a familiarity with the use of surveying equipment and an understanding of basic levelling and angle calculations is assumed.

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 well-planned investigative assignments, case studies or reports of practical assignments.

There are many suitable forms of assessment that could be employed. 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. General guidance on the design of suitable assignments is available on page 19 of this specification.

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, M1 and D1, the second would cover P2 and M2, the third would cover P3 and the fourth would cover P4, M3 and D2.

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

For P1, learners must undertake control surveys and calculate coordinates of stations. They must actively participate in the fieldwork for a traverse survey, calculate angles and distances from the basic observations and be able to carry out calculations of eastings and northings.

For P2, learners must undertake levelling surveys to establish vertical control. They must actively participate in the fieldwork and be able to carry out calculations of levels of stations.

For P3, learners must undertake surveys of either land or buildings using standard survey instruments and produce plans using standard software. They must actively participate in the fieldwork for a topographic survey, carry out calculations of eastings, northings and levels of observed points and produce a plan using survey software and/or computer-aided drawing.

For P4, learners must demonstrate an awareness of emerging technology in control and topographic surveying. They must be able to demonstrate, at the very least, a knowledge of all of the instruments mentioned in the content for learning outcome 4. The evidence should be in the form of a presentation, a report or oral answers to questions posed by the tutor/assessor.

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

For M1, learners must be able to adjust a simple traverse using a standard method of calculation.

For M2, learners must be able to adjust a simple levelling network using a standard method of calculation.

For M3, learners specify appropriate instruments and techniques for topographic surveying tasks. They must be able to discuss the application of these instruments to typical topographic surveying tasks including an explanation of how they are used on modern projects. The evidence should be in the form of a presentation, a report or oral answers to questions posed by the tutor/assessor.

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

For D1, learners must assess the accuracy of simple control networks relative to standard measures and discuss their suitability for purpose.

For D2, learners assess the accuracy and effectiveness of new technologies compared to current methods for control and topographic surveying. They must be able to make reasoned judgements about their appropriateness in terms of cost and site conditions, and demonstrate their understanding of the digital data flow from observation to final product. The evidence should be in the form of a presentation, a report or oral answers to questions posed by the tutor/assessor.

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

This unit provides the skills, knowledge and understanding of topographic surveying required for learners to progress to more advanced surveying or geomatics courses or to work as land surveyors. The learning outcomes in this unit are closely linked with, for example, *Unit 10: Surveying 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, communication, information and communication technology 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 total stations (preferably with on-board data storage) 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.

To meet the requirements of learning outcome 3, learners will need to have access to industry-standard surveying software or alternatively could use spreadsheets and a CAD package to produce the required drawings.

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

Bannister A and Baker R – *Solving Problems in Surveying, 2nd Edition* (Pearson Higher Education, 1994) ISBN 0582236444

Bannister A and Raymond S and Baker R – *Surveying, 7th Edition* (Pearson Higher Education, 1998) ISBN 0582302498

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

Johnson A – *Plane and Geodetic Surveying, 1st Edition* (Spon Press, 2004) ISBN 0415320046

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

Uren J and Price W F – *Surveying for Engineers, 4th Edition* (Palgrave MacMillan, 2005) ISBN 1403920540

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"> adjusting simple traverse and levelling networks by standard methods assessing the accuracy of simple control networks relative to standard measures and discussing their suitability for purpose. 	<p>N3.2 Use this 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>
Communication Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> analysing the accuracy and effectiveness of new technologies compared to current methods for control and topographic surveying. 	<p>C3.2 Read and synthesise information from at least two documents about the same subject.</p> <p>Each document must be a minimum of 1000 words long.</p> <p>C3.3 Write two different types of documents, each one giving different information about complex subjects.</p> <p>One document must be at least 1000 words long.</p>

Information and communication technology Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> • using the internet to help: <ul style="list-style-type: none"> - analyse the accuracy and effectiveness of new technologies compared to current methods for control and topographic surveying - demonstrate an awareness of emerging technology in control and topographic surveying. 	<p>ICT3.1 Search for information, using different sources, and multiple search criteria in at least one case.</p> <p>ICT3.2 Enter and develop the information and derive new information.</p> <p>ICT3.3 Present combined information such as text with image, text with number, image with number.</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"> • undertaking control surveys • undertaking levelling • carrying out surveys of either land or buildings using standard survey instruments. 	<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>