SQA Advanced Unit Specification

General information for centres

Unit title: Inspection and Testing of Low Voltage Electrical Installations

Unit code: HV2L 47

Unit purpose: The purpose of this Unit is to enable candidates to demonstrate knowledge, understanding and competence in testing and inspection of electrical installations.

On completion of the Unit the candidate should be able to:

1. Explain the general requirements for the inspection and testing of an electrical installation during its normal life-cycle.
2. Explain the recommended tests to verify the integrity of an electrical installation.
3. Explain the requirements and precautions for testing electrical installations.
4. Carry out appropriate testing procedures which conform to British Standard requirements.

Credit points and level: 1 SQA Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates.*

Recommended prior knowledge and skills: Candidates should possess a general knowledge and understanding of electrical principles and electrical installation. This may be evidenced by the possession of the SQA Advanced Unit, HP46 47 DC and AC Principles. A knowledge of the requirements of the current edition of the IEE Wiring Regulations (BS7671) would be beneficial. However, entry requirements are at the discretion of the centre.

Core skills: There may be opportunities to gather evidence towards the following listed Core Skills or Core Skills components in this Unit, although there is no automatic certification of Core Skills or Core Skills components:

- Written Communication (reading) at SCQF level 6
- Written Communication (writing) at SCQF level 5
- Critical Thinking at SCQF level 6
- Planning and Organising at SCQF level 5
- Reviewing and Evaluating at SCQF level 5

Context for delivery:. This Unit was developed for the SQA Advanced Certificate and SQA Advanced Diploma in Electrical Engineering awards. If this Unit is delivered as part of another group award, it is recommended that it should be taught and assessed within the subject area of the group awards to which it contributes.

Assessment: The assessment for Outcomes 1, 2 and 3 of this Unit should be combined together into one written assessment paper. This paper should be taken by candidates at one single assessment event that should last one and a half hours. The assessment paper should be composed of a suitable balance of short answer, restricted response and structured questions. This assessment should be conducted under controlled, supervised conditions

Outcome 4 will be assessed by practical exercises, the evidence being recorded using an observation checklist, the production of a short report and the completion of standard test result sheets and an inspection report during the testing procedures. The completion of documentation is extremely important in this Unit and all assessments should be based on the IEE Certificates for Inspection, Testing and Certification of Electrical Systems. These practical exercises should incorporate both a visual inspection of an electrical installation, lasting 30 minutes and a series of installation tests along with the completion of the required certification. The testing and certification section of the exercise should last 60 minutes.

NOTE: the electrical installation should contain a minimum of two faults which must be found during the testing exercise.

The first assessment (Outcomes 1, 2 and 3) should be carried out after delivery of Outcome 3 and the second assessment (Outcome 4) should be carried out at the end of the delivery of this Unit.

It should be noted that candidates must achieve all the minimum evidence specified for each Outcome in order to successfully achieve the Unit.

SQA Advanced Unit Specification: statement of standards

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The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Explain the general requirements for the inspection and testing of an electrical installation during its normal life-cycle.

Knowledge and/or skills

- Methods of initial inspection
- Recommended sequence of initial tests to be carried out
- Reason for periodic inspection and testing
- Procedures to be adopted for alterations and additions to an installation

Outcome 2

Explain the recommended tests to verify the integrity of an electrical installation.

Knowledge and/or skills

- Procedures for testing electrical installations
- The need to measure the maximum prospective fault current and external earth fault loop impedance at the point of origin of the installation.

Outcome 3

Explain the requirements and precautions for testing electrical installations.

Knowledge and/or skills

- The reasons for permit-to-work and sanction-for-test documents being required in certain work environments.
- The reasons for intrinsically safe test instruments being required in potentially explosive environments.
- The use of test instruments and precautions.

Evidence requirements

Evidence for the knowledge and /or skills in Outcomes 1 to 3 will be provided on a sample basis. The evidence may be presented in responses to specific questions. Each candidate will need to demonstrate that she/he can answer correctly questions based on a sample of the items shown under the knowledge and skills items in all three Outcomes. In any assessment of the Outcomes **three out of four** knowledge and/or skills items should be sampled from Outcome 1, **two out of two** knowledge and skills items from Outcome 2 and **two out of three** knowledge and skills items for Outcome 3.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of three out of four knowledge and/or skills items from Outcome 1, and two out of three knowledge and skills items from Outcome 3 are required each time the Unit is assessed. Candidates must provide a satisfactory response to all items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

Outcome 1

- Explain the methods of initial inspection
- List the recommended sequence of initial tests to be carried out
- Describe the reason for periodic inspection and testing
- Explain the procedures to be adopted for alterations and additions to an installation

Outcome 2

- Describe the procedures for testing electrical installations
- Explain the need to measure the maximum prospective fault current and external earth fault loop impedance at the point of origin of the installation.

Outcome 3

- Explain why in certain work environments permit-to-work and sanction-for-test documents are required.
- Explain why in potentially explosive environments intrinsically safe test instruments are required.
- Explain the use of test instruments and precautions.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed book conditions and as such candidates should not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates will be provided with current codes of practice, BS7671 or other relevant legislative documentation for use during the assessment.

Assessment guidelines

The assessment for Outcomes 1 to 3 should be combined together to form one assessment paper. This single assessment paper should be taken at a single assessment event lasting one and a half hours and carried out under supervised, controlled conditions. Such a paper should be composed of an appropriate balance of short answer, restricted response and structured questions. This assessment should be taken after delivery of Outcome 3.

Outcome 4

Carry out appropriate testing procedures which conform to British Standard.

Knowledge and/or skills

- Technical data requirements to enable testing and inspection to take place correctly.
- Safe isolation procedure on a simulated electrical installation
- Visual inspection of an electrical installation
- Testing of an electrical installation
- Schedules of testing results and a periodic inspection report

Evidence requirements

Evidence for the knowledge and/or skills in Outcome 4 will be provided by the candidate carrying out a visual inspection and a series of tests on a simulated electrical installation and completing the required documentation.

This exercise is intended to be undertaken on a simulated installation operating at a safe level of working voltage.

The simulated installation rig(s) should be supplied from a three-phase isolator and feed a single-phase distribution board from which lighting circuits and power circuits are supplied. A three phase motor circuit should be provided for. A residual current device or devices should be included in the design. The design of the rig(s) is not critical but must be such that all the tests can be performed effectively. Different rigs can be used to cover the complete range of tests.

Candidates will be required to carryout the following tests in the sequence prescribed in BS 7671 Part 7:

- Continuity of protective conductors including main and supplementary equipotential bonding
- Continuity of ring final circuit conductors
- Insulation resistance
- Polarity
- Earth electrode resistance
- Earth fault loop impedance
- Prospective fault current
- Residual Current Device (RCD) testing

A total of TWO fault conditions will be built into the test circuits to verify the candidate's ability to interpret the test results obtained. The candidate will be expected to identify the fault results and highlight these in his/her inspection report.

Observation checklists should be used to record the candidate's performance for the inspection and each of the testing procedures.

The candidate should be given the necessary work instructions to carry out the inspection and testing. A selection of the necessary hand tools and a range of test instruments should be provided.
During the tests, the candidate will be expected to record all relevant information and tests results for all circuits on a standard test results sheet and to complete a periodic inspection report.
Safe working practice must be observed throughout the inspection and testing procedure.

Written evidence should be produced to show the candidate's ability to explain the technical data requirements to enable testing and inspection to take place and to outline the safe isolation procedure which will be implemented prior to the testing procedures taking place.

A candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- Explain the technical data requirements to enable testing and inspection to take place correctly.
- Demonstrate a safe isolation procedure on a simulated electrical installation.
- Perform an inspection of the simulated electrical installation
- Perform the listed tests on a simulated electrical installation
- Complete the schedules of testing results and a periodic inspection report

Evidence should be generated through assessment under controlled, supervised conditions. Assessment should be conducted under closed-book conditions and, as such, candidates must not be allowed to bring any textbooks, handouts or notes to the assessment. Candidates will be provided with current codes of practice, BS7671 or other relevant legislative documentation for use during the assessment.

Assessment guidelines

Outcome 4 should be assessed by practical testing exercises on a simulated electrical installation rig(s).

Evidence of the candidate's ability to carry out the inspection and testing procedures should be recorded using observation checklists.

The candidate will also be required to complete the standard test result sheet and an inspection report which should include identification of the two fault condition results.

A report, of approximately 400 words plus diagrams, charts etc, along with completion of a 'Periodic Inspection Report for and Electrical Installation'

(Appendix 6, BS7671), should be produced by the candidate to show his/her ability to explain the technical data requirements to enable testing and inspection to take place and to outline the safe isolation procedure which will be implemented prior to the testing procedures taking place.
The assessment of the Outcome 4 should be undertaken at the end of the Unit.

Administrative Information

Unit code: HV2L 47

Unit title: Inspection and Testing of Low Voltage Electrical Installations

Superclass category: TH

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SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

SQA Advanced Unit Specification: support notes

Unit title: Inspection and Testing of Low Voltage Electrical Installations

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

This Unit has been written in order to allow candidates to develop their knowledge and competence in the following areas:

1. General requirements for the inspection and testing of an electrical installation during its normal life-cycle.
2. Recommended tests to verify the integrity of an electrical installation.
3. Requirements and precautions for testing electrical installations
4. Testing procedures which conform to British Standard requirements

In designing this Unit, the unit writer has identified the range of topics expected to be covered by lecturers. The writer has also given recommendations as to how much time should be spent on each Outcome. This has been done to help lecturers decide what depth of treatment should be given to the topics attached to each of the Outcomes. Whilst it is not mandatory for centres to use this list of topics, it is recommended that they do so since the assessment exemplar pack for this Unit is based on the knowledge and/or skills and list of topics in each of the Outcomes.

A list of topics for each Outcome is given below. Lecturers are advised to study this list in conjunction with the assessment exemplar pack so that they can get a clear indication of the standard of achievement expected of candidates in this Unit

1 Explain the general requirements for the inspection and testing of an electrical installation during its normal life-cycle. (10 hrs)

This Outcome should provide candidate with an understanding of the general requirements for inspection and testing of an electrical installation when it is newly installed, the periodicity of re-inspecting and testing and the action that should be taken if alterations or additions are made. The requirements of part seven of BS7671 provided the technical foundation for developing the subject and the IEE guidance notes on Inspection and Testing (ISBN 0-85296-991-0) develop the regulations.

- Safety
- Required competence
- The Client
- Record keeping
- Purpose of initial verification
- Frequency of subsequent installations
- Initial inspection

Consideration should also be given to the following:
Electrical installation: TN-S; TN-C-S; TT. Nominal voltage 230V and 400V; rating of over current protective devices at the origin of the installation not to exceed 100A; work environment is domestic; commercial and light industrial.

Initial Inspection: connection and identification of conductors; cable routing; current carrying capacity; voltage drop; connection of control devices; connection of accessories; equipment; fire barriers; methods of protection against electric shock; labelling, presence of notices; erection methods; presence of under-voltage protection; adequate access to switchgear and equipment; protection methods for direct and indirect contact; adequate earthing arrangements; selection of equipment and protective measures appropriate to external influences; position of devices for isolation and switching location.

Reasons for periodic testing and inspection; legislative requirements; verification of continued compliance with BS7671; change of ownership or tenancy of premises; alterations or additions to existing installation to change electrical loading.

2 Explain the recommended tests to verify the integrity of an electrical installation (10 hrs)

This Outcome should provide the candidate with an understanding of why the tests are being carried out; the requirements that have to be met to satisfy part seven of BS7671 and the methods of tests that are to be performed.

The Outcome should provide candidates with an understanding of why it is necessary to know the value of the prospective short circuit current and the external earth loop impedance and also provide an explanation of how to approach the measurement of these.

- Purpose of periodic inspection and testing
- Necessity for periodic inspection and testing
- Initial testing

Electrical installation: TN-S; TN-C-S; T.T. Systems

Tests: Continuity of protective conductors main and supplementary bonding, continuity of ring final circuit conductors; insulation resistance; polarity tests; earth electrode resistance; earth fault loop impedance; operation of residual current devices; measurement of characteristics of supply at the origin of the circuit.

3 Explain the requirements and precautions for testing electrical installations (10 hrs)

This Outcome should provide the candidate with an understanding of why safety documentation is essential before work is carried out in organisations that specify permits-to-work and sanction-to-test documents as part of their safety policy. The responsibility of the electrical contractor to comply with safety procedures and the delegation of authorised signatories by the company to the contractor, for safety documents, should be discussed. The need to recognise that intrinsically safe instruments are required in installations designated as hazardous should be emphasised. Reference only is required to the zoning of areas and the types of environment where more specialist testing consideration is necessary.

Relevant requirements of the Health and Safety at Work Act and the Electricity at Work Regulations in an industrial environment, where additional hazards may be present, permits-to-work and sanctions-for-test.

Requirements: instrument accuracy; field and instrument errors; routine calibration and checking of low resistance ohmmeter; insulation resistance ohmmeter; applied voltage tester; earth fault loop impedance testers; earth electrode, test sets; RCD Testers.

4 Carry out appropriate testing procedures which conform to British Standard requirements (10 hrs)

This Outcome should provide the candidate with the opportunity to prepare for inspection and testing and carry out inspection and testing.

The centre will require a simulated test rig(s) to enable the tests specified in the range statement to be carried out effectively. It is recommended that the rig(s) should be supplied from a three-phase isolator and feed a single-phase distribution board from which lighting circuits and power circuits are supplied. A three phase motor circuit should be provided for. A residual current device or devices should be included in the design. The design of the rig or rigs is not critical providing all the tests can be performed effectively. Different rigs can be used to cover the complete range of tests. Observation checklists are required for each of the tests. The candidate should be given the necessary work instructions to carry out the testing. A selection of the necessary hand tools and a range of test instruments should be provided. During the test the candidate will be expected to record all relevant information and tests results for all circuits on an appropriate results sheets; safe working practice must be observed throughout the inspection and testing procedure.

Technical data: available diagrams; charts; previous test results for inspection; test certificates; general characteristics of installation; access to design data (new installation).

Isolation procedure: isolate; lock off; issue permit-to-work; complete permit documentation; test for dead.

Test of external earth loop impedance and prospective short circuit current (PSCC); protective conductors continuity: continuity of ring final circuit conductors; insulation resistance; polarity; Earth fault loop impedance; earth electrode resistance; operation of residual current devices

A candidate-centred learning approach is recommended. Underpinning theory should be reinforced by use of short testing exercises where a hands-on-approach should be encouraged. Throughout the Unit the importance of accurate documentation should be stressed. Safety procedures and practices should be observed at every stage of the unit.

Guidance on the delivery and assessment of this Unit

The purpose of this Unit is to enable candidates to demonstrate knowledge, understanding and competence in the testing and inspection of electrical installations.

The Unit is aimed at those with previous electrical installation knowledge and some knowledge of BS7671.

This Unit was developed within the Options section of the SQA Advanced Certificate and SQA Advanced Diploma in Electrical Engineering awards. It should be seen as being complementary to the SQA Advanced Units Electricity Power Systems, Electrical Safety, Electrical Installation Skills and Electrical Installation Design.

Details on approaches to assessment are given under Evidence requirements and Assessment guidelines under each Outcome in the SQA Advanced Unit Specification: statement of standards section. It is recommended that these sections be read carefully before proceeding with assessment of candidates.

Open learning

This Unit may be delivered by distance learning however, due to the practical nature of Outcome 4, a considerable degree of centre support will be required. With regard to assessment, planning would be required by the centre to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that the assessments were conducted under controlled, supervised conditions.

For information on normal open learning arrangements, please refer to the SQA guide *Assessment and Quality Assurance of Open and Distance Learning* (SQA 2000)

Equality and inclusion

This unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

General information for candidates

Unit title: Inspection and Testing of Low Voltage Electrical Installations

This Unit has been designed to allow you to gain knowledge of the requirements of the16th Edition Wiring regulations (BS7671) inspection and testing techniques and of the test instruments required to carry out these tests. You will gain the opportunity to practice using these instruments and evaluating the test readings taken. In addition, you will be instructed on the mandatory and general requirements for inspection and testing of electrical installations.

You will be supported in developing an understanding of the following topics:

- General requirements for inspection and testing of an electrical installation.
- Periodicity of re-inspection and testing
- Actions to be taken when alterations or additions are made to an electrical installation
- Reason for testing
- How to perform tests as detailed in BS7671
- Test to be performed
- Continuity of protective conductors
- Continuity of ring circuit conductors
- Polarity
- Insulation resistance
- Earth loop impedance
- Prospective fault current
- RCD Test
- Safety documentation (permits-to-work)
- Why use calibrated instruments
- Use of standard test certificates as per Appendix 6 of BS 7671

This Unit is predominantly practical with a strong emphasis on understanding why and how to inspect and test low voltage electrical installations.