

SQA Advanced Unit Specification

General information for centres

Unit title: Electrical Systems in Potentially Explosive and Gas Hazardous Environments

Unit code: HV3K 47

Unit purpose: This Unit is designed to prepare candidates for working on electrical circuits, equipment and systems where the risk exists of explosion due to gas hazardous substances, eg vapours, mists or gasses present in the atmosphere, and which can be ignited from sources of incorrectly installed or maintained electrical equipment. Candidates should interpret current Standards and Codes of Practice in relation to the selection, installation and maintenance of electrical equipment and systems in potentially explosive areas.

NOTE: This Unit does NOT deal with mining applications of explosive processing and manufacture applications.

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

1. Describe the properties of flammable materials and the hazards associated with electrical equipment for use in potentially explosive and corrosive areas.
2. Outline the structure of Standards and Codes of Practice, and explain the certification process and design testing for electrical equipment.
3. Describe the constructional features and installation practices for power electrical equipment designed to provide explosion protection.
4. Explain the operation of intrinsically safe electrical apparatus and associated components designed to provide explosion protection.

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 have a broad knowledge and understanding of the design of electrical power distribution systems, the installation of electrical wiring systems, equipment and cabling and the testing of electrical installations. This may be evidenced by the possession of the following SQA Advanced Units: HT7K 47 Three Phase Systems, HV3L 47 Electricity Power Systems, HV2H 46 Application of Electrical and Electronic Instruments, HV2L 47 Inspection and Testing of Low Voltage Electrical Installations and HV3A 47 Electrical Safety. However, entry requirements are at the discretion of the centre.

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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
- ◆ Using Information Technology at SCQF level 5
- ◆ Critical Thinking at SCQF level 6

Context for delivery: This Unit was developed for the SQA Advanced Certificate and SQA Advanced Diploma in Electrical Engineering awards. If the Unit is to be used in another group award, it is recommended that it be taught and assessed in the context of that particular group award.

Assessment: The assessment for Outcomes 1 and 2 in 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 hour. 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.

The assessment for Outcomes 3 and 4 in 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 hour. 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.

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

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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

Describe the properties of flammable materials and the hazards associated with electrical equipment for use in potentially explosive and corrosive areas.

Knowledge and/or skills

- ◆ Properties and characteristics of vapours and gasses likely to cause explosion.
- ◆ Gas and equipment groupings.
- ◆ Identify hazards likely to cause ignition from electrical and other sources.
- ◆ Definition of hazardous areas.
- ◆ Zone and temperature classifications.
- ◆ Selection of apparatus in relation to zone, temperature class and gas group BS EN 60079-14.
- ◆ Standard methods of explosion protection.
- ◆ Ingress protection index in relation to codes IEC 529 and EN 60529
- ◆ Ingress protection requirements of apparatus.

Outcome 2

Outline the structure of Standards and Codes of Practice, and explain the certification process and design testing for electrical equipment.

Knowledge and/or skills

- ◆ Current standards and codes of practice for the design and use of Ex equipment
- ◆ Test houses and notified bodies
- ◆ The certification process for Ex equipment
- ◆ Confirmation of equipment design to meet the requirements of and compliance with current standards
- ◆ CE marking certification and labelling of equipment.

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Evidence Requirements

Evidence for the knowledge and/or skills of Outcomes 1 and 2 will be provided on a sample basis. The evidence may be provided in response to specific questions. Each candidate will need to demonstrate that they can answer questions based on a sample of the items shown above. In any assessment, **five out of nine** knowledge and/or skills items for Outcome 1 and **three out of five** knowledge and/or skill items for Outcome 2 should be sampled.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of five out of nine and three out of five knowledge and/or skills items is 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

- ◆ Describe the properties and characteristics of vapours and gasses likely to cause explosion.
- ◆ Identify gas and equipment groupings.
- ◆ Identify hazards likely to cause ignition from electrical and other sources.
- ◆ Define the term 'Hazardous Area'.
- ◆ Identify zone and temperature classifications.
- ◆ Select equipment in relation to zone, temperature class and gas group BS EN 60079-14.
- ◆ Describe the standard methods of explosion protection.
- ◆ Describe the ingress protection index in relation to codes IEC 529 and EN 60529
- ◆ Describe the ingress protection requirements of equipment.

Outcome 2

- ◆ Identify current standards and codes of practice for the design and use of Ex equipment
- ◆ Identify notified bodies
- ◆ Describe the certification process for Ex equipment
- ◆ Describe how confirmation of apparatus design to meet the requirements of and compliance with current standards is met.
- ◆ Identify the forms of CE marking certification and labelling of Ex equipment and describe the information contained on equipment labels.

This assessment should be carried out under controlled, supervised conditions. Candidates will be provided with current codes of practice or other relevant legislative documentation for use during the assessment. Candidates must not be allowed to bring any other textbooks, handouts or notes to the assessment.

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Assessment guidelines

The assessment for Outcomes 1 and 2 should be combined together to form one assessment paper. This single assessment paper should be taken at a single assessment event lasting one hour 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 the delivery of Outcome 2.

Outcome 3

Describe the constructional features and installation practices for power electrical equipment designed to provide explosion protection.

Knowledge and/or skills

- ◆ Description of EEx 'd' (Flameproof) protection method including types of flamepath and the methods of containment and suppression of and internal explosion.
- ◆ Description of EEx 'e' (Increased Safety) protection method including the design features and methods to control temperature and eliminate arcing and sparking.
- ◆ Description of EEx 'n' (Non-incentive) protection method including constructional features to control heat, arcing and sparking.
- ◆ Description of EEx 'p' (Pressurised) method of protection including specialist applications for purging and pressurisation.
- ◆ Description of installation techniques including the selection of cable glands and earthing and bonding.

Outcome 4

Explain the operation of intrinsically safe electrical apparatus and associated components designed to provide explosion protection

Knowledge and/or skills

- ◆ Description of operation and use of Zener barrier and Galvanic interface devices including the principle of controlling fault energy levels
- ◆ Explanation of EEx 'i'a and EEx 'i'b (intrinsically safe) protection including the identification of zones of use, advantages and applications.
- ◆ Description of the installation of Zener barrier and Galvanic isolators including the practices for terminating conductors, maintaining earth integrity and the security of system operation.

Evidence Requirements

Evidence for the knowledge and/or skills of Outcomes 3 and 4 will be provided on a sample basis. The evidence may be provided in response to specific questions. Each candidate will need to demonstrate that they can answer questions based on a sample of the items shown above. In any assessment, **three out of five** knowledge and/or skills items for Outcome 3 and **two out of three** knowledge and/or skill items for Outcome 4 should be sampled.

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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 five and two out of three knowledge and/or skills items is 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 3

- ◆ Describe the EEx 'd' (Flameproof) protection method including types of flamepath and the methods of containment and suppression of and internal explosion.
- ◆ Describe the EEx 'e' (Increased Safety) protection method including the design features and methods to control temperature and eliminate arcing and sparking.
- ◆ Describe the EEx 'n' (Non-incendive) protection method including constructional features to control heat, arcing and sparking.
- ◆ Describe the EEx 'p' (Pressurised) method of protection including specialist applications for purging and pressurisation.
- ◆ Describe the techniques for the installation of Ex equipment including the selection of cable glands, earthing and bonding.

Outcome 4

- ◆ Describe the operation and use of Zener barrier and Galvanic interface devices including the principle of controlling fault energy levels
- ◆ Explain the principle of EEx 'i'a and EEx 'i'b (intrinsically safe) protection including the identification of zones of use, advantages and applications.
- ◆ Describe the installation of Zener barrier and Galvanic isolator circuits including the practices for terminating conductors, maintaining earth integrity and the security of system operation.

This assessment should be carried out under controlled, supervised conditions. Candidates will be provided with current codes of practice or other relevant legislative documentation for use during the assessment. Candidates must not be allowed to bring any other textbooks, handouts or notes to the assessment.

Assessment guidelines

The assessment for Outcomes 3 and 4 should be combined together to form one assessment paper. This single assessment paper should be taken at a single assessment event lasting one hour 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 at the end of the Unit.

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Administrative Information

Unit code:	HV3K 47
Unit title:	Electrical Systems in Potentially Explosive and Gas Hazardous Environments
Superclass category:	XJ
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FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our [Centre Feedback Form](#).

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SQA Advanced Unit specification: support notes

Unit title: Electrical Systems in Potentially Explosive and Gas Hazardous Environments

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. Properties of flammable materials and the hazards associated with electrical equipment for use in potentially explosive and corrosive areas.
2. Standards and Codes of Practice, and the certification process and design testing for electrical equipment.
3. Constructional features and installation practices for power electrical equipment designed to provide explosion protection.
4. Operation of intrinsically safe electrical equipment and associated components designed to provide explosion protection

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. Describe the properties of flammable materials and the hazards associated with electrical equipment for use in potentially explosive and corrosive areas. (6 hours)

This Outcome is intended to outline the characteristics of flammable materials and the hazardous which arise from the presence of such materials in an explosive environment where an ignition source may also be present. It is also intended to outline the dangers associated with electrical apparatus in potentially corrosive environments

- ◆ Dangers of electrical equipment in hazardous environments
- ◆ The need for safety and training
- ◆ The hazard triangle
- ◆ Measures to prevent explosion i.e. avoid/minimise flammable substances, avoid release of flammable substances, prevent ignition of explosive atmospheres, control incipient explosions.
- ◆ Characteristics of vapours and gasses

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- ◆ Gas and apparatus groupings
- ◆ Definition of hazardous areas
- ◆ Area zone classifications
- ◆ Ignition sources: electrical sparks, electrical arcs, flames, hot surfaces, static electricity, electromagnetic radiation, chemical reactions, mechanical impact, mechanical friction, compression ignition, acoustic energy, ionising radiation.
- ◆ Temperature classification of apparatus.
- ◆ Properties of equipment relative to selection to BS EN 60079-14.
- ◆ Standard methods of explosion protection.
- ◆ Ingress protection index in relation to codes IEC 529 and EN 60529
- ◆ Selection of equipment in relation to their ingress protection requirements.

2. Outline the structure of Standards and Codes of Practice, and explain the certification process and design testing for electrical equipment. (6 hours)

It is intended that this Outcome provide the candidate with an appreciation of the need for equipment and enclosures to be certified and the requirements of the certification process.

- ◆ Certification test houses BASEEFA 2001, BSI and SIRA.
- ◆ Visible information required on all equipment and components:
 - Manufacturer, model and serial number
 - Code and type of protection, gas group and temperature class
 - Certifying body and certificate number
 - CENELEC and test house symbols
 - Electrical rating
- ◆ Current Standards for manufacture and codes of practice
- ◆ Definition of Certificate
- ◆ Test authorities
- ◆ Component certificates
- ◆ EC Type Examination Certificates
- ◆ Special condition for safe use
- ◆ EEx equipment labelling
- ◆ Samples of certification documents and labels for EEx equipment.

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3. Describe the constructional features and installation practices for power electrical equipment designed to provide explosion protection. (16 hours)

This Outcome is intended to provide candidates with the basic design concepts and installation practices for Power apparatus intended for use in potentially explosive environments. It deals with protection types EEx 'd', EEx 'e', EEx 'n' and EEx 'p'.

- ◆ Principles of explosion protection.
- ◆ Identification of types of protection i.e. EEx 'd' – Flameproof,
EEx 'e' – Increased Safety
EEx 'n' – Non-incendive
EEx 'p' - Pressurised
- ◆ Description of EEx 'd' protection methods.
- ◆ Design features of flameproof enclosures i.e. Strength of construction, flamepath length, gap and form in relation to gas grouping, cable entry threads, surface temperature control, temperature classification, internal components, lid fixing devices, unsuitable components.
- ◆ Flamepaths, flameproof joints, obstruction to flamepaths.
- ◆ Weatherproofing and ingress protection.
- ◆ Integrity of enclosure entries.
- ◆ Cable entry methods (direct and indirect)
- ◆ EEx 'd' inspection and preparation for maintenance.
- ◆ Description of EEx 'e' protection method.
- ◆ Important design features of increased safety protection i.e. Enclosure protection to at least IP54, tests for thermal endurance and impact resistance, terminal design, creepage distances as detailed in BS EN 60079-7, temperature limitation,
- ◆ current de-rating of terminals and conductors, circuit protection requirements.
- ◆ Equipment specifications
- ◆ Factors to control temperature and T classification
- ◆ Factors to eliminate arcing and sparking.
- ◆ EExe inspection and preparation for maintenance.
- ◆ Description of EEx 'n' protection method.
- ◆ Equipment design specifications.
- ◆ EEx 'n' inspection and preparation for maintenance
- ◆ Description of EEx 'p' protection method
- ◆ Description of pressurisation techniques with leakage compensation and continuous flow.
- ◆ Special EEx 'p' applications.
- ◆ General installation considerations: Appropriate construction and certification of apparatus, suitability of Ex protection concept for Zone classification, gas grouping, temperature classification of apparatus, environmental considerations,
- ◆ maintenance requirements, voltage and current ratings, suitability of Ex protected equipment for intended purpose.
- ◆ Installation of EEx 'e' terminal enclosures.
- ◆ Selection of cable glands to current standards and codes of practice.
- ◆ Use of EEx 'd' and EEx'e' certified glands and the applications for barrier/stopping type terminations.

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- ◆ Conduit entries and MICC terminations.
 - ◆ Earthing and Bonding requirements.
- 4. Explain the operation of intrinsically safe electrical apparatus and associated components designed to provide explosion protection. (8 hours)**

This Outcome is intended to provide candidates with knowledge of the concept of explosion protection by the use of intrinsically safe equipment and components (EExi).

- ◆ Description of EEx ‘i’ protection method.
- ◆ Current standards.
- ◆ IS interfacing Zener barrier and Galvanic isolators.
- ◆ EEx ‘i’a and EEx ‘i’b design.
- ◆ Zones of use.
- ◆ Earth integrity.
- ◆ Inductance/capacitance of components and cables.
- ◆ Documentation and compliance with as-built drawings.
- ◆ Earthing of screened type cables with drainwires.
- ◆ Safe termination of unused cables.
- ◆ EEx ‘i’ inspection and preparation for maintenance.

Guidance on the delivery and assessment of this Unit

The Unit has been developed within the Options section of the SQA Advanced Certificate and SQA Advanced Diploma in Electrical Engineering awards. The Unit is intended to be delivered in conjunction with the SQA Advanced Certificate Units: Electricity Power Systems, Application of Electrical and Electronic Instruments, Electrical Safety and Electrical Installation Skills, and in addition to these, the following SQA Advanced Diploma Unit: Electrical Installation Design.

Delivery of this Unit should relate to Current Codes of Practice, legislation and Standards including:

- ◆ The ATEX Directive (94/9/EC, 1999/92/EC)
- ◆ The IP Code BS EN 60529
- ◆ Electrical Installations in Hazardous Areas BS EN 60079-14
- ◆ Dangerous Substances and Explosive Atmosphere Regulations, 2002 (DSEAR)

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.

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Open learning

This Unit may be delivered by distance learning however, this may incorporate some degree of on-line support. However, with regard to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangement would be required to be put in place to ensure that the assessments are 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.

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General information for candidates

Unit title: Electrical Systems in Potentially Explosive and Gas Hazardous Environments

This Unit has been designed to provide you with an opportunity to develop your knowledge and understanding of electrical installations and equipment in potentially explosive and hazardous environments. If you already have some experience of working with installations in such environments, you will be familiar with the principles and concepts of Outcomes 1 and 2 and may even have some knowledge of the protection methods of Outcomes 3 and 4.

The Unit begins by considering the dangers associated with operating electrical plant and equipment in hazardous environments and allows you to develop an appreciation of the factors which come together to create dangerous situations.

The Unit then considers the need for legislation and the requirements for certification of equipment to be used in hazardous environments. It considers the need for information to be readily available to the designers and installers of equipment in such conditions and allows you to develop your knowledge of equipment marking standards and labelling requirements.

An awareness of the constructional features and methods used to protect electrical power equipment and intrinsically safe equipment is then developed and you will be able to develop your knowledge of both these protection methods.

By the end of this Unit you should have a good appreciation of the requirements of electrical plant and equipment suitable for use in potentially explosive and gas hazardous environments and the methods of reducing the risks associated with operating electrical plant in such environments.

The formal assessment of this Unit will consist of two assessment papers, each lasting one hour. These assessments will be conducted under closed book conditions in which you will not be allowed to take notes, textbooks etc into the assessment. You will sit the first assessment (Outcomes 1 & 2) after the delivery of Outcome 2 is complete and you will sit the second assessment (Outcomes 3 & 4) at the end of the Unit