Electrical Installation Fundamentals
Intermediate 2

First edition – published April 2003

National Course Specification

ELECTRICAL INSTALLATION FUNDAMENTALS (INTERMEDIATE 2)

COURSE NUMBER C06C 11

COURSE STRUCTURE

The course has three mandatory units as follows.

D9AF 11	***Fundamental Electrical Principles (Int 2)***	***1 credit (40 hours)***
D9AG 11	***Basic Electrical Installation Systems and Protection (Int 2))***	***1 credit (40 hours)***
D9AH 11	***Basic Electrical Installation Skills (Int 2)***	***1 credit (40 hours)***

In common with all courses, this course includes 40 hours over and above the 120 hours for the component units. This is for induction, extending the range of learning and teaching approaches, support, consolidation, integration of learning, preparation for external assessment and carrying out the project work.

RECOMMENDED ENTRY

Entry to this course is at the discretion of the centre and it may be that no formal pre-entry qualifications are required.

Candidates in possession of the following would find them helpful in studying this course:

- Mathematics and either Technological Studies or Physics at grade 3 standard grade, OR
- Equivalent National Units

Administrative Information

Publication date: April 2003

Source: Scottish Qualifications Authority

Version: 01

National Course Specification: course details

COURSE Electrical Installation Fundamentals (Int 2)

CORE SKILLS

This course gives automatic certification of the following:

Complete core skills for the course	Problem Solving	Int 2
Additional core skills components for the course	Numeracy	Int 2

For more information about the automatic certification of core skills for any individual unit in this course, please refer to the general information section at the beginning of the unit.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

National Course Specification: course details

COURSE Electrical Installation Fundamentals (Int 2)

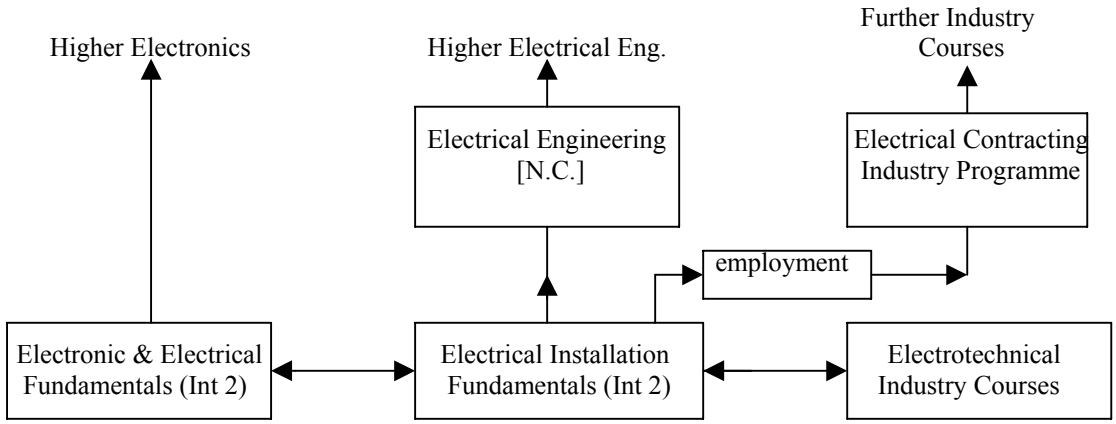
RATIONALE

This course is intended to provide candidates with an introduction to electrical installation knowledge and skills through a candidate-centred approach. It is aimed, primarily, at young people who wish to develop their interest in the field of electrical engineering with the possibility of entering a career in the electrical industry. The skills developed by the candidates, and the underpinning knowledge gained during this course, will give them with a firm foundation which may be further developed through training to an industrial standard. The knowledge and skills acquired during this course would give successful candidates an advantage in gaining a place on the electrical contracting training scheme. This course is also open to more mature persons who have an interest in electrical technology and feel they would benefit from it.

This course may be delivered as one element within a full time college programme and has the advantage that candidates succeeding in this element will be awarded a nationally recognised qualification. The course may also be offered by colleges, to school leavers as a short full-time programme. This would provide the opportunity to study the basics of electrical installation with a view to progressing to an Industry training scheme and into Electrical Contracting. Centres are also encouraged to offer this course to school pupils at S3/4 level who could attend college on a day release basis.

The course has the potential to provide, for the industry, a pool of successful candidates having a proven record during their time at a training centre.
The course may also be used by candidates following a more general engineering programme as a means of providing them with basic electrical engineering knowledge and skills.

Successful candidates may progress from this to other engineering programmes.
A selection of these are shown as follows:



The three course units are designed to form one integrated whole with the knowledge gained from the 'Systems and Protection' unit being underpinned by the relevant 'Electrical Principles' and implemented through the 'Installation Skills' unit.

Health and Safety issues are considered to be of prime importance in the delivery of this course with specific reference to the risks of electrical shock, fire and burn injuries. The relevant safe working practices and regulations will be stressed throughout and candidates will be expected, at all times, to work in a manner which respects their own safety and the safety of others and to comply with all health and safety requirements.

National Course Specification: course details

COURSE Electrical Installation Fundamentals (Int 2)

Test instruments will be used during the course and candidates will learn the correct and safe use of these.

In addition to developing their electrical skills, students will also develop their organisational, communication and study skills and, by this means, their personal development will be enhanced.

The aims of this course are:

- To provide candidates with an introduction to electrical installation work.
- To develop the candidate's awareness of the dangers associated with the use of electricity and the risks of shock, burns and fire (reference to Health and Safety at Work Act).
- To develop the candidate's understanding of how these risks are minimised through appropriate circuit design and the implementation of good practice.
- To develop the candidate's understanding of the design and protection of basic electrical systems.
- To develop the candidate's understanding of the electrical principles related to the design of circuits and their protection.
- To develop the candidate's practical skills and techniques in the installation of basic systems.
- To develop the candidate's understanding of measuring instruments and their use in relation to electrical circuits.
- To contribute to the personal development of candidates.
- To develop the candidate's awareness of electrical installation work as a career.

COURSE CONTENT

The units of this course are designed to be delivered as an integrated whole with 'Fundamental Electrical Principles' being used as a tool to aid the student's understanding of 'Basic Electrical Installation Systems and Protection' and 'Basic Electrical Installation Skills' providing candidates with the opportunity to construct simple installations using the design principles, procedures and good practice developed.

It is NOT the intention of this course to produce electricians or persons capable of installing electrical systems since the ability to do this requires years of study and practice under the supervision of competent practitioners. The role of this course is limited to being introductory only and further study and experience is necessary before competence in the skills of electrical installation can be attained.

Every opportunity should be taken to provide practical experiences for the candidates during the delivery of this course. Design and tutorial examples should not be of a theoretical nature but should use 'real' situations and values. Candidates should participate in practical workshop and laboratory activities and their motivation should be stimulated through a 'hands-on' approach which will encourage them to develop further their interest in electrical installation as a career.

Further information on careers in Electrotechnical engineering may be found on the NET web site: www.net-works.org.uk

National Course Specification: course details

COURSE Electrical Installation Fundamentals (Int 2)

Summary of Course Content

Fundamental Electrical Principles (Int 2)
This unit has been designed to provide candidates with the fundamental principles required to underpin their understanding of basic electrical installation systems and their design. It deals initially with the concept of current flow and the need for, and properties of, basic electrical circuits. It considers the relationships between current, voltage and resistance, the connection of load devices and the use of instruments.

This unit forms a base of knowledge which the student can apply to the technical specialisms of the other units.

CONTENT STATEMENTS

Fundamental Electrical Principles (Int 2)
The content statements given in the left-hand column of the table below describe in detail what the candidate should be able to do in demonstrating knowledge and understanding. The right-hand column gives suggested contexts, applications, illustrations and activities associated with the content statements.

	Knowledge and Understanding	***Contexts, applications, illustrations and activities***
1	Know the concept of current flow as the rate of electron flow through a conduction material	Discussion of electron theory of current flow
2	Know the concept of the conventional current flow direction	Explanation of the conventional flow direction being opposite to that of electron flow
3	Know the electrical characteristics of conducting and insulating materials	Practical investigation
4	Understand the need for both conducting and insulating materials in electrical engineering	
5	Know the types and applications of various conducting and insulating materials	Examples of various practical conductors and insulators
6	Know the concept of energy as the ability to perform work	Examples of various energy types i.e. chemical, mechanical, electrical, light, heat, etc.

National Course Specification: course details

COURSE Electrical Installation Fundamentals (Int 2)

	Knowledge and Understanding	*Contexts, applications, illustrations and activities*
7	Know that electricity is a form of energy	
8	Know common units of Power and Energy	Units of Watt, kilowatt, joule and kWhr.
9	Know the basic function of an electrical circuit as a means of delivering energy to a load device	
10	Know that energy transfer needs to be controlled	
11	Describe the component parts of an electric circuit	Examples of various simple circuits with control devices
12	Know the circuit load device as a means of converting electrical energy into another form	
13	State examples of load devices and their energy conversion processes	Examples of load devices i.e. motor, heater, lamp, etc and the energy output from each
14	Know the concept of Power as the rate of energy change	Examples of the energy/power relationship
15	Calculate current ratings for given power values of practical load devices	
16	Connect measuring instruments in circuits	Laboratory experiments
17	Measure circuit current, voltage and power	Laboratory experiments
18	Know the relationships between current, voltage, resistance and power in a series-parallel arrangement of resistors connected to a d.c. supply	Laboratory experiments
19	Calculate the values of voltage, current, resistance and power in a series-parallel arrangement of resistors connected to a d.c. supply	Tutorial work and Laboratory experiments
20	Calculate the voltage drop over circuit cables for given load power ratings	Tutorial work

Summary of Course Content

Basic Electrical Installation Systems and Protection (Int 2)
This unit has been designed to introduce candidates to the basic electrical installation circuit and the protection of electrical circuits. It gives an overall appreciation of the generation and supply of electrical energy and indicates typical values of generation and transmission voltages. Typical types of circuit protection devices are identified and an appreciation given of the dangers and risks associated with the use of electricity. Wiring arrangements are interpreted for various lighting and power circuits.

This unit provides candidates with the theory of installation design and protection which they will implement in the practical skills unit.

National Course Specification: course details

COURSE Electrical Installation Fundamentals (Int 2)

CONTENT STATEMENTS

Basic Electrical Installation Systems and Protection (Int 2)
The content statements given in the left-hand column of the table below describe in detail what the candidate should be able to do in demonstrating knowledge and understanding. The right-hand column gives suggested contexts, applications, illustrations and activities associated with the content statements.

Knowledge and Understanding	*Contexts, applications, illustrations and activities*
1 Know various methods of generating electrical energy.	
2 Know typical generating and transmission voltage values.	Draw diagrams to show typical transmission systems with voltages indicated
3 Know the sequence of control equipment at the consumer's intake point	Draw diagrams to show control sequence
4 Know the function of the consumer's control equipment	Describe the function of each item of control equipment
5 Know the purpose of earthing within the electrical installation	Describe earthing arrangements
6 Know the dangers of electricity and the risk of electric shock	Examples of how a person can become part of an electric circuit and the effects of increasing values of electric shock current Videos to show the dangers of electric shock
7 Know the devices used for the protection against over-current and shock	Manufacturer's information sheets. BS 7671
8 Draw circuit diagrams for 1-way and 2-way controlled lighting circuits	Diagrams of 1-way and 2-way lighting circuits using both loop-in and joint box methods
9 Draw circuit diagrams for radial power circuits	Diagrams for socket-outlet, immersion heater, cooker and shower circuits
10 Determine standard cable and protective device ratings for given loads	Use manufacturer's literature etc.
11 Convert circuit diagrams, for power and lighting circuits, to wiring diagrams.	Draw diagrams of lighting and power circuits to convert one diagram form to the other

Summary of Course Content

Basic Electrical Installation Skills (Int 2)
This unit has been designed to introduce candidates to the basic electrical installation techniques and equipment required to effectively assemble a range of accessories to form practical lighting and socket outlet power circuits. It considers the use of diagrams and how these are used for interpreting information and includes an outline of suitable safety regulations.

This unit brings together the work of the other units in the Course and develops the candidate's skills in building a practical electrical installation.

National Course Specification: course details

COURSE Electrical Installation Fundamentals (Int 2)

CONTENT STATEMENTS

Basic Electrical Installation Skills (Int 2)

The content statements given in the left-hand column of the table below describe in detail what the candidate should be able to do in demonstrating knowledge and understanding. The right-hand column gives suggested contexts, applications, illustrations and activities associated with the content statements.

Knowledge and Understanding	***Contexts, applications, illustrations and activities***
1 Identify control measures to ensure safe systems of work	Outline hazards in a workshop environment.
	1. Working at height *Control measures* • Slips, trips and falls • Supervision Safe Access and Egress • Housekeeping • Step ladders • Waste material disposal 2. Electricity • Reduced Voltage • Enclosures • Isolation
2 Know the difference between circuit diagrams and wiring diagrams	Tutorial supported by practical project
3 Identify electrical accessories and equipment required for lighting and socket outlet power circuits	Demonstrations supported by practical projects Manufacturer's catalogues
4 Recognise electrical symbols and their applications	Layout diagrams and their functions. Relate symbols to electrical accessories
5 State the type, application and installation method of wiring systems to be installed	Tutorial and practical exercises Example where systems are installed • sheathed cables • plastic conduit enclosures and accessories • plastic trunking enclosures and accessories
6 Recognise the tools required to install electrical systems (1st fix and 2nd fix)	Example in use of tools to enforce effective application when installing wiring systems
7 Identify good electrical installation techniques and match them to the requirements of the practical projects	• Identification of conductors • Protection from mechanical damage • Terminating procedures: screwing and crimping • Earthing: connections and sleeving • Circuit protection

National Course Specification: course details (cont)

COURSE Electrical Installation Fundamentals (Int 2)

Knowledge and Understanding	*Contexts, applications, illustrations and activities*
8 List the basic principles of electrical safety	Shock and fire protection • Standard cable types and sizes • Earthing function: expose metalwork, main earthing terminal • Consumer switchgear: protective devices
9 List types of electrical faults	• Loss of supply • Cable termination – open circuit • Insulation failure – short circuit • Overload or fault/m.c.b. or fuse operating • Equipment failure
10 Perform testing and fault finding procedures on systems installed	Demonstration and practical activity • Isolation • Continuity checks: earth and polarity • Insulation tests • Take measurements and record results • Open circuit and short circuit faults
11 Know the difference between incandescent filament lamps and discharge fluorescent luminaries. Filament lamp caps. Luminaire selection	Demonstrations supported by diagrams Applications outlined • Tungsten filament • Fluorescent tube • Edison screw • Bayonet cap
12 Understand the minimum requirements for a final circuit	Integrate within practical project • Supply source • Cables • Load • Protection • Control

ASSESSMENT

To gain the award of the course, the candidate must pass all the unit assessments as well as the external assessment. External assessment will provide the basis for grading attainment in the course award.

When the units are taken as component parts of the course, candidates may have the opportunity to achieve a level beyond that required to attain each on the unit outcomes. This attainment may, where appropriate, be recorded and used to contribute towards course estimates and to provide evidence for appeals. Additional details are provided, where appropriate, with the exemplar assessment materials. Further information on the key principles of assessment is provided in the paper *Assessment* (HSDU 1996) and in *Managing Assessment* (HSDU 1998)

National Course Specification: course details (cont)

COURSE Electrical Installation Fundamentals (Int 2)

DETAILS OF THE INSTRUMENTS FOR EXTERNAL ASSESSMENT

The external assessment will comprise a practical project which will be assessed according to the appropriate criteria. The total time allocation for the course is 160 hours with each of the course units being allocated 40 hours. The remaining 40 hours should focus on ensuring that candidates have the skills necessary to carry out the project work and on the completion of the project, since this forms the external assessment. Approximately 10 hours should be allowed for the preparation of candidates to undertake the project and the remaining 30 hours should be used for candidates to carry out the project and produce their assessment evidence. This means that the time allowed for completion of the course assessment is approximately 30 hours of 'supervised' time with any additional work being carried out in the candidate's 'own time'.

The project specification should be completed by all candidates and evidence provided for external assessment. This evidence should be presented in three sections as follows

- planning
- developing
- evaluating

Planning

Candidates must produce a 500 word (or equivalent) plan of action. The plan should include an introduction and the main body. Centres should ensure that candidates have, or are taught, the necessary skills to devise their own plan before they start the project.

NOTE: It should be stressed that the use of diagrams, drawings, tables, calculations and/or other graphical illustrations will be counted towards the 'equivalence' of the word count and candidates should be encouraged to take advantage of this.

For the introduction of the plan candidates should:

- provide a rationale for selecting a particular brief
- interpret the brief
- gather information to clarify the brief
- define the aims and objectives of the Practical Assignment

For the main body of the plan candidates should:

- identify information sources
- identify materials and resources
- establish timescales for completion of stages of the Practical Assignment

The plan of action should be produced in a supervised environment although candidates may carry out the preparation beforehand. Candidates may communicate with each other when producing their plans of action but each plan must be tailored to the candidate's own project and the action points should relate to the work to be carried out by the individual candidate.

The work produced should always be the candidate's own. However, teachers/lecturers are expected to provide candidates with advice, guidance and constructive criticism as necessary when they are devising their plans. It is important to note that, as the plan underpins the rest of the project, centres should ensure that no candidate proceeds to the development stage until that candidate has devised a plan that is potentially workable. The level of support that candidates need to devise a viable plan of action will, of course, vary from candidate to candidate. Centres should indicate the level of support needed for each candidate on the flyleaf for the project provided by SQA. This should not inhibit centres from providing constructive comment nor candidates from acting on their own initiative and taking on board the advice. In some cases, however, if the level of support and intervention needed is more than that which would normally be seen as reasonable, the authenticity of the candidate's work may be called into question.
If the level of input needed from the teacher/lecturer is above normal (for example, the quality of the plan is such that it would mean the project would be unworkable if the plan was not revised) then the candidates cannot score more than 20 of the 40 marks allowed for the planning stage.

Developing

Candidates must provide evidence that:

- testifies to the quality of the practical activity
- documents the processes underpinning the activity

Specific evidence requirements for this Course are given below.

All of the evidence should be produced in a supervised environment. Candidates may communicate with each other but should produce work which can be clearly attributed to the candidate as being his/her own.

Evaluating

Candidates must produce an extended evaluation report which should:

- provide a brief summary of what the assignment was about
- review and update the action plan in the light of experience
- assess the effectiveness of the action plan
- summarise any unseen events and how they were handled
- identify knowledge and skills which have been gained and/or developed
- assess the strengths, weaknesses and quality of any hands-on activity
- assess the effectiveness of the research methods used
- determine to what extent the assignment met the original brief

The evaluation report should be 500 words (or equivalent) at Intermediate 2. Candidates at Intermediate 2 should be allowed up to 1 hour 30 minutes to complete an evaluation (including the summary). Candidates should be allowed to take one side of an A4 page of notes (maximum of 200 words or equivalent allowed) which they have prepared, into the room with them. The centre has the responsibility for ensuring that the notes brought in are the candidate's own work.

For this activity the accommodation should be arranged to reflect centre-invigilated conditions and candidates should not be allowed to communicate with each other in any way.

NOTE: As with the 'Planning' stage, it should be stressed that the use of diagrams, drawings, tables, calculations and/or other graphical illustrations will be counted towards the 'equivalence' of the word count and candidates should be encouraged to take advantage of this.

National Course Specification: course details (cont)

COURSE Electrical Installation Fundamentals (Int 2)

Specific evidence requirements and assessment arrangements for the Practical Assignment for Electrical Installation Fundamentals at Intermediate 2

Planning	
Evidence:	Plan of action: 500 words **or** equivalent (40 marks)
Conditions of external assessment:	Supervised
Who assesses it?	Send to SQA for marking after initial marking in Centre

Developing	
Evidence:	For hands-on activity and for processes underpinning the activity: Portfolio of: Risk Assessment (10 marks) BS3939 symbols and cable routes including (5 marks) Circuit and wiring diagrams (10 marks) List of accessories and materials including cable list (10 marks) Breakdown/sequence of activities (10 marks Good installation practice points observed (30 marks) Determination of cable sizes and rating of protective devices (10 marks) Earthing arrangements (10 marks) Tests required (15 marks) Test results (10 marks) (120 marks allocated for this stage)
Conditions of external assessment:	Supervised
Who assesses it?	Transportable evidence: All portfolio Send to SQA marking after initial marking in Centre

Evaluating	
Evidence:	Evaluation report – including summary. 500 words **or** equivalent (40 marks)
Conditions of assessment:	Centre-invigilated
Who assesses it?	Send to SQA for marking after initial marking in Centre

It is important that candidates know that they will be penalised for submitting evidence that significantly exceeds the stated word count.

GRADE DESCRIPTIONS

The grade of award A, B or C will be based on the detailed criteria set out in the 'Project Specification' document. The descriptions given below indicate the nature of the achievement which is required for the award of grades A, B, and C in the course assessment. They are intended to assist candidates, teachers, lecturers and users of the certificate and to help establish standards when project work is being undertaken.

National Course Specification: course details (cont)

COURSE Electrical Installation Fundamentals (Int 2)

Grade Descriptions for a Practical Assignment at Intermediate 2

A	B	C
Content and scope appropriate for Intermediate 2		
And looking at the evidence as a whole:	**And looking at the evidence as a whole:**	**And looking at the evidence as a whole:**
A practical assignment at Grade A: • produces **high** quality, **clearly** inter-related documented and process or product-related evidence for the three essential phases of planning, developing and evaluating • is an exercise to which candidates have brought an **accurate** and **enthusiastic** interpretation of the practical assignment brief • is **tightly** structured, relevant to the content of the Units and displays a **high** level of subject/occupational expertise • applies integrated and consolidated knowledge, understanding and skills **effectively** and **consistently** from course Units to situations and/or design specifications with varying degrees of complexity	**A practical assignment at Grade B:** • produces **good** quality, inter-related documented and process or product-related evidence for the three essential phases of planning, developing and evaluating • is an exercise to which candidates have brought an **accurate** and **fairly innovative and enthusiastic** interpretation of the practical assignment brief • is **well** structured, relevant to the content of the Units and displays a **good** level of subject/occupational expertise • applies integrated and consolidated knowledge, understanding and skills **fairly effectively** and **consistently** from course Units to situations and/or design specifications with varying degrees of complexity	**A practical assignment at Grade C:** • produces **adequate fairly well** inter-related documented and process or product-related evidence for the three essential phases of planning, developing and evaluating • is an exercise to which candidates have brought an **acceptable** interpretation of the practical assignment brief • is **reasonably well** structured, relevant to the content of the Units and displays an **adequate** level of subject/occupational expertise • applies integrated and consolidated knowledge, understanding and skills from course Units with **some lack of continuity and consistency**

National Course Specification: course details (cont)

COURSE Electrical Installation Fundamentals (Int 2)

APPROACHES TO LEARNING AND TEACHING

It is important to stress that this course should be taught as an integrated whole rather than as three separate stand-alone units. Some sequential delivery will inevitably be required however and teachers/lecturers should appreciate the need to teach the basic principles and design theory at an early stage to give candidates an appreciation of these technical issues before being required to implement them in a practical manner. Every opportunity should be taken to integrate concepts where possible across the three course units.

Candidates may wish to take separate units on a stand-alone basis and the delivery of these should be suitable to meet the needs of the individual. It is permissible for candidates to build up their achievement of the course units over a period of time. In such a case, units may be credited on an individual basis provided the unit achievement conditions are achieved. The Course award may only be achieved, however when the candidate has satisfied the requirements of the three unit assessments and the external project assessment for the course.

Candidates wishing to progress to higher studies will be required to develop abilities in Mathematics at grade 3 Standard Grade and are advised to complete appropriate units in Mathematics concurrently with this course.

The course units *Fundamental Electrical Principles (Int 2)* and *Basic Electrical Installation Systems and Protection (Int 2)* should be taught, as far as possible, in a workshop/laboratory environment so that the principles and concepts of the course content may beset in the context of practical installation work. The unit *Basic Electrical Installation Skills (Int 2)* should be taught entirely in a practical workshop environment in such a way that the theory and principles of all the units are implemented in developing the candidate's skills and awareness of the reasons behind installation design and implementation.

Health and Safety issues MUST be given a prominent position in the delivery of practical skills and candidates must be aware, at all times, of their responsibilities in this regard. Health and Safety issues must include as awareness of, not only the dangers of electricity, but also more general issues regarding safety and good practise in a workshop environment.

Candidates will be required to produce reports and written evidence in relation to their project assessment and it would be advantageous for their report-writing skills to be developed during the course.

With reference to all three units, it would be appropriate to use computer simulation to reinforce the teaching/learning process.

National Course Specification: course details (cont)

COURSE Electrical Installation Fundamentals (Int 2)

COURSE DELIVERY/ASSESSMENT RATIONALE

Introduction:

It has been stressed throughout that the THREE course units, i.e.

- **Fundamental Electrical Principles (Int 2)**
- **Basic Electrical Installation Systems and Protection (Int 2)**
- **Basic Electrical Installation Skills (Int 2)**

Should be taught as an integrated whole rather than as stand-alone units.
In addition to this the external project should be conducted at the same time as these units are being delivered to candidates.

This guidance information is an attempt to give one possible means of linking the units and the assessment together in order to ensure that candidates progress through the course in a logical and integrated manner.

It is accepted that, for logistical or other reasons, centres may not find it possible, or desirable, to link the course elements in this way however, this suggestion will go some way to ensuring that candidates gain best advantage from the course.

Underpinning Principle:

In order to provide a stimulus for candidates, this course should be taught in a workshop environment and the work should revolve round the central unit 'Basic Electrical Installation Skills'. This gives the course a truly hands-on emphasis and allows the other supporting topics to be introduced as required. The content of the units ' Fundamental Electrical Principles' and 'Basic Electrical Installation Systems and Protection' should be seen as underpinning the 'skills' unit and providing the necessary breadth of knowledge to give a better understanding of the Electrical Installation Industry.

The following 'mapping' grid illustrates how the various units and the project could be linked together.

Assessment:

The assessment instruments are built into the course at strategic points to provide both an measure of the candidate's understanding and a point of progress feedback for the candidate.

Assessment instruments are also shown on the mapping grid.

National Course Specification: course details (cont)

COURSE Electrical Installation Fundamentals (Int 2)

Mapping Grid (See Unit and Project Specifications)

Seq. No.	Skills.	Princ.	Inst.	Project	Assess.
1	Hazards and control measures	Concept of current flow	Generation and ac waveforms		
2	Equipment selection	Conducting and insulating materials	National Grid system		
3		Function of electrical circuit	Transmission/ Distribution voltage values		
4		Loads as energy-converting devices			
5			Control Gear arrangements	Planning: Introduction	
6	Assembly and installation		Function of control gear	Planning: Info. Sources Aims and objectives Identify Stages	
7	Interpret diagrams and symbols		Purpose of Earthing	Planning: Set time-scales Progress recording methods	Inst. Outcome 1
8	Safety practices		Dangers of electricity	Developing: Risk Assessment	Skills: Outcome1
9	Test instrument selection	Purpose of measuring instruments		Developing: Site plan Circuit and wiring diagrams	
10		Connection of instruments		Developing: Materials lists	
11		Use of instruments		Developing: Activities list	
12		Ohms Law relationship		Developing: Good Inst. Practice points	
13		Volt drop across conductors		Developing: Calcs. Earthing arrangements	
14	Record test readings	Power and current ratings of loads	Over-currents and their dangers	Developing: Explanation of required tests	
15	Compare and confirm test values	Series-parallel circuit relationships	Earth-fault currents	Developing: Test results	Princ: Outcomes 1 and 3 a,b,c
16	Correct circuit function		Protective devices for over-current and earth fault	Evaluating: Progress, problems etc.	Princ: Outcomes 2 & 3d
17	Identify circuit faults		Wiring arrangements for lighting circuits	Evaluating: Changes and planning	Inst: Outcome 2
18			Wiring arrangements for power circuits	Evaluating: Skills and knowledge gained	Skills: Outcome 2
19				Evaluating: Brief interpretation /questions	Inst: Outcome 3
20				Evaluating: Was project successful?	

National Course Specification: course details (cont)

COURSE Electrical Installation Fundamentals (Int 2)

SPECIAL NEEDS

This course specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, 2001).

National Unit Specification: general information

UNIT Fundamental Electrical Principles (Intermediate 2)

NUMBER D9AF 11

COURSE Electrical Installation Fundamentals (Intermediate 2)

SUMMARY

This unit has been designed to provide candidates with the fundamental principles required to underpin their understanding of basic electrical installation systems and their design. It deals initially with the concept of current flow and the need for, and properties of, basic electrical circuits. It considers the relationships between current, voltage and resistance, the connection of load devices and the use of instruments.

OUTCOMES

1 Interpret the requirements of basic electrical circuits.
2 Use instruments to measure current, voltage, resistance and power in d.c. networks.
3 Determine the relationships between current, voltage and resistance in d.c. networks.

RECOMMENDED ENTRY

While entry to this unit is at the discretion of the centre, candidates would normally be expected to have attained one of the following:

- Mathematics and either Technological Studies or Physics at Grade 3 and 4 (General level) Standard Grade
  OR
- Equivalent National Units

Administrative Information

Superclass: XJ

Publication date: March 2003

Source: Scottish Qualifications Authority

Version: 01

National Unit Specification: general information (cont)

UNIT Fundamental Electrical Principles (Intermediate 2)

CREDIT VALUE
1 credit at Intermediate 2 (6 SCOTCAT points*) at SCQF level 5.

*SCOTCAT 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 SCOTCAT points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.

CORE SKILLS
There is no automatic certification of core skills or core skills components in this unit.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

National Unit Specification: statement of standards

UNIT Fundamental Electrical Principles (Intermediate 2)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1
Interpret the requirements of basic electrical circuits.

Performance criteria
a) The concept of current as the rate of electron flow through a conducting material is correctly stated.
b) The characteristics and applications of electrical conducting and insulating materials are correctly determined.
c) The concept of a basic electrical circuit as a means of transmitting and controlling the transfer of energy from a source to a load device is correct.
d) The use of loads as energy-conversion devices is correctly determined.

EVIDENCE REQUIREMENTS
The candidate should be presented with restricted response questions to assess the recall of knowledge and the understanding of circuits as arrangements of conductors and insulators which permit electrical energy to be transmitted safely from a source to a load device.

The assessment could consist of 10 restricted response questions to be allocated as follows:

1	Electron theory of current flow	2 questions
2	Conducting and insulating materials	2 questions
3	Applications of conducting and insulating materials	2 questions
4	Function and component parts of the electric circuit	2 questions
5	Function of a load device and energy conversion	2 questions

Satisfactory achievement of the outcome will be based on the candidate producing correct responses to SEVEN out of TEN questions as shown for the various assessment sections:

Section 1: ONE correct out of TWO responses
Section 2: TWO correct out of TWO responses
Section 3: TWO correct out of TWO responses
Section 4: ONE correct out of TWO responses
Section 5: ONE correct out of TWO responses.

National Unit Specification: statement of standards (cont)

UNIT Fundamental Electrical Principles (Intermediate 2)

OUTCOME 2
Use instruments to measure current, voltage, resistance and power in d.c. networks.

Performance criteria
a) The identification of instruments to measure electrical quantities is correctly determined.
b) The determination of the connections of the ammeter, voltmeter, ohmmeter and wattmeter is correct.
c) The use of measuring instruments to determine current, voltage, resistance and power is correct.

Evidence requirements
The candidate should be given an assignment designed to measure the ability to connect instruments in a circuit and to take accurate readings of current, voltage, resistance and power in a circuit supplying a practical resistive load device.

The assignment would require the candidate to:
- Choose the appropriate instrument for measurement of the appropriate load property
- Correctly connect the instrument
- Accurately take the appropriate measurement.

Write a report on the assignment including the need for instruments.

The exercise should be carried out in conjunction with a suitably constructed checklist covering all aspects of the practical elements of the assignment.

Satisfactory achievement of the outcome will be based on the candidate producing a satisfactory report on the assignment and a checklist record which shows that all elements of the PCs are achieved.

OUTCOME 3
Determine the relationships between current, voltage and resistance in d.c. networks.

Performance criteria
a) The determination of the relationship between current, voltage and resistance in a d.c. circuit is correct.
b) The determination of voltage drop across circuit conductors is correct.
c) The determination of power and current ratings of practical load devices is correct.
d) The determination of current, voltage and resistance relationships in a series-parallel resistive d.c. network is correct.

National Unit Specification: statement of standards (cont)

UNIT Fundamental Electrical Principles (Intermediate 2)

Evidence requirements

i) PC (d)

The candidate should be given an assignment designed to measure the ability to determine the relationships between current, voltage and resistance in a d.c. resistive network.
The assignment could require the candidate to make measurements of current, voltage and resistance within a network comprising FOUR resistors, of known value, connected as a series-parallel network across a known d.c. supply.
The candidate will be required to:

- Use the ohmmeter to measure the actual resistance values of the resistors to be connected
- Connect the resistors, and measuring instruments, in the given d.c. network configuration
- Apply the required input voltage and measure the volt drops within the network
- Measure the branch and supply currents of the network
- Calculate the network resistance from the known resistance values
- Calculate the supply and circuit currents using the known resistance and supply voltage values
- Calculate the network volt drops using the known resistance and supply voltage values
- Write a report confirming the relationships between the measured and calculated values of current and voltage.

The exercise should be carried out in conjunction with a suitably constructed checklist covering all aspects of the practical elements of the assignment.

ii) PCs (a, b, c)

The candidate should be presented with restricted response questions to assess the recall of knowledge and the understanding of the relationship between current, voltage and resistance in a d.c. circuit and the determination of current and power ratings of practical load devices.

The assessment could consist of 8 restricted response questions to be allocated as follows:

1	Ohm's Law relationship and cable volt-drop calculations	3 questions
2	Power relationships $P = I^2R$, V^2/R, VI watts and calculations	5 questions

Satisfactory achievement of the outcome will be based on the candidate producing:

1 A satisfactory report on the assignment and a checklist record which shows that all elements of PC (d) are achieved and
2 A satisfactory response to FIVE out of EIGHT questions as follows. An incorrect response should be considered as one which shows a lack of understanding rather than one caused by a trivial arithmetic error.

Section 1: TWO correct out of THREE responses
Section 2: THREE correct out of FIVE responses.

NOTE: The restricted response questions of Outcomes 1 and 3 (a, b, c) may be combined into one Assessment Instrument. Also, the laboratory assignments of Outcomes 2 and 3 (d) may be combined into one Assessment Instrument.

National Unit Specification: support notes

UNIT Fundamental Electrical Principles (Intermediate 2)

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

It is recommended that you refer to the SQA Arrangements Document for the Intermediate 2 Electrical Installation Fundamentals course before delivering this unit.

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

This unit will provide candidates with the fundamental principles required to underpin their understanding of basic electrical installation systems and their design. It is aimed at young people and adult returners, who wish to enter the electrical contracting industry and/or to progress to further studies in Electrical Installation or Electrical Engineering.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

Appropriate units, symbols and unit-symbols should be used throughout.

Outcome 1

Elementary approach to the electron theory of current flow.
Conventional direction of current flow.
The characteristics of conducting and insulating materials in relation to their ability to permit electron (current) flow.
The need for both conducting and insulating materials in electrical engineering.
Types and applications of various conducting and insulating materials and a comparison of their characteristics.
The concept of 'electricity' as a form of energy.
The unit of energy as the joule, kilowatt hour etc.
The concept of a basic electrical circuit as a means of transmitting electrical energy to a load device.
The need for the energy transfer process to be controlled.
The component parts of a basic circuit to include a source, load, conductors, insulation, switch.
The concept of a load as an energy conversion device.
Examples of practical load devices to provide energy conversion from electrical to heat, mechanical, light etc. energy.

Outcome 2

The need to make measurements of electrical quantities i.e. current, voltage, resistance and power, in a circuit.
The units of current, voltage, resistance and power as the ampere, volt, ohm and watt respectively.
The ammeter as an instrument for measuring current in a circuit.
The concept of the measured current flowing through the ammeter and the need for a series connection.
The voltmeter as an instrument for measuring the voltage across a component.
The concept of measured voltage being across the voltmeter and the need for a parallel connection.
The concept of resistance as an opposition to current flow.
The ohmmeter as an instrument for measuring resistance.
The concept of power as the rate of change of energy.
The concept of power as a function of current and voltage.
The wattmeter as an instrument for measuring load power.

UNIT Fundamental Electrical Principles (Intermediate 2)

The wattmeter as an instrument having two measuring elements i.e. a series element to measure current and a parallel element to measure voltage.

Use of instruments in practical circuits to measure electrical quantities, including the use of instrument scales.

Outcome 3

Relationship between current, voltage and resistance in a d.c. circuit i.e. $I = V/R$.
Practical investigations to verify the Ohm's Law relationship.
The concept of practical circuit conductors having resistance.
The concept of volt drop across practical conductors when carrying current.
The implication of conductor volt drop on the effectiveness of energy conversion by means of a load device.
Calculation of power and current ratings of practical load devices $P = VI$, $P = I^2R$, $P = V^2/R$.
Calculation of current, volt drops, resultant resistance in a series connected resistive circuit.
Current relationship in a series circuit i.e. I is common to all series components.
Voltage distribution relationship in a series circuit i.e. $V = V_1 + V_2 + V_3$ etc.
Resistance relationship in a series circuit i.e. $R = R_1 + R_2 + R_3$ etc.
Practical investigations to verify series circuit relationships.
Calculation of supply and branch current, branch volt drops, resultant resistance in a parallel connected resistive circuit.
Current distribution in a parallel network i.e. $I = I_1 + I_2 + I_3$ etc.
Voltage relationship in a parallel network i.e. V is common across all branches.
Resistance relationship in a parallel network i.e. $I/R = I/R_1 + I/R_2 + I/R_3$
Practical investigations to verify parallel network relationships.
Calculation of supply and branch currents, volt drops, resultant resistance in a series-parallel connected resistive circuit.
Current distribution in a series-parallel network.
Voltage distribution in a series-parallel network.
Resistance relationships in a series-parallel network.
Practical investigations to verify series-parallel network relationships.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Laboratory investigations should be used wherever possible to determine and reinforce the relationships between current, voltage and resistance in d.c. networks.

Circuit relationships should be discussed and calculations used to reinforce an appreciation of these relationships.

The concepts of power and energy should be discussed and related to meaningful examples which convey the function of electrical engineering as a means of transmitting energy and converting it into various forms for the benefit of society.

Reference should be made throughout the delivery of this unit to the other units in the Electrical Installation Fundamentals course and these units should not be taught in isolation.

National Unit Specification: support notes (cont)

UNIT Fundamental Electrical Principles (Intermediate 2)

The use of ammeters, voltmeters ohmmeters and wattmeters should be demonstrated and practical exercises devised to provide candidates with experience in connecting these in circuits and taking accurate readings. The use of instrument ranges.

Knowledge and Understanding	*Contexts, applications, illustrations and activities*
1 Know the concept of current flow as the rate of electron flow through a conduction material	Discussion of electron theory of current flow
2 Know the concept of the conventional current flow direction	Explanation of the conventional flow direction being opposite to that of electron flow
3 Know the electrical characteristics of conducting and insulating materials	Practical investigation
4 Understand the need for both conducting and insulating materials in electrical engineering	
5 Know the types and applications of various conducting and insulating materials	Examples of various practical conductors and insulators
6 Know the concept of energy as the ability to perform work	Examples of various energy types i.e. chemical, mechanical, electrical, light, heat, etc.
7 Know that electricity is a form of energy	
8 Know common units of power and energy	Units of watt, kilowatt, joule and kWhr
9 Know the basic function of an electrical circuit as a means of delivering energy to a load device	
10 Know that energy transfer needs to be controlled	
11 Describe the component parts of an electric circuit	Examples of various simple circuits with control devices
12 Know the circuit load device as a means of converting electrical energy into another form	
13 State examples of load devices and their energy conversion processes	Examples of load devices i.e. motor, heater, lamp, etc and the energy output from each
14 Know the concept of power as the rate of energy change	Examples of the energy/power relationship
15 Calculate current ratings for given power values of practical load devices	
16 Connect measuring instruments in circuits	Laboratory experiments
17 Measure circuit current, voltage and power	Laboratory experiments
18 Know the relationships between current, voltage, resistance and power in a series-parallel arrangement of resistors connected to a d.c. supply	Laboratory experiments
19 Calculate the values of voltage, current, resistance and power in a series-parallel arrangement of resistors connected to a d.c. supply	Tutorial work and laboratory experiments
20 Calculate the voltage drop over circuit cables for given load power ratings	Tutorial work

National Unit Specification: support notes (cont)

UNIT Fundamental Electrical Principles (Intermediate 2)

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Examples of instruments of assessment that could be used for each outcome are given below.

Outcome 1

A number of restricted response questions to assess the recall of knowledge and understanding of the basic function and component parts of a simple electric circuit. This would include questions on the characteristics of the circuit components and the concept of current flow.

Outcome 2

The candidate could be given an assignment designed to measure the ability to connect instruments in a circuit and to take accurate readings of current, voltage, resistance and power in a circuit supplying a practical load device.

The exercise could be carried out in conjunction with a suitably constructed checklist covering all aspects of the practical elements of the assignment.

Satisfactory achievement of the outcome would be based on the candidate producing a satisfactory report on the assignment and checklist record which shows that all elements of the PCs are achieved.

Outcome 3

Two types of assessment instrument could be used for this outcome:

i) The candidate could be given an assignment designed to measure the ability to determine the relationships between current, voltage and resistance in a d.c. resistive network.
The assignment could require the candidate to make measurements of current, voltage and resistance measurements within a network comprising FOUR resistors, of known value, connected as a series-parallel network across a known d.c. supply.
The exercise could be carried out in conjunction with a suitably constructed checklist covering all aspects of the practical elements of the assignment.

ii) A number of restricted response questions to assess the recall of knowledge and the understanding of the relationship between current, voltage and resistance in a d.c. circuit and the determination of current and power ratings of practical load devices.

Satisfactory achievement of the assignment would be based on the candidate producing: a satisfactory report on the assignment and a checklist record which shows that all elements of PC (d) are achieved.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering special alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, publication code AA0645/3).

National Unit Specification: general information

UNIT Basic Electrical Installation Systems and Protection (Intermediate 2)

NUMBER D9AG 11

COURSE Electrical Installation Fundamentals (Intermediate 2)

SUMMARY

This unit has been designed to introduce candidates to the basic electrical installation circuit and the protection of electrical circuits. It gives an overall appreciation of the generation and supply of electrical energy and indicates typical values of generation and transmission voltages. Typical types of circuit protection devices are identified and an appreciation of the dangers and risks associated with the use of electricity. Wiring arrangements are interpreted for various lighting and power circuits.

OUTCOMES

1 Identify the stages of transfer of electrical energy.
2 Identify the types of protective devices used for overload and short circuit protection.
3 Interpret electrical circuit diagrams for 1 way and 2 way switching for lighting circuits and radial power circuits.

RECOMMENDED ENTRY

While entry to this unit is at the discretion of the centre, candidates would normally be expected to have attained one of the following:

- Mathematics and either Technological Studies or Physics at Grade 3 and 4 (General level) Standard Grade
  OR
- Equivalent National Units

Administrative Information

Superclass: XJ

Publication date: March 2003

Source: Scottish Qualifications Authority

Version: 01

National Unit Specification: general information (cont)

UNIT Basic Electrical Installation Systems and Protection (Intermediate 2)

CREDIT VALUE
1 credit at Intermediate 2 (6 SCOTCAT points*) at SCQF level 5.

*SCOTCAT 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 SCOTCAT points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.

CORE SKILLS
There is no automatic certification of core skills or core skills components in this unit.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

National Unit Specification: statement of standards

UNIT Basic Electrical Installation Systems and Protection (Intermediate 2)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1
Identify the stages of transfer of electrical energy.

Performance criteria
a) A knowledge of the nature of the generation of ac waveforms and their significant values is correctly displayed.
b) A knowledge of the National Grid System is correctly displayed.
c) The voltages for all the stages from generation through to the customer's installation are correctly produced.
d) The arrangements of control gear for a domestic installation consumer's intake position are accurately sketched.
e) The function of each component of the intake position equipment is correctly stated.
f) The purpose of earthing within an electrical installation is clearly described.

EVIDENCE REQUIREMENTS
The candidate could be given a graphical/written, objective/short answer exercise where the candidate displays an understanding of the generation of ac waveforms, its r.m.s. and peak values and demonstrates the ability to calculate the frequency of the waveform. A knowledge of the National Grid System and the order and voltages of the stages to the consumer will be accurately determined. The candidate will also be asked to identify the order of a consumer's intake position equipment and to explain the function of each piece of equipment shown in a given diagram.

Satisfactory achievement of the outcome will be based on giving the correct responses to all of the exercise.

OUTCOME 2
Identify the types of protective devices used for overload and short circuit protection.

Performance criteria
a) The dangers of electricity are clearly recognised.
b) The types of over-currents that can occur within electrical installations and their associated dangers are correctly identified.
c) The term earth fault current is correctly explained.
d) Devices used in electrical installations to protect against over-current and earth fault currents are correctly identified.

Evidence requirements

The candidate could be given an objective type exercise or a structured question to test the comprehension of the types, causes and dangers associated with over-currents, the types of over-current and shock protection devices.

One of the questions will ask the candidate to recognise a number of different types of protective devices. To achieve this part, the centre must supply the following devices for the candidate to physically handle. These are: miniature circuit-breaker, cartridge fuse holder and residual current device.

Satisfactory achievement of the outcome will be based on giving the correct responses to all of the exercise.

OUTCOME 3

Interpret electrical circuit diagrams for 1 way and 2 way switching for lighting circuits and radial power circuits.

Performance criteria

a) The wiring arrangements for a 1 way and 2 way lighting circuit, using the loop-in and joint box wiring methods, are drawn using the correct colour codes for cables and are labelled correctly with standard cable sizes and protective device which conform to accepted standards.

b) The wiring arrangement for a radial power circuit are drawn using the correct colour codes for cables and are labelled correctly with standard cable sizes and protective device which conform to accepted standards.

Evidence requirements

The candidate could be given a written exercise to test his/her knowledge by producing wiring arrangements for each circuit. The candidate must also be able to show an understanding of the circuits' applications and relevant British Standards.

Satisfactory achievement of the outcome will be based on giving the correct responses to all of the exercise.

National Unit Specification: support notes

UNIT Basic Electrical Installation Systems and Protection (Intermediate 2)

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

It is recommended that you refer to the SQA Arrangements document for the Intermediate 2 Electrical Installation Fundamentals course before delivering this unit.

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

This unit will establish a foundation of electrical installation systems and circuits. It is written for electrical craft candidates but could also be used for craft candidates from other technology related backgrounds.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

Outcome 1

Methods of generation.
Generation, transmission and distribution voltages.
The correct sequencing of the equipment at a consumer's intake position (supply and neutral link, kWh meter, isolation switch, consumer unit; what each piece of equipment provides.
The purpose of earthing.

Outcome 2

Forms of protection against over-current and shock used in a domestic consumer unit (semi-enclosed fuse, cartridge fuse, m.c.b and r.c.d).
The construction, operation, typical current ratings of protection devices.
The concept of earthing.

Outcome 3

The production of wiring arrangements for 1 way and 2 way lighting systems using singles and multi-core cables in a loop-in and joint box wiring system.
Cable sizes; protective device ratings of circuits for lighting circuits.
The production of wiring arrangements for a basic power radial circuit; socket outlet circuit.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Film/Video and discussions should be used on the methods of generation and how the electricity is transmitted to customers.

Physical examples of the intake position and discussion should be used to generate information on the customer's equipment at these positions.

Discussions, physical examples of and videos should be used to introduce the types of protective devices used and their advantages and disadvantages.

Discussions and practical workshop exercises reinforce the wiring of lighting circuits.

Discussions and practical workshop exercises to reinforce the wiring of the radial circuits.

National Unit Specification: support notes (cont)

UNIT Basic Electrical Installation Systems and Protection (Intermediate 2)

Knowledge and Understanding	*Contexts, applications, illustrations and activities*
1 Know various methods of generating electrical energy	Videos and technical literature to show the different types of fuels used to generate electricity
2 Know typical generating and transmission voltage values	Draw diagrams to show typical transmission systems with voltages indicated
3 Know the sequence of control equipment at the consumer's intake position	Draw diagrams to show the sequence of the equipment at a consumer's intake point
4 Know the function of the consumer's control equipment	Describe the function of each item of control equipment
5 Know the purpose of earthing within an electrical installation	Describe earthing arrangements
6 Know the dangers of electricity and risks of electric shock	Examples of how a person can become part of a live electric circuit and the effects of increasing values of electric shock current. Videos to show the dangers of electric shock
7 Know the devices used for the protection against over-current and shock	Manufacturer's information sheets BS 7671
8 Draw circuit diagrams for 1-way and 2-way controlled lighting circuits	Diagrams using both loop-in and join box methods
9 Draw circuit diagrams for radial power circuits	Diagrams of socket, immersion heater, cooker and shower circuits
10 Determine standard cable and protective device ratings for given loads	Use manufacturer's literature, etc
11 Convert circuit diagrams, for power and lighting circuits to wiring diagrams	Draw diagrams of lighting and power circuits to convert one diagram form to the other

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Examples of instruments of assessment that could be used for each outcome are given below.

A graphical/written, objective/short answer exercise to assess the understanding of the generation of ac waveforms, its r.m.s. and peak values and the calculation of waveform frequency.

This exercise may also be used to assess the candidate's knowledge of the National Grid System and the order and voltages of the stages from generation to the consumer's input terminals.

The exercise will also assess the candidate's ability to identify the order of a consumer's intake position equipment and to explain the function of each piece of equipment shown in a given diagram.

Satisfactory achievement of the outcome will be based on giving the correct responses to all of the exercise.

Outcome 2

An objective type exercise or a structured question to assess the candidate's comprehension of the types, causes and dangers associated with over-currents, the types of over-current and shock protection devices.

One of the questions will assess the candidate's recognition of a number of different types of protective devices. (The centre must supply the following devices for the candidate to physically handle: miniature circuit-breaker, cartridge fuse holder and residual current device.)

National Unit Specification: support notes (cont)

UNIT Basic Electrical Installation Systems and Protection (Intermediate 2)

Satisfactory achievement of the outcome will be based on giving the correct responses to all of the exercise.

Outcome 3
A written exercise to assess the candidate's ability to produce wiring arrangements for lighting and radial power circuits and an understanding of circuit applications and relevant British Standards.

Satisfactory achievement of the outcome will be based on giving the correct responses to all of the exercise.

SPECIAL NEEDS
This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering special alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, publication code AA0645/3).

National Unit Specification: general information

UNIT Basic Electrical Installation Skills (Intermediate 2)

NUMBER D9AH 11

COURSE Electrical Installation Fundaments (Intermediate 2*)*

SUMMARY
This unit has been designed to introduce candidates to the skills and safe working practices required when installing electrical equipment. It will focus on the formation of practical lighting and socket outlet circuits. It incorporates planning where electrical diagrams have to be interpreted and electrical equipment has to be identified and correctly selected. The completed practical exercises have to be evaluated to ensure they function correctly and comply with all the safety requirements relevant to Intermediate 2.

OUTCOMES
1 Assemble equipment to form electrical circuits.
2 Perform testing procedures on electrical systems.

RECOMMENDED ENTRY
While entry to this course is at the discretion of the centre, candidates would normally be expected to have attained one of the following:

- Mathematics and either Technological Studies or Physics at Grade 3 and 4 (General level) Standard Grade
  OR
- Equivalent National Units.

Administrative Information

Superclass: XJ

Publication date: March 2003

Source: Scottish Qualifications Authority

Version: 01

National Unit Specification: general information (cont)

UNIT Basic Electrical Installation Skills (Intermediate 2)

CREDIT VALUE
1 credit at Intermediate 2 (6 SCOTCAT points*) at SCQF level 5.

*SCOTCAT 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 SCOTCAT points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.

CORE SKILLS
There is no automatic certification of core skills or core skills components in this unit.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

National Unit Specification: statement of standards

UNIT Basic Electrical Installation Skills (Intermediate 2)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to the Scottish Qualifications Authority.

OUTCOME 1
Assemble equipment to form electrical circuits.

Performance criteria
a) Hazards and control measures for safe working practices are correctly identified.
b) Manufacturer's catalogues are used to select electrical equipment.
c) Plastic enclosures and PVC sheathed cables are correctly assembled and installed to form wiring systems.
d) Electrical diagrams and BS symbols are correctly interpreted when forming lighting and socket outlet circuits.
e) Standard installation wiring practices for electrical safety are correctly identified.

EVIDENCE REQUIREMENTS
The candidate will be given the Installation Layout Diagram which is designed to measure the ability to interpret diagrams, identify and install electrical equipment to form lighting and socket outlet circuits. The practical exercises include the installation of PVC sheathed cables, plastic conduit and trunking wiring systems. A basic visual inspection schedule, highlighting good practices, has to be completed for each circuit.

The candidate will be required to:

1 Correctly identify three selected hazards and the control measures required to ensure a safe system of work when installing electrical equipment (risk assessment report).
2 Use manufacturers' catalogues to identify reference numbers for selecting electrical equipment.
3 Assemble the equipment outlined in the Installation Layout Diagram to form the following three final circuits.

(i) Install PVC sheathed cables to form a loop in lighting circuit.
(ii) Assemble plastic conduit and form a loop in lighting circuit.
(iii) Install PVC sheathed cables and plastic trunking and form a socket outlet radial circuit.

The practical lighting exercises incorporate 1-way and 2-way control for both wiring systems.

The circuits should incorporate bayonet cap and Edison screw lampholders. The radial circuit should include two socket outlets and one fused connection unit with a connected load.

National Unit Specification: statement of standards (cont)

UNIT Basic Electrical Installation Skills (Intermediate 2)

The candidate will be required to:

- Mark out position of equipment and cable runs.
- Secure backboxes in position with the correct fixing device.
- Install the correct type and size of PVC sheathed cable for the lighting circuit.
- Install the correct type and size of PVC sheathed cable for a 20A radial circuit.
- Form bends and off-sets in PVC sheathed cable systems.
- Select supports and secure PVC sheathed cables.
- Terminate PVC sheathed conductors at accessories when forming a lighting and socket outlet circuit.
- Identify, sleeve and terminate protective conductors at electrical equipment.
- Fabricate, assemble and secure plastic conduit and trunking systems.
- Install single core cables and terminate conductors at electrical accessories when forming a lighting circuit within a plastic conduit system.
- Select the correct rating of protective device for each final circuit.
- Complete the visual inspection schedule for each circuit installed.

Satisfactory achievement of the outcome will be based on the candidate producing:

(i) a completed report for safe systems of work given in Table 1;
(ii) the correct catalogue reference numbers for the selected electrical equipment given in Table 2;
(iii) a completed visual inspection schedule given in Table 3 for the practical exercises contained in the Installation Layout Diagram.

OUTCOME 2
Perform testing procedures on electrical systems.

Performance criteria

a) Instrument selected for each test is correct.
b) Measured test results and readings are correctly recorded.
c) Compare and confirm test values with relevant criteria.
d) Circuits function correctly when connected to an electrical supply.
e) Electrical faults on systems are correctly identified.

Evidence requirements

A test report for each circuit has to be completed before being connected to an electrical supply. All covers and enclosures have to be secured to ensure no live parts are exposed to touch.

The candidate will be required to complete a test report for the lighting and radial circuits constructed in Outcome 1.

National Unit Specification: statement of standards (cont)

UNIT Basic Electrical Installation Skills (Intermediate 2)

To achieve this the candidate must:

- Select the correct instrument scale, test voltage range and measure the insulation resistance values of the final circuits.
- Confirm earth continuity requirements of each final circuit.
- Apply polarity checks to each final circuit.
- Record measured results and readings for each final circuit tested.
- Compare and identify unacceptable results.
- Test the function of each circuit by connection to an electrical supply.

Satisfactory achievement of the outcome will be based on the candidate completing the Test Report for all the circuits given.

An incorrect result, reading or circuit function should be considered as one that shows a lack of understanding rather than one caused by a lack of knowledge.

National Unit Specification: support notes

UNIT Basic Electrical Installation Skills (Intermediate 2)

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

It is recommended that you refer to the SQA Arrangements document for the Intermediate 2 Electrical Installation Fundamentals course before delivering this unit.

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

This unit will provide candidates with the introductory practical skills to be able to install equipment and form electrical circuits. It incorporates overriding safety factors, which ensure equipment is installed in a safe manner and systems are designed to minimise the risk from electric shock.

It is aimed at young people and adult learners who wish to enter the electrical contracting industry and/or progress to further studies in Electrical Installation or Electrical Engineering courses.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

Safety regulations and safe working practices should be observed at all times.

- Safe systems of work and control measures are clearly identified.
- The risks of working with electricity are clearly explained.
- Safe touch voltages should be selected for all project work.
- Only a basic explanation between the two different light sources is required.
- Reference to regulations should only refer to good practice and relate to the candidates' Project Brief requirements.
- Good workmanship and proper materials shall always be used.
- A simplified form will allow candidates to record results when testing.
- Project represents an installation with no simulation except for voltage levels.
- Filament light sources to include bayonet cap and Edison screw lamp holders.

The candidate could be given a practical assignment, which would demonstrate the ability to assemble a range of electrical accessories to form practical lighting and socket outlet power circuits when connected to a safe working voltage. The practical exercises could be constructed around specific tasks where the candidate would produce wiring diagrams from an initial understanding of circuit diagrams. Wiring diagrams should be labelled and clearly indicate the function of the conductors.

Additional assignments should permit the candidate to recognise BS symbols and their function when interpreting electrical layout diagrams. The candidate should also be encouraged to use manufacturers' catalogues and lists when selecting electrical equipment. This should include protective equipment, accessories and cable types and sizes.

A mixture of non armoured sheathed cables and plastic enclosures can be used to form lighting and power circuits to comply with current practice. The candidate must demonstrate the techniques required to install sheathed cables, plastic conduit and mini trunking systems. Basic testing and fault finding should be encouraged to minimise the risks when using electricity. Each circuit can be formed separately providing that all the elements of the PCs are achieved.

National Unit Specification: support notes (cont)

UNIT Basic Electrical Installation Skills (Intermediate 2)

The candidate must demonstrate a knowledge of bayonet and recommended Edison screw lamp holder terminating requirements. The application of filament and discharge luminaires in domestic or small installations (garages, house extensions etc.) should be briefly outlined.

Outcome 1
Standard installation wiring practices should include conductor preparation, terminating methods, conductor identification and earthing connections. Electrical safety factors should ensure that protective and single pole switching devices are only connected to the phase conductor. PVC sheathed cable and plastic enclosure layout procedures should be outlined and the correct supporting methods identified. Cable sizes and over current device ratings for standard lighting and socket outlet circuits are to be identified by reference to selected tables or information charts. Electrical diagrams (wiring, circuit and layout) and the use of BS symbols will be incorporated into the planning for the implementation of the Project Brief.

The following tasks will underpin the knowledge and understanding when installing electrical installation circuits:

- Completing a risk assessment when forming safe systems of work.
- Producing wiring diagrams for lighting circuits.
- Recognition of BS symbols and the function of layout diagrams.
- Identifying electrical equipment using manufacturers' catalogues, lists or information charts.
- Application of selected wiring systems.
- Forming 1-way and 2-way lighting circuits with PVC sheathed cables.
- Forming 1-way and 2-way lighting circuits in a plastic conduit system.
- Forming a socket outlet radial circuit with PVC sheathed cables and a plastic trunking system.
- Identifying protective devices, isolating devices and switch disconnectors.
- Functional earthing requirements: conductor preparation, sleeving and cross bonding if metal socket boxes are used.
- Visual inspection requirements to recognise good practice.
- Isolating procedures to be outlined to ensure a safe system when assembling electrical circuits.
- Correct use of hand tools: 1st fix assembly: 2nd fix terminations.

The tasks would include:

- Marking and laying out of equipment.
- Plastic enclosure layout: conduit and mini trunking systems.
- PVC sheathed cable layout and supports when forming a lighting and socket outlet circuit.
- Accessory fixing methods.
- Installing single core cables for lighting circuits.
- Cable preparation and conductor terminating methods: screw and crimping connections.

In assembling a circuit, the candidate should not be exposed to simulation, although a supply point may already be secured in position. The wiring systems could be assembled and secured to a wooden surface.

Outcome 2
Tests should be used to confirm that each circuit is electrically safe when connected to a supply. The candidate must not be exposed to live parts when the covers are removed.

UNIT Basic Electrical Installation Skills (Intermediate 2)

The task would include:

- Outlining the dangers of electricity: shock, arcing and burns.
- Knowledge of purpose of testing.
- Using continuity and insulation resistance test instruments to record results.
- Recording insulation resistance values.
- Check circuits for earthing requirements.
- Check the requirements for polarity.
- Methods of recording and comparing test results in the schedule.
- Identifying different types of electrical faults: open and short circuit.
- Identifying and rectifying the cause of unsatisfactory test results.
- Functional testing of completed circuits.

Safety regulations and safe working practices should be observed at all times.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

This practical unit should be taught mainly in a workshop since it requires recognising and installing electrical equipment to form lighting and socket outlet circuits. The circuits will be formed using PVC sheathed cable, plastic conduit and trunking wiring systems. It is essential that wiring diagrams can be interpreted when forming lighting circuits with 1-way and 2-way control. Installation techniques should be reinforced through continued example and practice. Manufacturers' catalogues should be used to underpin the knowledge required to recognise electrical accessories and control equipment. Good installation practices should be integrated within skill development to ensure wiring systems are correctly assembled and installed.

There should only be a minimum reference to basic cable tables or centre devised information charts for the circuits specified in the installation layout diagram. Practical examples in the application of wiring systems should be outlined in preparation for the selection of the Installation Project design brief. Further development in the use of electrical diagrams and BS symbols is essential in enhancing the knowledge and understanding of electrical systems.

Accident prevention control measures, identified by risk assessment procedures should be continually enforced throughout the practical skill development in the workshop. The use of test instruments is designed to underpin the basic requirement for electrical safety. Throughout the unit, standard design practices for cables, protection and control functions should be reinforced in preparation for the Installation Project.

Reference should be made to the other two units and Project within the Electrical Installation Fundamentals Intermediate 2 course of study.

National Unit Specification: support notes (cont)

UNIT Basic Electrical Installation Skills (Intermediate 2)

Knowledge and Understanding	*Contexts, applications, illustrations and activities*
1 Identify control measures to ensure safe systems of work	Outline hazards in a workshop environment. Instruction - Information - Training 1 Working at height - slips, trips and falls control measures: • Supervision • Safe Access and Egress • Housekeeping • Step ladders • Waste material disposal 2 Electricity - electric shock control measures: • Reduced voltage • Enclosures • Isolation
2 Know the difference between circuit diagrams and wiring diagrams	Tutorial supported by practical project
3 Identify electrical accessories and equipment required for lighting and socket outlet power circuits	Demonstrations supported by practical projects Manufacturers' catalogues
4 Recognise electrical symbols and their applications	Layout diagrams and their functions. Relate symbols to electrical accessories
5 State the type, application and installation method of wiring systems to be installed	Tutorial and practical exercises. Example where systems are installed • Sheathed cables • Plastic conduit enclosures and accessories • Plastic trunking enclosures and accessories
6 Recognise the tools required to install electrical systems (1st fix and 2nd fix)	Example in use of tools to enforce effective application when installing wiring systems
7 Identify good electrical installation techniques and match them to the requirements of the practical projects	• Identification of conductors • Protection from mechanical damage • Terminating procedures: screw and crimping • Earthing: connections and sleeving • Circuit protection
8 List the basic principles of electrical safety	Shock and Fire Protection • Standard cable types and sizes • Earthing function: exposed metalwork, main earthing terminal • Consumer switchgear: protective devices
9 List the types of electrical faults	• Loss of supply • Cable termination – open circuit • Insulation failure – short circuit • Overload or fault/mcb or fuse operating • Equipment failure
10 Perform testing procedures on system installed and compare results	Demonstration and practical activity • Isolation • Continuity checks – earth and polarity • Insulation tests • Take measurements and record results • Open circuit and short circuit faults

National Unit Specification: support notes (cont)

UNIT Basic Electrical Installation Skills (Intermediate 2)

Knowledge and Understanding	*Contexts, applications, illustrations and activities*
11 Know the difference between incandescent filament lamps and discharge fluorescent luminaries. Filament lamp caps. Luminaire selection.	Applications outlined • Tungsten filament • Fluorescent tube • Edison screw • Bayonet cap
12 Understand the minimum requirements for a final circuit	Integrate within practical project • Supply source • Cables • Load • Protection • Control

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Accident prevention control measures (risk assessment report) should include forming a safe system when working at height eg stepladders, identifying good housekeeping practices and the purpose of keeping traffic routes clear. The report should also incorporate the purpose of identifying worn tools and the risks when continuing to use them. Safe methods of disconnecting the electrical supply using isolating or switching devices have to be identified and recorded in the risk control report.

Outcome 1

The practical exercises outlined in the installation layout diagram have to be completed and visually inspected before being tested.

Completion of the assessor's checklist will confirm that the standards outlined for each circuit has been achieved.

The exercises incorporate an activity where the candidate has to identify electrical equipment. Catalogue reference numbers have to be identified and recorded in the report.

Three work activities are outlined and the candidate has to identify the hazards and control measures to ensure a safe system of work.

Satisfactory achievement of the outcome will be based on the candidate completing the exercises and the assignments and a checklist record which shows all elements of the PCs are achieved.

Outcome 2

The candidate will be given a test report, which is designed to record results and compare the values with standard circuit criteria. The tests for each circuit are to be completed before any circuit is connected to the electrical supply. The exercises must be carried out with the appropriate test instruments, which will underpin the precautions that have to be taken before any circuit is connected to an electrical supply.

The testing report is designed to measure the ability to select the correct instruments, range and scale and correctly compare the test results and readings obtained. The report will require the candidate to confirm the continuity of protective conductors and measure circuit insulation resistance values. Practical polarity checks should confirm that circuit breakers, fuses and single pole switches have only been connected to the live phase conductor.

National Unit Specification: support notes (cont)

UNIT Basic Electrical Installation Skills (Intermediate 2)

Satisfactory achievement of this outcome will be based on the candidate producing a completed report on the assignment and a checklist record which shows that all elements of the PCs are achieved.

SPECIAL NEEDS

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering special alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, publication code AA0645/3).