Unit 47: Measurement Techniques in Construction

Unit code: Y/600/0356

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 the skills required to apply measurement techniques to produce a bill of quantities.

Unit introduction

This unit is specifically aimed at learners who aspire to working either as a professional quantity surveyor or a contractor's quantity surveyor.

Measurement is the process of producing quantities for the materials used in a project. These quantities are then abstracted and entered into a bill of quantities. This is then used in the tendering process to obtain quotations from main contractors in the form of a written tender document.

Employer and client organisations use agreed methods of measurement which is the Standard Method of Measurement (SMM7) for construction work and the Civil Engineering Standard Method of Measurement (CESMM) for civil engineering work. These standard methods set out clearly the rules for measuring quantities from the drawings and schedules created by architects and other members of the design team. The reason for employing a standard measurement rule is that each of the main contractors tendering for the work will have an equal chance of winning the tender.

Bills of quantities are the summary documents that quantify the total items measured under the rules, and they follow closely the contents titles of the standard methods of measurement. The main contractor adds their own rate to each quantity to produce a final price for the construction work. This document is also used to prepare interim and final valuations of the work.

The unit has been designed to enable learners studying construction, civil engineering and similar programmes to apply, analyse and measure a range of the components and elements found in buildings and structures to a known and agreed standard.

Learning outcomes

On completion of this unit a learner should:

1 Be able to apply standard measurement techniques

2 Know about the standard methods of measurement

3 Be able to undertake measurement tasks, applying mathematical calculations to the measurement process

4 Be able to produce quantity abstracts and bills of quantities pages of measured works using manual techniques.

Unit content

1 Be able to apply standard measurement techniques

Measurement techniques: initial and/or approximate estimating techniques; production of client's budgets or scheme comparisons; production of contract documentation; measurement of variations; sub-contract and supply chain packages; final account procedures; term maintenance; refurbishment works

2 Know about the standard methods of measurement

Standard methods of measurement: SMM7 (building; building services engineering); CESMM (civil engineering); bill format (bills of quantities, codes, National Schedule of Rates)

3 Be able to undertake measurement tasks, applying mathematical calculations to the measurement process

Measurement tasks: taking off measurements and production of quantities for building (sections of a simple construction project, foundations and substructures, superstructure including external and internal walls, flat and pitched roof construction and coverings, internal and external finishes, internal components such as doors, windows, staircases and floors); taking off measurements and production of quantities for civil engineering (earthworks, cut and fill, drainage, manholes, roadways, simple concrete works, reinforcement)

Mathematical calculations: as appropriate to what is being measured

4 Be able to produce quantity abstracts and bills of quantities pages of measured works using manual techniques

Final summaries: word processed bill of quantities pages; abstracted quantities using spreadsheets

Quantity abstracts and bills of quantities: abstraction; working up; production of bills of quantities; production of final summaries

Production of bill of quantities: abstraction of dimensioned quantities; working up processes involved with these methods, production of a bill of quantities for a simple work section or trade section of a construction or civil engineering project

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 assessment 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 carry out measurement techniques for length area, item, volume and number [IE1, IE4, RL6, SM3]	**M1** produce quantities using dimension paper correctly	**D1** analyse the differences between SMM7 and CESMM in terms of the application of rules for common items
P2 use dimension paper following the take off process [IE1, IE4, RL6, SM3]		
P3 outline the contents of SMM7 [IE1, IE4, RL6, SM3]		
P4 outline the contents of CESMM [IE1, IE4, RL6, SM3]		
P5 produce quantities for a simple low-rise domestic property from substructure and superstructure elements [IE1, IE4, RL6, SM3]	**M2** evaluate the production of quantities in terms of the accuracy and relevance of the information supplied for taking off purposes	
P6 apply mathematical calculations to the measurement process [IE1, IE4, RL6, SM3]		
P7 produce final summaries from quantity abstracts [IE1, IE4, RL6, SM3]	**M3** produce final quantities in a format that can be rated and totalled electronically.	**D2** evaluate the production of accurate quantities using standard estimating software packages.
P8 produce a bill of quantities for one building or civil engineering element. [IE1, IE4, RL6, 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	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Quantity surveying is both a professional and a non-professional role, undertaken for the client's quantity surveyor and the main contractor's quantity surveyor. Architects produce the design, quantity surveyors cost it for the budget and produce quantities for the contractor to price against as part of the tendering process. Often a professional quantity surveyor (PQS) may not be employed and the contractor will have to take off the quantities from drawings and specifications themselves in order to compile a price. The difference between the two types of quantity surveyor, and the different methods of tendering, needs to be made very clear to learners.

A small project or development should be used to assist in the understanding of measurement, in all its forms and by all professionals involved in the construction process. An understanding of the methods of construction and the technology involved is required in order to comprehend the sequence of taking off and what to measure. Access to architects' drawings for low-rise domestic or commercial applications is essential, along with a civil or structural engineer's details of a related project. The construction and technology units therefore provide important prior knowledge.

It is important that learners have access to the main standard methods of measurement and use them where appropriate. These must be current and include amendments where appropriate. The emphasis on one method of measurement or another will depend on whether learners are studying construction or civil engineering programmes.

A site visit to a professional quantity surveyor's office would benefit the learners in observing the current methods of taking off quantities and the production of bills of quantities. This would enable them to place the theory in a real-life context.

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
Unit introduction – why we measure – theory, use of dimension paper-rules Presentation by tutor with take off dimensioning rules exercises by learners
Invited guest speaker – Professional Quantity Surveyor – learners prepare questions to interview the speaker
Production of quantities – centre line method, reinforcement schedules, door schedules, drawings – tutor-led practice assessment
Taking off dimensions from drawn information and the use of booking onto dimension paper – individual learner exercise with tutor guidance
The production of some quantities for construction or civil elements from drawn information to produce units, items, areas, volumes, weights Individual practice exercises **Assignment 1: Introduction to Quantities**
Analysis of the SMM7 – read and understand the development of the SMM7 and its content – individual learner research
Analysis of the CESMM – read and understand the development of the CESMM – individual research
Differences between the two standards – theory and assessment of content to include the differences between civil and construction methods of measurement – tutor-led seminar discussion
Substructure production of quantities from low-rise property – individual practice and assessment
Assignment 2: Performing Measurement Tasks
Superstructure production of quantities from low-rise property – practice and assessment. Tutor example with learner exercises from drawn information
Abstraction of final quantities from dimension paper – presentation by tutor followed by learner exercise abstracting superstructure quantities from previous sessions
Individual practice abstraction from supplied dimensions prepared by the tutor
Assignment 3: The Bill of Quantities
Final completion of all assessments including tutor-directed and learner-centred corrections
Unit review and assignment feedback

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 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.

Evidence can be produced through well-planned assignments and projects. These will usually be undertaken individually but it is possible to introduce elements of teamwork into the collection or collation of data or simulations. Where available, evidence from the workplace can be incorporated to enhance the learning outcomes. This evidence must be appropriate and authenticated as the learner's own work.

The volume of evidence required for each assessment should take into account the overall number of assessments within this unit and the design of the overall teaching programme.

The structure of the unit suggests that the grading criteria could be addressed fully by using three assignments. The first of these would cover data collection and preparation and P1, P2, P3, P4, M1 and D1, the second would cover the standard methods of measurement and P5, P6 and M2, and the third would cover bill production and P7, P8, M3 and D2.

To achieve a pass grade learners must meet the eight pass criteria.

For P1, learners must carry out measurement techniques for length, area, item, volume and number. This is to enable learners to comprehend the mathematics behind the production of quantities.

For P2, learners must be able to use dimension paper following the take off process. This should build on the evidence for P1.

For P3, learners must outline the contents of SMM7. A list of headings and the meaning of each will be sufficient.

For P4, learners must outline the contents of CESMM. A list of headings and the meaning of each will be sufficient. CESMM should be clearly differentiated from SMM7.

For P5, learners must produce quantities for a simple low-rise domestic property from substructure and superstructure elements. The focus is on the use of the accepted standard methods of measurement and the building chosen to support the exercise should not contain any unusual features.

For P6, learners must apply mathematical calculations to the measurement process. If P5 was about using the appropriate processes, P6 is about arriving at the correct answers. These should be generally correct, with all working shown and the correct units used throughout. A limited number of incorrect calculations are acceptable if corrected after feedback from the tutor.

For P7, learners must produce final summaries from quantity abstracts. They must abstract the quantities obtained in previous take offs to produce a final summary sheet for several dimensions and several different work items, using mathematical summary calculations.

For P8, learners must produce a bill of quantities for one building or one civil engineering element. This should be in a suitable format, that is preferentially word processed, to produce a professional document that could be used for tendering purposes.

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

For M1, learners must produce quantities using dimension paper following closely the rules of using dimension paper for the quantities in P1.

For M2, learners need to evaluate the production of quantities in terms of the accuracy and relevance of the information supplied for taking off purposes. This should build on P1, P2, P3 and P4.

For M3, learners have to produce final quantities in a format that can be rated and totalled electronically. This should build on the evidence for P7 and P8.

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 analyse the differences between the two standard methods of measurement and identify several differences in the application of the rules for common items, for example concrete.

To achieve D2, learners must evaluate the production of accurate quantities using standard estimating software packages. This should take the form of a comparison of the advantages and disadvantages of each and an evaluation of the use and purpose of each in specific situations.

Programme of suggested assignments

The following table 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 Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, P4, M1, D1	Introduction to Quantities	The QS on your contract has asked you to undertake a check on some of the quantities before ordering the materials, calculate centre lines, areas, weight of reinforcement and volumes correctly from the information supplied and check these against the QS's quantities. The QS on the project is also not happy with the client's bill of quantities and has asked you to look at the SMM and check that the rules have been applied correctly.	Basic quantities to establish the units required. Report on the rules of measurement.
P5, P6, M2	Performing Measurement Tasks	You have been asked to produce quantities for a simple low-rise domestic property from substructure and superstructure elements.	Accurate measured quantities from graphical information.
P7, P8, M3, D2	The Bill of Quantities	The contracts manager is using your measurement experience on a design and build contract. Produce a small section of a bill of quantities so that the CM can evaluate your expertise.	Abstraction and compilation of a bill of quantities.

Links to 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
		Construction Technology and Design in Construction and Civil Engineering
		Building Technology in Construction
		Measuring, Estimating and Tendering Processes in Construction and the Built Environment

Essential resources

Learners will require copies of the Standard Method of Measurement 7 or the Civil Engineering Standard Method of Measurement. Access to low-rise domestic architects' drawings and small-scale civil engineering projects will also be required. Dimension paper for taking off quantities should also be available.

Employer engagement and vocational contexts

A visiting professional quantity surveyor would place the large amount of theoretical work into an employer framework so that learners can see the value of their output in terms of construction or civil engineering. Using current construction or civil drawings, and a site visit on the same drawn project, would enable learners to establish the accuracy of dimensions taken from drawings when compared to the physical building.

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

Code of Procedure for the Measurement of Building Work SMM7 Measurement Code Revised 2000, 2nd Edition (RICS, 2000) ISBN 97808540636 11

Cartlidge D – *New Aspects of Quantity Surveying Practice* (Butterworth Heinman, 2006) ISBN 9780750668415

ICE – *Civil Engineering Standard Method of Measurement, 3rd Edition* (Thomas Telford, 1991) ISBN 9780727715616

Lee S Trench W and Willis A – *Willis Elements of Quantity Surveying* (Blackwell Publishing, 2005) ISBN 9781405125635

Packer A – *Building Measurement* (Longman Group, 1996) ISBN 9780582098169

RICS – *SMM7 The Standard Method of Measurement of Building Works, 7th Revised Edition* (RICS, 1998) ISBN 9780854063604

Seeley I – *Building Quantities Explained, 5th Edition* (Palgrave Macmillan, 1998) ISBN 9780333719725

Journals

RICS Construction Journal – RICS

Websites

www.rics.org	Royal Institute of Chartered Surveyors
www.ricsbooks.com	Property, Land & Construction Bookshop

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	identifying questions to answer and formulating answers to the calculation of quantities analysing and evaluating the standard methods of measurement, judging the differences between the two
Reflective learners	producing a professional standard for the bill of quantities pages
Self-managers	organising their time and resources in evaluating drawn information producing quantities to an assessment deadline.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Creative thinkers	asking questions related to understanding the differences between SMM7 and CESMM
Team workers	working on dimension practice within a team to achieve a collective goal peer marking progress and evaluating input providing constructive support and feedback to other team members
Effective participators	proposing practical solutions in breaking down a set of drawings into manageable items for individual team members to take off items.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	developing a spreadsheet for the bill of quantities pages which includes the use of formulae
Present information in ways that are fit for purpose and audience	presenting final completed bill of quantities pages
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	understanding the mathematics required to calculate quantities from drawings
Identify the situation or problem and the mathematical methods needed to tackle it	identifying the item to be taken off and the mathematical solution in quantifying that item
Use appropriate checking procedures and evaluate their effectiveness at each stage	checking the calculation of quantities
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	contributing within a team to discussions on the differences between the two standard methods of measurement
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	reading the standard method of measurement to comprehend the rules relating to measuring a work item.