

Unit 42: Commissioning Electrical Installations in Building Services Engineering

Unit code:	R/600/0405
QCF Level 3:	BTEC Nationals
Credit value:	10
Guided learning hours:	60

● Aim and purpose

The aim of this unit is to give learners the opportunity to gain knowledge of the purpose of commissioning electrical installations, and an understanding of the inspection and testing process used to provide reports to gain certification.

● Unit introduction

The commissioning of a newly completed electrical installation requires a series of inspections, preliminary tests and functional tests to be carried out in order to ensure that the installation is safe and will operate to the design specification.

It is also a requirement that any new installation is inspected and tested before connection to the electrical mains supply in order to ensure that it meets current regulatory requirements.

In addition, all existing installations must undergo periodic inspection and testing. This may be a requirement of obtaining and/or maintaining a specific licence, or could be needed for insurance purposes.

The purpose of inspection, testing and commissioning is explored in this unit and learners are introduced to the main processes and procedures involved. These include safe isolation, identification and selection of instruments, methods of testing, certification and reporting.

The need for test results in order to comply with test specification limit values is investigated, together with the actions that should be taken in the event of obtaining unsatisfactory inspection and testing results.

● Learning outcomes

On completion of this unit a learner should:

- 1 Know the requirements for inspection, testing and commissioning of electrical installations
- 2 Understand the inspection process for electrical installations
- 3 Understand how to carry out testing and commissioning operations
- 4 Understand the certification and reporting process.

Unit content

1 Know the requirements for inspection, testing and commissioning of electrical installations

Requirements for inspection, testing and commissioning: new installations; factors to be considered; periodic inspection; sources of information

New installations: initial verification; compliance with regulations; meeting design specifications; safety in use

Factors to be considered: safety precautions; assessment of safe working practice; permit to work; isolation, purpose and usage of systems and equipment; identification of circuits; equipment; test procedures; test instruments; correct methods; relevant data; accurate labelling; recording; contact with relevant parties; customers; clients

Periodic inspection: change of use of buildings; alterations; additions to electrical systems; damage

Sources of information: current British standards; contract specification; distribution and wiring diagrams; schedules; manufacturer instructions; previous test results (if any); relevant statutory legislation

2 Understand the inspection process for electrical installations

Inspection: visual inspection of main intake/switchboard connections; power circuits; lighting circuits; conduit; trunking; cable tray; components; procedure to be followed if inspection results are unsatisfactory

3 Understand how to carry out testing and commissioning operations

Testing and commissioning operations: test methods; instruments

Instruments: multimeter; wattmeter; tong tester; earth loop impedance tester; low-ohm continuity tester; insulation resistance tester; residual current device and prospective short-circuit current tester; approved voltage indicator; proving unit; verifying test instruments; calibration procedure; use of documentary evidence

Test methods: sequence of tests; precautions to be taken; continuity; insulation resistance; polarity; earth fault loop impedance; earth electrode resistance; operation of residual current devices; functional testing; test values; reasons for unsatisfactory results; action to be taken

4 Understand the certification and reporting process

Certification: people responsible for design, testing and construction; electrical installation certificate; schedule of inspection; schedule of test results; minor works certificate; periodic inspection report

Reporting process: report forms; documentation; operation and maintenance manual

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 describe safe isolation procedures [IE2, IE4, IE6, SM2,SM3, SM4]	M1 interpret accurately BS7671 in relation to inspection and testing of electrical installations	D1 evaluate the different electrical systems in a building for compliance with relevant legislation and regulations
P2 state the conditions for periodic inspection [IE2, IE4, IE6, SM2,SM3, SM4]		
P3 list sources of information for inspection and testing [IE2, IE4, IE6, SM2,SM3, SM4]		
P4 discuss the procedure for carrying out visual inspections [IE2, IE4, IE6, SM2,SM3, SM4]	M2 make valid decisions relating to the inspection, testing and commissioning requirements of buildings	
P5 explain the procedure for dealing with unsatisfactory inspection results [IE2, IE4, IE6, SM2,SM3, SM4]		
P6 discuss the suitability of different instruments for specific test procedures [IE2, IE4, IE6, SM2,SM3, SM4]	M3 prepare comprehensive reports on inspection, testing and commissioning procedures	D2 justify the testing and commissioning techniques, equipment and results used in the electrical installations for a given building.
P7 explain how to carry out testing and commissioning operations [IE2, IE4, IE6, SM2,SM3, SM4]		

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:
P8 explain the procedure for dealing with unsatisfactory test results [IE2, IE4, IE6, SM2, SM3, SM4]		
P9 compare different certification processes [IE2, IE4, IE6, SM2, SM3, SM4]	M4 produce clear and accurate answers to the calculations required to verify compliance with BS7671.	
P10 explain the procedure for dealing with report forms and associated documentation. [IE2, IE4, IE6, SM2, SM3, SM4]		

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, discussions, seminar presentations, site visits, supervised practicals, research using the internet and/or library resources and 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.

It is assumed that learners following this unit will be working with, or have experience of, electrical installations within building services. Tutors will need to encourage learners with little knowledge of the IEE Wiring Regulations to undertake a considerable amount of self-study. Individual tutorial support will be a key factor.

This unit can be delivered as a stand-alone package but could also be integrated with other electrical services units to produce a more holistic approach to building services.

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 content
Whole-class teaching – reasons for inspection, testing and functional testing in the commissioning process related to the requirements of BS7671
Whole-class teaching – initial verification of new installations; complying with regulations, meeting the specification, safe to use, safety precautions, assessment of safe working practice, permit to work, isolation, purpose and usage of systems and equipment, identification of circuits, equipment, test procedures, test instruments, correct methods, relevant data, accurate labelling, recording, contact with relevant parties, customers, clients
Whole-class teaching – purpose and conditions for periodic inspection, change of use of buildings, alterations, additions to electrical systems, damage
Individual learner research – sources of information to facilitate inspection and testing, BS7671, contract specification, distribution and wiring diagrams, manufacturers' instructions, relevant statutory legislation
Assignment 1: Requirements for Testing, Inspection and Commissioning
Whole-class teaching – visual inspection process prior to commissioning, main intake/switchboard connections, power circuits, lighting circuits, conduit, trunking, cable tray, components
Practical exercise on carrying out a visual inspection

Topic and suggested assignments/activities and/assessment

Assignment 2: The Inspection Process

Whole-class teaching – instrumentation used: multimeter, wattmeter, tong tester, earth loop impedance tester, low-ohm continuity tester, insulation resistance tester, residual current device and prospective short-circuit current tester, approved voltage indicator, proving unit, verifying test instruments, calibration procedure, use of documentary evidence

Whole-class teaching – methods of testing: sequence of tests, precautions to be taken, continuity, insulation resistance, polarity, earth fault loop impedance, earth electrode resistance, operation of residual current devices, functional testing, test values, reasons for unsatisfactory results, action to be taken

Practical exercise on testing and commissioning

Whole-class teaching – the certification process: person(s) responsible for the design, testing and construction, electrical installation certificate, schedule of inspection, schedule of test results, minor works certificate, periodic inspection report, dealing with report forms, documentation, operation and maintenance manual

Individual learner work to prepare reports from given data

Assignment 3: Testing and Commissioning, Certification and Reporting

Review of unit 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 format is used then suitable evidence would be observation records or witness statements.

Much of the required evidence can be achieved through realistic project work based on electrical installations for real buildings. Learners should complete their evidence for the various aspects of learning in formal, written or computer-produced reports and drawings with, where appropriate, a verbal presentation.

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

To achieve a pass grade learners must meet the 10 pass criteria listed in the grading criteria grid.

For P1, learners must describe safe isolation procedures. There should be reference to safe working practices and permits to work.

For P2, learners must state the conditions for periodic inspection. Evidence should refer to a comprehensive range of situations where this would be necessary.

For P3, learners must list sources of information for inspection and testing and identify items associated with visual inspection prior to commissioning. P3 could be viewed as an extension of P1 and P2. This could include reference to the use of drawings, plans, specifications and equipment schedules.

For P4, learners must discuss the procedure for carrying out visual inspections. Learners do not need to perform visual inspections in order to achieve this criterion, but there must be evidence of understanding what a visual inspection entails. Evidence could be in the form of a written report.

For P5, learners must explain the procedure for dealing with unsatisfactory inspection results. This should relate clearly to the evidence for P4.

For P6, learners must discuss the suitability of different instruments for specific test procedures. The instruments are listed in the unit content and it is anticipated that learners will explain where each is used and state the advantages of each in use. Evidence could be in the form of a written report.

For P7, learners must explain how to carry out testing and commissioning operations as per BS7671 and understand the need to comply with test values. There should be reference to the operations, the proper sequence of operations and the required safety precautions.

For P8, learners must explain the procedure for dealing with unsatisfactory test results. This should relate clearly to the evidence for P7.

For P9, learners must compare different certification processes for a completed installation and the stages of the installation process where certification is required.

For P10, learners must explain the procedure for dealing with report forms and associated documentation. Evidence should differentiate clearly between the purposes of each piece of documentation and describe the purpose of operation and maintenance manuals.

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

For M1, learners must interpret accurately BS7671 in relation to inspection and testing electrical installations.

For M2, learners must make valid decisions relating to the inspection, testing and commissioning requirements of domestic, small commercial and industrial buildings.

For M3, learners must prepare comprehensive reports on inspection, testing and commissioning procedures. This should include the use of installation certificates, schedule of items inspected and a schedule of test results.

For M4, learners must produce accurate answers to the calculations required to verify compliance with BS7671. This should include checking for compliance with voltage drop, shock protection and thermal constraints.

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 evaluate the different electrical systems in a building for compliance with relevant legislation and regulations. This can be demonstrated as a progression from M1, with learners evaluating results and drawing conclusions in relation to compliance with both statutory and non-statutory legislation. Learners should show how a proposed electrical design meets the needs of the building, client and end user in terms of protection from electrical fire, shock and burns.

For D2, learners must justify the testing and commissioning techniques, equipment and results used in the electrical installations for a given building. In justifying the techniques, learners must explain clearly why they used particular methods and what alternative methods could be used.

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 any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, M1, D1	Requirements for Testing, Inspection and Commissioning	The quality control department has requested you to provide a training manual to be used by trainee building services engineers. This comes in three parts. The first part should deal with the requirements for testing, inspection and commissioning. Exemplar calculations should be included throughout.	Report, accompanied by sketches, drawings, graphs, charts, tables, specifications, calculations and text as appropriate.
P4, P5, M2	The Inspection Process	As above, but for the inspection process.	Report, accompanied by sketches, drawings, graphs, charts, tables, specifications, calculations and text as appropriate.
P6, P7, P8, P9, P10, M3, M4, D2	Testing and Commissioning, Certification and Reporting	As above, but for testing and commissioning processes.	Report, accompanied by sketches, drawings, graphs, charts, tables, specifications, calculations and text as appropriate.

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
		Building Services Control Systems
		Electrical Principles in Building Services Engineering
		Electrical Installation Standards and Components in Building Services Engineering
		Electrical Installation Design in Building Services Engineering

This unit links to the Edexcel Level 4 NVQ in Site Inspection. It also links to the following National Occupational Standards at Level 3:

- BE Design
- Construction Contracting Operations.

There are also links with Summit Skills N/SVQ Level 3: Building Services Engineering Technology and Project Management, in particular:

- Unit SST/NOS 5: Monitor Commissioning and Testing Procedures for Building Services Engineering Projects
- Unit SST/NOS 7: Provide Technical and Functional Information to Relevant People.

Summit Skills N/SVQ Level 4: Building Services Engineering Technology and Project Management, in particular:

- Unit SSTE/NOS 11: Commission Building Services Engineering Products After Installation.

Essential resources

Learners will need access to a range of publications, reference data, manufacturers' products/information, approved test instruments and computer facilities. Centres should work closely with major building services contractors in order to add realism and relevance to the project work.

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
- Summit Skills – www.summitskills.org.uk
- 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

Construction Skills – *IEE Regulations Study Notes: BS 7671 – Requirements for Electrical Installation, 17th Edition* (CITB, 2008) ISBN 1 8575 12782

Kitcher C J – *Practical Guide to Inspection, Testing and Certification of Electrical Installations* (Elsevier Science and technology, 2008) ISBN 9781856176071

IEE – *Inspection and Testing, 5th Edition* (IET, 2008) ISBN 9780863418570

Institution of Electrical Engineers – *Requirements for Electrical Installations: IEE Wiring Regulations, 17th Edition* (IEE, 2004) ISBN 09780863418440

Whitfield J – *The Electrician's Guide to the 17th Edition of the IEE Wiring Regulations, 8th Edition* (EPA Press, 2005) ISBN 9780953788552

Journals

Electrical and Mechanical Contractor – Electrical Contractors' Association

Professional Electrician and Installer – Hamerville Magazines Ltd

Websites

www.elecsa.org.uk	Electrical Contractors' Association
www.enginuity.org.uk	Engineering resources
www.jib.org.uk	Joint Industry Board for the Electrical Contracting Industry
www.jtltraining.com	Training in the electrical sector
www.scenta.co.uk	Engineering and technology careers and news
www.sectt.org.uk	Scottish Electrical Charitable Training Trust
www.semta.org.uk	Sector Skills Council for Science, Engineering and Manufacturing Technologies
www.summitskills.org.uk	Sector Skills Council for the Building Services Engineering Sector

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>planning and carrying out research, appreciating the consequences of decisions, analysing and evaluating information, judging its relevance and supporting conclusions using reasoned arguments and evidence, as they:</p> <ul style="list-style-type: none"> ● describe safe isolation procedures ● state the conditions for periodic inspection ● list sources of information for inspection and testing ● discuss the procedure for carrying out visual inspections ● explain the procedure for dealing with unsatisfactory inspection results ● discuss the suitability of different instruments for specific test procedures ● explain how to carry out testing and commissioning operations ● explain the procedure for dealing with unsatisfactory test results ● compare different certification processes ● explain the procedure for dealing with report forms and associated documentation
Self-managers	<p>working towards goals, showing initiative, commitment and perseverance, organising time and resources, prioritising actions and anticipating, taking and managing risks, as they:</p> <ul style="list-style-type: none"> ● describe safe isolation procedures ● state the conditions for periodic inspection ● list sources of information for inspection and testing ● discuss the procedure for carrying out visual inspections ● explain the procedure for dealing with unsatisfactory inspection results ● discuss the suitability of different instruments for specific test procedures ● explain how to carry out testing and commissioning operations ● explain the procedure for dealing with unsatisfactory test results ● compare different certification processes ● explain the procedure for dealing with report forms and associated documentation

● 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 a range of software programs, including internet and intranet resources, in the centre, home or workplace, to produce information for reports and assignments
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	using time management systems in the centre, home or in the workplace
Manage information storage to enable efficient retrieval	opening, using and saving report and assignment files
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	using a range of software programs, including internet and intranet resources, to produce information for reports and assignments at home and in the workplace
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	making decisions to select information for the production of reports and assignments whilst recognising the need for correctly referenced material, the requirements for data protection and avoiding plagiarism
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 	organising and structuring information to produce formatted information for reports and assignments
Bring together information to suit content and purpose	producing formatted information for reports and assignments
Present information in ways that are fit for purpose and audience	presenting information to produce formatted information for reports and assignments
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	using email communication with tutors and/or work colleagues

Skill	When learners are ...
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	analysing calculation data
Identify the situation or problem and the mathematical methods needed to tackle it	performing calculations to support inspection and testing procedures
Select and apply a range of skills to find solutions	performing calculations to support inspection and testing procedures
Use appropriate checking procedures and evaluate their effectiveness at each stage	conducting ongoing analysis of calculated values
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	including answers to calculations in reports and assignments
Draw conclusions and provide mathematical justifications	analysing calculated values in reports and assignments
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	taking part in class discussions and answering questions taking part in workplace-related reviews and presentations to line managers
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching course notes and other documents for information to produce formatted information for reports and assignments. responding to written queries and instructions in the workplace
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	presenting written information in reports and assignments producing written answers to queries and instructions in the workplace