

# Level 2 Certificate in Electrotechnical Technology

Scheme handbook

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# Level 2 Certificate in Electrotechnical Technology

This award is aimed at candidates who

- are following Apprenticeship programmes
- who do and do not have access to an N/SVQ
- wish for career progression within the electrotechnical industry

This award is designed to contribute towards the knowledge and understanding for Electrotechnical NVOs at Levels 2 & 3 (City & Guilds 2356), containing skills and knowledge which reflect the scope of the National Occupational Standards.

Candidates must follow **one** of six occupational pathways. Successful candidates will receive a certificate endorsed with their chosen pathway:

**Level 2 Certificate in Electrotechnical technology-Installation (Buildings & Structures)**

**Level 2 Certificate in Electrotechnical technology- Electrical Maintenance**

**Level 2 Certificate in Electrotechnical technology- Installing Instrumentation & Associated Equipment**

**Level 2 Certificate in Electrotechnical technology- Highway Electrical Systems**

**Level 2 Certificate in Electrotechnical technology- Electrotechnical Panel building**

**Level 2 Certificate in Electrotechnical technology- Electrical Machines Rewind & Repair**

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## **General information**

This certificate has been designed by City & Guilds to support government initiatives towards the National Qualifications Framework. It can contribute towards the knowledge and understanding required for the related N/SVQ while not requiring or proving evidence of occupational competence.

## **General structure**

The Award is made up of units expressed in a standard format. Each unit is preceded by details of

- the structure of the unit
- the aims and general coverage of the unit
- the outcomes
- the assessment methods

## **Assessment and quality assurance**

National standards and rigorous quality assurance are maintained by the use of

- City & Guilds set and marked multiple choice on-line test(s)
- City & Guilds Assignments, marked by the centre according to externally set marking criteria, with quality assurance monitored by City & Guilds' external verification system.

The multiple choice on-line tests assess knowledge and understanding.

## **Verification of Assignments**

Although the certificate does not imply occupational competence, it has a very close relationship with N/SVQ programmes. It is for this reason that, when assignments are assessed, it is important that reference is made to N/SVQ assessment methodology. Award assessors/tutors will need to be familiar with the occupational standards for Electrotechnical N/SVQs, because a similar system of internal verification is used. This means that the work of assessors involved in the qualification must be monitored by an Internal Verifier/scheme co-ordinator, to ensure that they are applying the standards consistently throughout assessment activities.

The use of grading for the assessment of assignments makes it possible for assessors/verifiers to use a system of sampling. By using the evidence checklists, assessors/verifiers can also ascertain whether the evidence for an assignment is complete, and can ensure that the allocation of scores has been fair and beyond dispute.

Assessors must ensure that candidates understand why a particular grade has been given for the award.

If a candidate's work is selected for verification, samples of work must be available to the appointed external verifier.

An external verifier will make an annual visit to the centre and their role includes the following:

- ensuring that internal verifiers are undertaking their duties satisfactorily
- monitoring internal quality assurance systems and sampling assessment activities, methods and records
- acting as a source of advice and support
- promoting best practice
- providing prompt, accurate and constructive feedback to all relevant parties on the operation of centres' assessment systems.

Assignments assess practical outcomes.

As assignments are designed to sample practical activities, it is essential that the centres ensure that candidates cover the content of the whole unit.

Assessment components are graded (Pass, Credit, Distinction). A pass is the achievement level required for the knowledge and understanding in an N/SVQ and generally represents the ability to follow instructions and procedures. Credit and distinction represent increasing levels of ability to adapt to changing circumstances and to independently resolve problems.

For candidates with particular requirements, centres should refer to City & Guilds policy document *Access to assessment, candidates with particular requirements*.

External verifiers act on behalf of City & Guilds to ensure that national standards are maintained. Full details of their role can be found in *Providing City & Guilds' Qualifications - a guide to centre and scheme approval*.

## Course Design and entry requirements

Teacher/assessors should familiarise themselves with the structure and content of the award before designing an appropriate course; in particular they are advised to consider the knowledge and understanding requirements of the relevant N/SVQ. The award programme contains three core units; it is strongly recommended that centres undertake the learning and assessments of units 1 and 2 prior to unit 3. As long as the requirements for the award are met, teachers/assessors may design courses of study in any way that they feel best meets the needs and capabilities of the candidates.

It is recommended that centres cover the following in the delivery of the course, where appropriate

- Key Skills (such as Communication, Application of Number, Information technology, Working with others, Improving own learning and performance, Problem solving)
- Health and safety considerations, in particular the need to impress to candidates that they must preserve the health and safety of others as well as themselves
- Equal opportunities
- Spiritual, moral, social and cultural issues
- Environmental education
- European dimension.
- Employment rights and responsibilities

It is **recommended** that centres and candidates complete an initial assessment plan to take into account

1. Any prior learning that can be taken into account
2. The type of course appropriate for the candidate
3. The candidate's preferred learning styles
4. Key skills strengths and weaknesses
5. Any open or distance learning materials that will be used
6. A target for completion of the award
7. Links to employer's training programme.

It is recommended that 500 hours should be allocated for the core and occupational units required for certification. Approximately half of this time may be devoted to practical delivery.

City & Guilds does not itself provide courses of instruction or specify entry requirements. Within the context of this award centres should evaluate the abilities of the candidate to meet the technical requirements of the syllabus content and the assessments. Furthermore centres should ensure that candidates do not register for this award if they hold or are registered with City & Guilds or another awarding body for an award the same level and content.

## Centre and scheme approval

Centres wishing to offer City & Guilds qualifications must gain approval.

New centres must apply for centre and scheme approval.

Existing City & Guilds centres will need to get specific scheme approval to run this Award.

Full details of the process for both centre and scheme approval are given in Providing City & Guilds qualifications - a guide to centre and scheme approval which is available from City & Guilds' regional offices.

# Guidance notes on assessment

## Section 1- Introduction

The City & Guilds Level 2 Electrotechnology Award is designed to provide opportunities for candidates to gain accreditation for their individual level of understanding of the underpinning knowledge relevant to the appropriate related NVO.

The emphasis is on 'learning by doing', not on competence. For this reason candidates are required to complete a number of assignments to show their attainment of practical skills which in turn implies understanding of the theoretical knowledge required to complete a number of activities successfully.

For the endorsed certificate at level 2 candidates will be required to achieve

- The **Three** core units (Units 001, 002 and 003)
- and **One** occupational unit (from Units 004 to 009)

Candidates **must** achieve Units 1 and 2 before progressing to the other units in the award.

## Section 2 – Assessment

In order to gain the full certificate candidates **must** complete

**one** multiple-choice paper for **each** unit.

**one** centre devised assignment based on an assignment template provided for unit 3 and the nominated occupational unit taken.

### 2.1 What is provided by City & Guilds

City & Guilds will provide on-line, on-demand testing using multiple choice questions, for each unit.

City & Guilds will also provide an assignment template for unit 3 and **each** occupational unit.

## 2.2 Assessment

The units are assessed by externally set multiple choice question papers. These tests are available on line through the City & Guilds GOLLA system.

Each test comprises multiple choice items in accordance with the test specifications provided.

### 2.2.1 On Line assessment requirements

Full details of the City & Guilds GOLLA system requirements, becoming a GOLLA centre and downloadable information sheets can be found at: <http://www.cityandguilds.com/e-assessment>

### 2.2.2 Further information

Any queries on the technical requirements for running City & Guilds' GOLLA assessment should be directed to the GOLLA helpline: **0845 2410 070**

## 2.3 Assessment of Unit 3 and occupational units

In each of these units there are a number of learning outcomes and each of these learning outcomes specifies a number of practical activities. Unit 3 and **each** occupational unit are assessed by the use of an assignment.

The assignment can be produced by the centre in accordance with the template provided by City & Guilds, or centres can use the sample assignment provided. It will be made up of a number of practical tasks. The resultant level of candidate achievement will be graded. Candidates **must** pass all tasks within an assignment.

Assignments will provide opportunities for candidates to be assessed for a **sample** range of the practical activities required for the unit. Assignments will usually consist of several tasks. The range of assignments developed by the centre for each unit should ensure that all the practical activities for all the outcomes are assessed as the centre uses a range of assignments over a period of time.

City & Guilds will provide assignment templates from which centres can produce the assignments for the units contained in this award. Centres are required to use the templates provided by City & Guilds. All centre devised assignments must be approved by an EV prior to use by the centre. (see **2.5.5** page 15)

### 2.3.1 Assignment templates

Detailed assignment templates for **each** optional unit are available on request from the Building Services Team on 020 7294 2716.

### 2.3.2 Guidance for Marking

Grading of assignments is Pass, Credit and Distinction; grades of Credit and Distinction are intended to distinguish those candidates who show greater degrees of autonomy in the way they organize themselves, or apply reflective thinking and originality in the completion of tasks.

Detailed marking and grading criteria are provided for each assignment in the Marking Criteria section of the assignment. The candidate must display satisfactory performance throughout the tasks. Failure to do so will result in the candidates requiring further training.

### 2.3.3 Marking assignments

Centres will be taking into account the following aspects of candidate's performance:

- planning, preparation and recording
- practical activity

Each aspect must be marked and awarded a Pass, Credit or Distinction. Specific guidance for marking is provided in the assignment template. Candidates **must** achieve a minimum of a Pass in **each** aspect of performance.

The marks that should be awarded for **planning, preparation and recording** are as follows

Marks	
Pass	1
Credit	2
Distinction	3

(Note: half marks are NOT available)

The marks that should be awarded for the **practical activities** are as follows

Marks	
Pass	2
Credit	4
Distinction	6

(Note: these marks are NOT divisible ie, Pass candidates must be awarded 2 marks, Credit candidates 4 marks and so on)

To award an overall grade the number of marks given for each task are totalled and then a grade is applied as follows

Marks	Grade
3-5	Pass
6-7	Credit
8-9	Distinction

### 2.3.4 Recording marks and grades

To record candidate marks and overall grades for each completed assignment, assessors should enter details onto the appropriate Assignment marksheet.

For example, below is a completed Assignment marksheet as it would appear in the candidates' Assignment Guide. It shows how the overall grade was produced.

	Pass	Credit	Distinction
Planning, preparation and recording	1		
Practical activity		4	
		<b>Total</b>	5
		<b>Grade</b>	Pass

### 2.3.5 Feedback

The assignments are intended as a formal assessment of candidates' practical skills. They are not designed as teaching aids and candidates should not be entered until they are ready. Should a candidate fail any of these tasks other than on health & safety grounds, as stated above, appropriate feedback should be given by the assessor both to the candidate and the tutor concerned. Assessors must ensure that candidates understand why a particular grade has been given.

If a candidate's work is selected for verification, samples of work must be available to the appointed external verifier.

## 2.4 What centres need to do

### 2.4.1 Machinery, tools and equipment

Centres **must** have access to sufficient equipment in the college, training centre or workplace to ensure candidates have the opportunity to cover all of the practical activities.

It is acceptable for centres to use specially designated areas within a centre for some of the units: e.g. to train and assess the installation of specialised electrical systems, alignment and setting up of electric motors and driven devices (pumps, compressors generators etc.)

The equipment, systems or machinery must be of an industrial standard and be capable of being used under normal working conditions: e.g. electric motors must have a method of applying sufficient power and not merely be connected up to show movement.

### 2.4.2 Producing assignments to assess occupational units

The centre devised assignments **must** be made up of three sections:

#### 1 Assessor's Guidance Notes

This section is intended for use by the assessor only. It should contain

- a health and safety statement
- the location of where the assignment should be taken
- the requirements for tools, equipment, materials and data
- notes on the content of the assignment to include any preparatory work required by the assessor/centre
- details of evidence and recording requirements
- time consideration.

Any new assignments set must have the same time allocated to the completion of the assignment as set in the guidance note in the assignment template.

#### 2 Candidate's Instructions

The candidate's instructions should contain:

- general advice to candidates about the need to understand the assignment before starting work and the need to seek guidance if clarification is required
- guidance on the time limits
- the importance of health and safety
- an assignment brief which sets the scene or a scenario to contextualise the task(s)
- clearly defined tasks covering a range of practical activities – an outline of each task should be provided rather than a series of marking checklists
- recording/report sheets for recording the progress of the activity
- notes which refer to how the evidence they produce should be stored and labelled.

**NOTE:**

Where the use of drawings/specifications is essential for the activity, relevant pages can be photocopied from workshop manuals, etc – copyright and industrial confidentiality permitting. It is not usually necessary for such items to be copied out by the candidates, however, the use of sketches to show specific, important aspects of the work undertaken: e.g. points of wear, location of components within a system, alignment methods, etc should be encouraged.

CAD and word processing packages can be used but time spent on the presentation should not be excessive. The final grade awarded will not necessarily depend upon presentation provided the candidates' work is clear, neat and technically correct. Candidates generating evidence for IT Key Skills may wish to spend more time on this aspect of their work.

**2.4.5 Centre devised assignment approval**

All centre devised assignments **must** be approved for use by a City & Guilds External Verifier.

# Level 2 Certificate in Electrotechnical Technology

## The Award

For the award of a certificate, candidates must successfully complete the assessments for Units 1, 2 and 3 plus the assessments for **one** occupational unit.

Core units		Assessment components required	
Unit 1	Working effectively and safely in the electrotechnical environment	2330-201	Multiple choice (OL)
Unit 2	Principles of electrotechnology	2330-202	Multiple choice (OL)
Unit 3	Application of Health and Safety and Electrical principles	2330-203	Multiple choice (OL)
		2330-204	Assignment
Occupational units			
Unit 4	Installation (Buildings & Structures)	2330-205	Multiple choice (OL)
		2330-206	Assignment
Unit 5	Electrical Maintenance	2330-207	Multiple choice (OL)
		2330-208	Assignment
Unit 6	Highway Electrical Systems	2330-209	Multiple choice (OL)
		2330-210	Assignment
Unit 7	Installing Instrumentation & Associated Equipment	2330-211	Multiple choice (OL)
		2330-212	Assignment
Unit 8	Electrotechnical Panel building	2330-213	Multiple choice (OL)
		2330-214	Assignment
Unit 9	Electrical Machine Repair & Rewind	2330-215	Multiple choice (OL)
		2330-216	Assignment

## Registration and certification

Candidates must be registered at the beginning of their course. Centres should submit registrations using Form S (Registration).

When assignments have been successfully completed, candidate results should be submitted on Form S (Results submission). Centres should note that results will **not** be processed by City & Guilds until verification records are complete.

Multiple choice tests are available through the GOLLA electronic on-line assessment system.

Full details on all the above procedures will be found on City & Guilds Web site <http://www.cityandguilds.com>

## Relationship to N/SVQ

### Core Units

Unit	Outcome		Element of S/NVQ (2356) for which knowledge and understanding is covered
1	1	Identify the legal responsibilities of employers and employees and the importance of health and safety in the working environment	This is a generic outcome which can relate to any unit where there is a reference to health and safety regulations and other relevant legislation Specific units are 18; 18a; 18d; 81; 81a and 81d
	2	Identify the occupational specialisms	
	3	Identify sources of technical information	This is a generic outcome which can relate to any unit where there is a reference to technical information. Specific units are 70, 70a and 70d.
Unit	Outcome		Element of S/NVQ (2356) for which knowledge and understanding is covered
2	1	Describe the application of basic units	This is generic outcome and can relate to any unit where there is a requirement for electrical principles and theory
	2	Describe basic scientific concepts	
	3	Describe basic electrical circuitry	
	4	Identify tools, plant, equipment and materials	
Unit	Outcome		Element of S/NVQ (2356) for which knowledge and understanding is covered
3	1	Safe systems of working	This is a generic outcome and can relate to any unit where there is a requirement for safety. Specific units are 18, 18a, 18d and 81, 81a and 81d
	2	Use technical information	
	3	Electrical machines and a.c. theory	This is a generic outcome and can relate to any unit where there is a requirement for machine and a.c. theory
	4	Polyphase systems	This is a generic outcome and can relate to any unit where there is a requirement for theory of polyphase systems
	5	Overcurrent, short circuit and earth fault protection	This is a generic outcome and can relate to any unit where there is a requirement for theory of protection

## Occupational units

<b>Unit</b>	<b>Outcome</b>		<b>Element of S/NVQ (2356) for which knowledge and understanding is covered</b>
4	1	Regulations and related information for electrical installations	18, 20, 23, 41, 70, 81
	2	Purpose and application of specifications and data	20, 23, 41, 70
	3	Types of electrical installations	20, 23, 41
	4	Undertake electrical installation	18, 20, 23, 41, 81
<b>Unit</b>	<b>Outcome</b>		<b>Element of S/NVQ (2356) for which knowledge and understanding is covered</b>
5	1	Functions and purpose of electrical maintenance	24, 40, 70
	2	Regulations and related information for electrical maintenance	24, 40, 70
	3	Electrical systems, installations, and electrical equipment	24, 40, 70
	4	Purpose and application of specifications and data	24, 40, 70
	5	Undertake electrical maintenance	24, 40, 70
<b>Unit</b>	<b>Outcome</b>		<b>Element of S/NVQ (2356) for which knowledge and understanding is covered</b>
6	1	Recognise the function of highway electrical equipment, systems and components	60, 61, 63, 70
	2	Understand the operational features of highway electrical equipment, systems and components	60, 61, 63, 70
	3	Identify the relevant statutory and non-statutory legislation associated with highway electrical equipment, systems and components	60, 61, 63, 70
	4	Recognise the purpose and application of instructions and manufacturers information involved with the installation and maintenance of highway electrical equipment, systems and components	60, 61, 63, 70
	5	Understand approved methods of installation	60, 61, 63, 70
	6	Select and apply fault identification and rectification techniques	60, 61, 63, 70
	7	Select appropriate methods and use tools and instruments to restore systems equipment and components to working order	60, 61, 63, 70
<b>Unit</b>	<b>Outcome</b>		<b>Element of S/NVQ (2356) for which knowledge and understanding is covered</b>
7	1	Function and application of instrumentation/display devices	14, 15, 70
	2	Regulations and related information for instrumentation	14, 15, 70
	3	Purpose and application of specifications and data	14, 15, 70
	4	Installation methods for instrumentation/display devices	14, 15, 70
	5	Environmental effects on display devices	14, 15, 70
<b>Unit</b>	<b>Outcome</b>		<b>Element of S/NVQ (2356) for which knowledge and understanding is covered</b>
8	1	Functions and applications for electrical panels	22, 27, 70a
	2	Regulations and related information for panels	18a, 22, 27, 70a, 81a

	3	Purpose and application of specifications and data	22, 27, 70a
	4	Panel building and installation techniques	22, 27, 70a

<b>Unit</b>	<b>Outcome</b>		<b>Element of S/NVQ (2356) for which knowledge and understanding is covered</b>
9	1	Functions and applications of electrical motors	25, 26,
	2	Regulations and related information	18d 25, 26, 28 70d, 81d
	3	Purpose and application of specifications and data	25, 26, 28,
	4	Methods of installation and repair of electrical motors	25, 26, 28, 70d

## Test Specification

The knowledge requirements will be assessed by a multiple choice question paper for each unit.

### Core Units

<b>Paper 201: Working effectively and safely in an electrotechnical environment</b>			
<b>Test duration 45 minutes (30 item multiple choice)</b>			
<b>Unit</b>	<b>Outcome</b>	<b>No of questions</b>	
1	1	Identify the legal requirements	17
	2	Identify occupational specialisms	3
	3	Identify sources of technical information	10

<b>Paper 202: Principles of electrotechnology</b>			
<b>Test duration 45 minutes (30 item multiple choice)</b>			
<b>Unit</b>	<b>Outcome</b>	<b>No of questions</b>	
2	1	Describe the application of basic units used in electro technology	7
	2	Describe basic scientific concepts related to electro technology	10
	3	Describe basic electrical circuitry and applications	7
	4	Identify tools, plant, equipment and materials	6

<b>Paper 203: Applications of health and safety and electrical principles</b>			
<b>Test duration 45 minutes (30 item multiple choice)</b>			
<b>Unit</b>	<b>Outcome</b>	<b>No of questions</b>	
3		Part 1	
	1	Safe systems of working	10
	2	Using technical information	5
		Part 2	
	3	Electrical machines and a.c. theory	5
	4	Polyphase systems	5
5	Over current, short circuit and earth fault protection	5	

### Optional units

<b>Paper 205: Installation (Buildings and structures)</b>			
<b>Test duration 45 minutes (30 item multiple choice)</b>			
<b>Unit</b>	<b>Outcome</b>	<b>No of questions</b>	
4	1	Regulations and related information	4
	2	Purpose of specifications and data	4
	3	Types of installations	12
	4	Undertaking electrical installation	10

<b>Paper 207: Electrical maintenance</b>			
<b>Test duration 45 minutes (30 item multiple choice)</b>			
<b>Unit</b>	<b>Outcome</b>	<b>No of questions</b>	
5	1	Function and purpose of electrical maintenance	2
	2	Regulations and related information	4
	3	Electrical systems and equipment	12
	4	Purpose of specifications and data	2
	5	Undertaking electrical maintenance	10

<b>Paper 209: Highway Electrical Systems</b>			
<b>Test duration 45 minutes (30 item multiple choice)</b>			
<b>Unit</b>	<b>Outcome</b>	<b>No of questions</b>	
6	1	Recognise the function of highway electrical equipment, systems and components	2
	2	Understand the operational features of highway electrical equipment, systems and components	6
	3	Identify the relevant statutory and non-statutory legislation associated with highway electrical equipment, systems and components	4
	4	Recognise the purpose and application of instructions and manufacturers information involved with the installation and maintenance of highway electrical equipment, systems and components	2
	5	Understand approved methods of installation	6
	6	Select and apply fault identification and rectification techniques	5
	7	Select appropriate methods and use tools and instruments to restore systems equipment and components to working order	5

<b>Paper 211: Installing instrumentation and associated equipment</b>			
<b>Test duration 45 minutes (30 item multiple choice)</b>			
<b>Unit</b>	<b>Outcome</b>	<b>No of questions</b>	
6	1	Function of application of instrumentation/display devices	8
	2	Regulations and related information	6
	3	Purpose of specifications and data	2
	4	Installation methods for instrumentation	12
	5	Environmental effects on display devices/instrumentation	2

<b>Paper 213: Electrotechnical panel building</b>			
<b>Test duration 45 minutes (30 item multiple choice)</b>			
<b>Unit</b>	<b>Outcome</b>	<b>No of questions</b>	
7	1	Function of applications for panels	14
	2	Regulations of information	4
	3	Purpose of specifications and data	2
	4	Panel building and installation	10

<b>Paper 215: Electrical machines repair and rewind</b>			
<b>Test duration 45 minutes (30 item multiple choice)</b>			
<b>Unit</b>	<b>Outcome</b>	<b>No of questions</b>	
8	1	Functions of electrical motors	12
	2	Regulations and information	4
	3	Purpose of specifications and data	2
	4	Methods of installation and repair of electrical motors	12

## Assignment specification

### Core unit (204)

Unit	Outcome		Weighting of assignment	
			Min	Max
3	1	Safe systems of working	35	40
	2	Using technical information	15	30
	3	Electrical machines and a.c. theory	15	30
	4	Polyphase systems	15	30
	5	Over current, short circuit and earth fault protection	15	30

### Occupational assignments

Installations (Buildings and Structures) (206)				
Unit	Outcome		Weighting of assignment	
			Min	Max
4	1	Regulations and related information	20	30
	2	Purpose and application of specifications and data	20	30
	3	Types of electrical installations	40	50
	4	Undertake electrical installations	40	50
Electrical maintenance (208)				
Unit	Outcome		Weighting of assignment	
			Min	Max
5	1	Function and purpose of electrical maintenance	10	20
	2	Regulations and related information	15	20
	3	Electrical systems and equipment	30	40
	4	Purpose and application of specifications and data	10	20
	5	Undertaking electrical maintenance	40	50
Highway electrical systems (210)				
Unit	Outcome		Weighting of assignment	
			Min	Max
6	1	Recognise the function of highway electrical equipment, systems and components.	10	15
	2	Understand the operational features of highway electrical equipment, systems and components	10	15
	3	Identify the relevant statutory and non-statutory legislation associated with highway electrical equipment, systems and components	15	20
	4	Recognise the purpose and application of instructions and manufacturers information involved with the installation and maintenance of highway electrical equipment, systems and components	20	30
	5	Understand approved methods of installation	15	20
	6	Select and apply fault identification and rectification techniques	20	30
	7	Select appropriate methods and use tools and instruments to restore systems equipment and components to working order	10	15

<b>Installing instrumentation and associated equipment (212)</b>					
<b>Unit</b>	<b>Outcome</b>			<b>Weighting of assignment</b>	
				Min	Max
7	1	Function and application of instrumentation		15	25
	2	Regulations and related information		20	30
	3	Purpose and application of specifications and data		15	25
	4	Installation methods for instrumentation		40	50
	5	Environmental effects on instrumentation/display devices		10	20

<b>Electrotechnical panel building (214)</b>					
<b>Unit</b>	<b>Outcome</b>			<b>Weighting of assignment</b>	
				Min	Max
8	1	Function and application of panels		20	25
	2	Regulations and related information		20	25
	3	Purpose and application of specific data		20	25
	4	Panel building and installation techniques		40	50
<b>Electrical machines rewind and repair (216)</b>					
<b>Unit</b>	<b>Outcome</b>			<b>Weighting of assignment</b>	
				Min	Max
9	1	Function of electrical motors		20	30
	2	Regulations and related information		20	30
	3	Purpose and application of specifications and data		20	50
	4	Methods of installation and repair		40	50

## Level 2 Certificate in Electrotechnical Technology

### Key Skills Signposting

The aim is to extract evidence of the required key skills from within the natural context of the technical aspects of work. However in order to meet some of the requirements it may be necessary to extend the normal recording/documentation activities. It is unlikely that all of the requirements can be met in this way and additional opportunities by means of tasks/projects will be provided by your tutor/trainer. In order to achieve success at this level the candidate MUST meet ALL of the requirements as specified in the key skills publication. Note that these documents also provide useful additional information and guidance to help with the production of evidence.

The following reference table shows where suitable evidence could be obtained, but note

- it is not necessary to provide examples of evidence from every unit that you undertake
- not all of the unit elements can be obtained, and so a complete list of the unit elements is given.

If producing certain types of evidence for some units creates difficulties because of disability or other factors, you may be able to use other ways to show your achievement. Ask your supervisor for further information.

**Information Technology**

IT2.1 Search for and select information

**Communication**

C2.1a Contribute to a group discussion.

C2.2 Read and synthesise information

C2.3 Write documents

**Application of number**

N2.1 Plan, and interpret information.

N2.2 Carry out calculations

**Problem solving**

PS1.1 Confirm the problem

PS1.2 Plan and try out an option

PS1.3 Check and describe results

**Working with others**

WO2.1 Plan straightforward work.

WO2.2 Work cooperatively with others

**Improving own learning and performance**

LP2.1 Help set targets.

Identification of Key Skills - Summary relationship table

Unit Number and title	Communication	Application of number	Information Technology	Working with others	Improving own learning and performance	Problem solving
1 Working effectively and safely in an electrotechnical environment	C 2.1 C 2.2		IT 2.1	WO 2.1 WO 2.2	LP 2.1	
2 Principles of electrotechnology		N 2.1 N 2.2				
3 Application of health and safety and electrical principles	C 2.1	N 2.1 N 2.2	IT 2.1			
4 Installation (Buildings and structures)	C 2.2	N 2.1				
5 Electrical maintenance	C 2.2	N 2.1				
6 Highway electrical systems	C 2.2	N 2.1				
7 Installing instrumentation and associated equipment	C 2.2	N 2.1				
8 Electrotechnical panel building	C 2.2	N 2.1				
9 Electrical machines rewind and repair	C 2.2	N2.1				

## Grading descriptors

<b>Practical assignments</b>		
<b>Pass</b>	<b>Credit</b>	<b>Distinction</b>
In a practical activity, involving some non-routine operations the candidate demonstrated the use of skills in meeting the essential requirements of the outcomes of the unit	In a practical activity, involving some non-routine operations the candidate demonstrated the use of skills in meeting the substantial majority of requirements of the outcomes of the unit	In a practical activity, involving some non-routine operations the candidate demonstrated the use of skills in meeting the comprehensive requirements of the outcomes of the unit

<b>Written tests</b>		
<b>Pass</b>	<b>Credit</b>	<b>Distinction</b>
In a written test the candidate demonstrated meeting the essential requirements of the outcomes of the unit.	In a written test the candidate demonstrated meeting the substantial majority of requirements of the outcomes of the unit.	In a written test the candidate demonstrated meeting the comprehensive requirements of the outcomes of the unit.

## Level 2 Certificate in Electrotechnology

Identification of opportunities for evidence generation of moral, ethical, spiritual, European dimension, Environmental education and Health and safety

Unit No and Title	Moral, Ethical and Spiritual	European dimension	Environmental education	Health and safety
<b>Outcome</b>				
1 Working effectively and safely in an electrotechnical environment	1.1 1.2		1.1	1.1
2 Principles of electrotechnology				2.4
3 Application of health and safety and electrical principles	3.1	3.1		3.1
4 Installation (Buildings and Structures)		4.1		4.1
5 Electrical maintenance		5.2		5.2
6 Highway electrical systems		6.3	6.5	6.3
7 Installing instrumentation and associated equipment		7.2	7.5	7.2
8 Electrotechnical panel building		8.2	8.4	8.2
9 Electrical machines rewind and repair		9.2	9.4	9.2

### Employment rights and responsibilities matrix

ERR	Scheme handbook reference
<b>Employment law</b>	
Statutory rights	
Procedures and documentation	
Sources of information and advice	
<b>Organisation and representation</b>	
Organisation of the industry and how the job fits in	1.2
Jobs, roles and careers	
Representation in the industry	1.2
Sources of information and advice	
<b>Industry issues</b>	
Principles and codes of practice	Identified within each optional unit
Issues of public concern	

# Unit 1 – 201 Working effectively and safely in an electrotechnical environment

## Rationale

The aim of this core unit is to develop the candidates' ability to identify and work within the parameters set by current health and safety legislation and best practice related to the Electrotechnical Industry.

This unit is concerned with the requirements that are essential to enable electrotechnical activities to be carried out safely and effectively. It includes dealing with statutory and organisational requirements in accordance with approved regulations, codes of practice and procedures. It covers responsibilities, accident reporting and the identification of hazards and risks.

There are three learning outcomes to this unit. The candidate will be able to

1. identify the legal responsibilities of both employers & employees and the importance of health and safety in the working environment
2. identify the occupational specialisms within the breadth of companies that form the electrotechnical industry identify sources of technical information and methods of retrieval and use drawings, diagrams and manufacturers' data .

## Connection with other awards

This core unit combines with units 2 and 3 and one of the occupational units (4-9) to form the Level 2 Certificate in Electrotechnical Technology

## Assessment

1. Practical Activities  
There is no formal practical assessment for this unit but candidates will be expected to demonstrate the skills learnt through a range of practical activities.
2. Written Tests  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper produced in accordance with the test specification.

# Outcome 1: Identify the legal responsibilities of both employers and employees and the importance of health and safety in the working environment

## Practical Activities

The candidate will be able to

- 1 identify, select and use Personal Protective Equipment (PPE) appropriate for the task being undertaken
- 2 follow agreed procedures for obtaining and returning specialist PPE after use
- 3 recognise warning, advisory, mandatory and prohibition signs
- 4 follow accident and emergency procedures

## Underpinning Knowledge

The candidate will be able to:

- 1 state the legal responsibilities within the Health and Safety at Work Act (1974) for the
  - a employer
  - b employee
- 2 list the current Health and Safety legislation relevant to the workplace/site within the electrotechnical Industry
- 3 identify from the following, those regulatory requirements which are statutory and those which are non-statutory
  - a Health & Safety at Work Act (1974)
  - b Electricity at Work Regulations (1989)
  - c The Electricity Safety, Quality and Continuity Regulations 2002 (Formerly Electricity Supply Regulations 1989)
  - d Management of Health & Safety Regulations (1992)
  - e Provision & use of Work Equipment Regulations (1992)
  - f COSHH Regulations (2002)
  - g Personal Protective Equipment Regulations (1992)
  - h BS 7671 Requirements for Electrical Installations
- 4 state the main responsibilities of employers towards the maintenance of health and safety
  - a making the workplace safe and without risk to health
  - b keeping dust, fumes and noise under control
  - c ensuring plant and machinery are safe and that safe systems of work are set and followed
  - d ensuring articles and substances are moved, stored and used safely
  - e providing adequate welfare facilities
  - f providing adequate information, instruction, training and supervision necessary for staff's health & safety
  - g providing a health & safety policy statement if there are five or more employees
  - h providing any protective clothing or equipment specifically required by the Health & Safety Act
  - i reporting certain injuries, diseases and dangerous occurrences to the enforcing authority
  - j providing adequate first aid facilities
  - k undertaking precautions against fire, providing adequate means of escape and the means of fighting fire
  - l displaying a current certificate as required by the Employers Liability (Compulsory Insurance) Act 1969

- 5 state the responsibilities of an employee as being
- a taking reasonable care for your own health and that of others who may be affected by what you do or may not do
  - b co-operating with your employer on health and safety issues
  - c not interfering with or misusing anything provided for health and safety or welfare in the workplace
  - d reporting any identified health and safety problem in the workplace, in the first instance to the supervisor, manager or employer
- 6 explain the use of personal protective clothing appropriate to the task being undertaken
- a eyes
    - i spectacles
    - ii goggles
    - iii face screens
    - iv helmets
  - b head and neck
    - i. helmets
    - ii. bump caps
    - iii. hairnets
    - iv. sou'westers
    - v. cape hoods
  - c ears
    - i. earplugs
    - ii. muffs
  - d hands and arms
    - i gloves
    - ii gauntlets
    - iii mitts
    - iv wrist cuffs
    - v armlets.
  - e feet and legs
    - i. safety (boots, shoes, trainers)
    - ii. gaiters
    - iii. leggings
    - iv. spats and clogs
  - f lungs
    - i. disposable respirators
    - ii. half-masks
    - iii. full face respirator with filtering cartridge
    - iv. powered respirator blowing filtered air to a mask
    - v. fresh air hose equipment
    - vi. breathing apparatus (self-contained and fresh air line types)
  - g whole body
    - i. conventional or disposable overalls
    - ii. boiler suits
    - iii. warehouse coats
    - iv. donkey jackets
    - v. high visibility clothing
    - vi. chemical suits
    - vii. thermal clothing
    - viii. safety harness.
- 7 state the need for isolation before any work is carried out on an electrical installation or system

8. identify types and meaning of safety signs
  - a warning
  - b advisory
  - c mandatory
  - d prohibition
  
- 9 follow accident and emergency procedures
  - a recognise situations which could lead to accidents
  - b detail the procedures to be followed in the event of an accident
  - c identify the location of first aid facilities
  - d state accident reporting procedures
  - e recognise emergency procedures
  
- 10 state the basic action to be taken in the event of electric shock
  - a do not touch the casualty
  - b isolation of supply
  - c removal from live source using insulating material
  - c first aid through resuscitation
  - d treatment for burns, shock
  
- 11 identify types and applications for fire extinguishers
  - a water
  - b powder
  - c foam
  - d gas

## Outcome 2 Identify the occupational specialisms within the breadth of companies that form the electrotechnical Industry

### Practical Activities

The candidate will be able to

- 1 Produce an organisational flow chart to show the structure of company staff from owner/managers to operatives
- 2 identify role and responsibilities within the place of work

### Underpinning Knowledge

The candidate will be able to:

- 1 describe briefly the service provided within the following specialisms
  - a lighting installations
  - b power installations
  - c emergency lighting
  - d security systems/alarms
  - e building management systems
  - f control systems
  - g instrumentation
  - h electrical maintenance
  - i computer installations
  - j fibre optics
  - k data infrastructure cabling
  - l HV/LV Jointing
  - m public lighting
  - n panel building
  - o electrical machine drive installations
  - p consumer/commercial electronics
- 2 state that organisations that have electrotechnical activities can be
  - a Electrical Contractors
  - b Factories
  - c Process Plants
  - d Local Councils
  - e Commercial/Business buildings and complexes
  - f Leisure Centres
  - g Panel Builders
  - h Motor rewind & repair companies
  - i Railways
  - j Armed Forces
  - k Hospitals
  - l Equipment and machine manufacturers

- 3 state the role of the following personnel within an organisation that has electrotechnical activities.
- a design engineer
  - b maintenance manager/engineer
  - c service manager
  - d estimator/cost engineering
  - e contracts manager
  - f project manager
  - g technician
  - h supervisor/foreman
  - I operative-installation; maintenance; servicing
  - J mechanic/fitter – installation; maintenance; servicing
- 4 identify those Professional bodies, Trade and Employer Associations, Trade Union and Regulatory bodies associated with a specific specialist company in the electrotechnical industry.

## Outcome 3 Identify sources of technical information and methods of retrieval and use drawings, diagrams and manufacturers' data

### Practical Activities

The candidate will be able to

1. retrieve technical information
2. use diagrams, charts and data
3. use BS and/or BSEN symbols to identify required equipment, machines, switchgear, accessories in the workplace or on site

### Underpinning Knowledge

The candidate will be able to:

- 1 state that sources of technical information include
  - a British Standards Institute (BSI)
  - b BSEN Harmonized Standards
  - c Codes of Practice
  - d libraries (eg IET )
  - e manufacturers' catalogues, manuals
- 2 explain that technical information maybe retrieved by using
  - a conventional drawings, diagrams
  - b CD-ROM
  - c DVD
  - d video tapes
  - e VDUs/internet
  - f facsimile (fax) machines
  - g E-mail
  - h USB flash memory keys
- 3 identify types of drawings and diagrams as:
  - a circuit diagrams
  - b wiring diagrams
  - c block diagrams
  - d location drawings
  - e assembly and detail drawings
  - f distribution cable route plans/drawings
  - g site plans
  - h data sheets and wall charts
  - i component positional reference systems
  - j manufacturers' data and service manuals
- 4 identify and describe, how and why different scales are used to produce drawings, plans and diagrams relevant to the workplace
- 5 recognise and explain how B.S.E.N 60617 symbols are used
- 6 state the necessity to use drawings, diagrams in conjunction with the related specification

# Unit 2 - 202 Principles of electrotechnology

## Rationale

The aim of this core unit is to enable the candidate to understand the purpose and fundamental principles of electro technology within the industry specialisms

There are four learning outcomes to this core unit. The candidate will be able to

1. Describe the application of the basic units used in electro technology.
2. Describe basic scientific concepts related to electro technology.
3. Describe basic electrical circuitry and applications
4. Identify tools, plant, equipment and materials used for electrotechnical applications

## Connection with other awards

This core unit combines with units 1 and 3 and one of the occupational units (4-9) to form the Level 2 Certificate in Electrotechnical Technology

## Assessment

1. Practical Activities  
There is no formal practical assessment for this unit as candidates will be expected to demonstrate these core skills through practical activities in other units.
2. Written Tests  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper produced in accordance with the test specification.

# Outcome 1 Describe the application of the basic units used in electro technology

## Practical Activities

The candidate will be able to

- 1 measure low voltage current using an ammeter or multimeter
- 2 measure resistance in a battery operated circuit
- 3 use a range of instruments to measure basic units

## Underpinning Knowledge

The candidate will be able to

- 1 state the relationship between
  - a force and its effect on movement
  - b force, mass and acceleration (the Newton)
  - c mass and weight, the effect of gravitational pull
  - d force times distance moved in the direction of the force
  
- 2 identify the SI Unit, multiple, sub-multiple, symbol and quantity for
  - a current
  - b potential/pressure
  - c resistance
  - d resistivity
  - e temperature
  - f mass
  - g force
  - h magnetic flux
  - i magnetic flux density
  - j period
  - k frequency
  - l power
  - m energy
  - n time
  - o length
  - p area
  - q weight
  
- 3 describe how the SI Units in 2 (a-q) relate to the fundamental principles of
  - a electrical, electronic, and magnetic circuits
  - b alternating current production
  - c electrical machine efficiency
  - d mechanical lifting devices
  
- 4 state the relationship of
  - a resistance
  - b resistivity
  - c length
  - d area when applied to conductors, cables
  
- 5 state the construction features and operating principles of a simple alternator

- 6 state with the aid of diagrams how the alternator produces an output that follows a sinusoidal waveform pattern
- 7 state the efficiency of a machine in terms of output (energy or power) / input (energy or power) as a percentage.

## Outcome 2 Describe basic scientific concepts as related to electro technology

### Practical Activities

The candidate will be able to

- 1 connect conductors and simple electrical loads to an ELV source to form
  - a open and closed circuits
  - b series and parallel circuits
- 2 connect switches, lamps and measuring instruments into an ELV circuit
- 3 construct a diagram for a sinusoidal waveform and indicate
  - a average, RMS, peak or maximum values
  - b peak to peak
  - c period and frequency

### Underpinning Knowledge

The candidate will be able to:

- 1 list the materials used as conductors across the specialisms within the electrotechnical industry
- 2 list the materials used as insulators across the specialisms within the electrotechnical industry
- 3 state in simple terms, the reaction of electrons when charged, forming the concept of electric current
- 4 state how an electromotive force may be produced by chemical, magnetic and thermal means
- 5 state the chemical, magnetic and thermal effects of an electric current
- 6 explain the properties and application of conductor materials used across the specialisms within the electrotechnical industry
- 7 explain the properties and application of insulator materials used across the specialisms within the electrotechnical industry
- 8 explain how current flow differs in series and parallel circuits
- 9 describe how voltmeters, ammeters are connected into circuits in order to quantify circuit voltages, current and resistance
- 10 describe the magnet fields and flux patterns set up by
  - a differing arrangements of permanent magnets
  - b current carrying conductors
  - c solenoids
- 11 describe the benefits of using an a.c. supply compared with a d.c. supply

- 12 describe the construction of basic transformers in terms of
  - a laminations
  - b primary and secondary windings
  - c enclosures, cooling
  - d SELV source
- 13 state the benefits gained by the use of transformers with the transmission and distribution of electrical energy (National Grid etc).
- 14 transpose and apply basic formulae to include base, derived units and related constants/factors
- 15 apply calculations involving force, mass, energy, power and efficiency
- 16 apply calculations related to 'Ohm's Law' & resistivity

## Outcome 3 Describe basic electrical circuitry and applications

### Practical Activities

The candidate will be able to

1. identify and select appropriate components to construct simple electrical circuits

### Underpinning Knowledge

The candidate will be able to:

1. state the component parts of an electrical circuit as
  - a source of supply a.c. or d.c.
  - b circuit conductor - cable
  - c circuit protection
  - d circuit control
  - e load
2. determine appropriate wiring systems, enclosures and equipment with reference to the
  - a use of single and three phase power systems
  - b installation of lighting circuits
  - c use of radial and ring circuits
3. state the component elements of electrical cables
  - a conductor
  - b insulation
  - c sheathing
  - d materials used for conductors
4. differentiate between the terms earthing and bonding and give examples of the usage of each
5. list possible exposed conductive parts and extraneous conductive parts of other metallic structures or services
6. state the purpose of earthing and the function of earth protection
7. list basic principles of shock protection, circuit overload and short-circuit protection.

# Outcome 4 Identify tools, plant, equipment and materials used for electrotechnical applications

## Practical Activities

The candidate will be able to

1. identify, select and use appropriate tools for basic applications
2. identify and fix appropriate components and fittings in electrotechnical systems

## Underpinning Knowledge

The candidate will be able to:

- 1 state the application and safe use of hand and power tools relative to their
  - a strength
  - b rigidity
  - c control of movement
  - d insulation properties
  - e hand tools – pliers, cutters, saws, strippers, screwdrivers, hammers, files, crimping tools, conduit benders, socket sets, spanners, soldering irons, solders and fluxes, riveting tools, measuring tools, levels, testing devices
  - f power tools - drills, saws, grinders,
- 2 state that electrically operated tools (110V a.c. or battery operated) undergo inspection checks prior to and after use
- 3 state the inherent risks of electric shock when using extension leads and electrical tools/equipment
- 4 state the need or safe handling and storage of tools, equipment and electrically operated tools
- 5 identify basic types of electrotechnical systems and features
  - a power sources
  - b wiring/cable systems
  - c controls
  - d electrical components
  - e supports/fixings
- 6 identify fitting/fixing activities
  - a isolation procedures
  - b check specifications
  - c determine appropriate fixing/fitting methods
- 7 identify and deal appropriately with potential hazards
  - a working at heights
  - b lifting and handling
- 8 identify good housekeeping
  - a leave the work area clear and tidy
  - b note environment conditions
  - c label and record finished work

# Unit 3 – 203 Application of Health and Safety and Electrical Principles

## Rationale

The aim of this core unit is to develop the candidates' ability to apply safe working practices and electrical principles to the methods of work employed within the industry.

There are five learning outcomes to this unit. The candidate will be able to:

- 1 describe safe systems of working.
- 2 use technical information, specifications and data in relation to electro technical equipment and systems
- 3 describe the basic principle of operation of electrical machines and alternate current theory
- 4 describe the basic principles and operation of polyphase.
- 5 describe the basic principles of over-current & short-circuit rated protective devices and earth fault protection

## Connection with other awards

This core unit combines with units 1 and 2 and one of the occupational units (4-9) to form the Level 2 Certificate in electrotechnology

## Assessment

- 1 Practical Activities  
These will be assessed by a practical assignment set and marked by the centre to a template provided by City & Guilds.
- 2 Written Tests  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper produced in accordance with the test specification.

# Outcome 1 Describe safe systems of working

## Practical Activities

The candidate will be able to

1. compile a list of the competencies required to work safely and effectively.
2. identify safety equipment in the workplace/shop/site.
3. carry out safe working practices.
4. carry out safe isolation to current industrial standards.
5. check that warning notices and barriers are sited and installed correctly.
6. check that the workplace/site conditions remain safe for work to continue.
7. check that all working equipment is in safe working condition.
8. ensure that on completion of work, all tools, equipment and materials are removed, stored safely and securely.

## Underpinning Knowledge

The candidate will be able to:

- 1 state the health & safety risks, precautions and procedures associated with tasks in the workplace
  - a health and safety risks and causes of accidents
    - i human - carelessness, improper behaviour, lack of training supervision, fatigue, drug alcohol abuse.
    - ii environmental – unguarded or faulty machinery and tools, inadequate ventilation, untidy, dirty, badly lit workplaces.
  - b precautions
    - i risk assessment
    - ii positive personal attitudes
  - c procedures
    - i personal protection
    - ii safety from electricity
    - iii emergency procedures
- 2 list the five main stages of a risk assessment process as being:
  - a identify the hazards
  - b evaluate the risks
  - c record the findings
  - d prepare and implement an action plan
  - e periodically review findings
- 3 list the common categories of risk as
  - a falling and tripping
  - b manual handling
  - c use of equipment, machinery and tools
  - d storage of goods and materials
  - e fire
  - f electricity
  - g mechanical handling

- 4 list the common options for risk control as
  - a elimination
  - b substitution
  - c enclosure
  - d guarding
  - e safe system of work
  - f supervision, training and information
  - g personal protective equipment
  
- 5 state the necessity to develop positive personal attitudes to safety in order to adopt safe systems of working.
  - a the need to act and work responsibly and safely in order to protect themselves, other people and the environment
  - b the need to know the hazards that can occur, the protection available and the means of preventing accidents
  
- 6 list safety procedures to prevent injury or accident
  - a personal protection
    - i personal protection, eye, face protectors, protective clothing,
    - ii safety guards, screens
  - b safety from electricity
    - i checking and inspection of cables, leads and plugs, earthing of portable equipment, reduced voltage equipment
    - ii action to take in the event of electric shock, isolation, removal, treatment
  - c emergency procedures
    - i fire drills, location of extinguishers, types of extinguishers
    - ii evacuation procedures, escape routes, assembly points
  
- 7 state methods of formalized, controlled methods of establishing safe access and exit from site to include site visitors' records, diaries
  
- 8 establish that access equipment is in safe working order and suitable for a specific task
  - a the safe angle for erecting ladders
  - b methods of securing ladders
  - c safety requirements when working with tower scaffolds
  - d the need for guard rails and toe boards on scaffolding
  - e select appropriate access equipment such as ladders, trestles, scaffolding, platforms and give examples of their correct use/limitations
  
- 9 state the need to secure tools and equipment in order to both avoid losses and maintain insurance cover.
  
- 10 identify emergency switches, isolators, alarms and emergency equipment in the workplace and describe methods of verifying and securing (locking off) isolation.
  
- 11 state the need to ensure that on completion of work, the workplace/site is cleaned tidied and left in a safe condition
  
- 12 state the rules for manual handling and lifting with reference to
  - a body position
  - b balance
  - c carrying
  - d safety of others
  
- 13 state correct procedures for
  - a removing unused and waste materials and equipment
  - b disposing of waste materials

## Outcome 2 Use technical information, specifications and data in relation to electrotechnical equipment and systems

### Practical Activities

The candidate will be able to:

- 1 use drawings, diagrams in conjunction with a related specification.
- 2 demonstrate the ability to distribute technical information by the use of:
  - a A written report
  - b BS, BSEN symbols on a suitable drawing or diagram
  - c E-mail
  - d Facsimile (fax) machine
- 3 identify the need to check that the recipient of the technical information can understand such information.

### Underpinning Knowledge

The candidate will be able to

- 1 describe the types of technical information as
  - a equipment and system specifications
  - b manufacturers' data
  - c working drawings
  - d reports and schedules
  - e user instructions
  - f job sheets/time sheets
- 2 interpret drawings, diagrams in order to produce, locate, or install electrical/electronic systems, equipment, machines or cabling
- 3 describe how dimensions, measurements may be transferred from a scaled drawing or diagram to a workplace or site
- 4 prepare materials lists and requisites from working drawings and specifications
- 5 state how to take in situ measurements
- 6 state the relevant people normally involved in the use of technical information
  - a operative
  - b supervisor
  - c contractor
  - d site agent/manager
  - e customer/client
- 7 describe the recording methods for the receipt and checking of materials, appliances, tools and equipment
- 8 describe the need to present the right image to recipients of the technical information by
  - a appearance
  - b manner/attitude
  - c confidence
  - d knowledge
- 9 state conventional and electronics methods of distributing technical information.
- 10 state the importance of ensuring that the recipient can understand the information distributed

## Outcome 3 Describe the basic principle of operation of electrical machines and alternate current theory

### Practical Activities

The candidate will be able to

1. undertake measurements within a.c. circuits

### Underpinning Knowledge

The candidate will be able to:

- 1 state the basic principle of operation of
  - a a.c. motors
  - b relays
  - c d.c. machines
  - d fluorescent luminaire
- 2 state with the operating principles of basic transformers in terms of:
  - a change in flux linkage
  - b concept of self and mutual inductance
  - c turns ratio
  - d step up and step down configurations
  - e potential and current transformers
  - f isolating transformer
- 3 recognise the effects of resistance, inductance, capacitance, reactance and impedance in a.c. circuits
- 4 define the term power factor
- 5 measure the power factor for an a.c. circuit in terms of kW, kVA and kVAR.
- 6 state why power factor correction is required and how this may be achieved.

## Outcome 4 Describe the basic principles and operation of polyphase systems

### **Practical Activities**

The candidate will be able to

1. undertake measurements in three phase circuits

### **Underpinning Knowledge**

The candidate will be able to:

- 1 describe the production/operation, transmission and distribution of energy by a polyphase system.
- 2 differentiate between voltages and currents in balanced star and delta connected three phase supplies
- 3 state the reason for balancing single phase loads across a three phase supply

# Outcome 5 Describe the basic principles of over-current and short-circuit rated protective devices and earth fault protection

## Practical Activities

The candidate will be able to

1. use appropriate regulations, requirements and other published data in order to establish the rated short-circuit capacities of protective devices (fuses & circuit breakers)

## Underpinning Knowledge

The candidate will be able to

- 1 state the need for protective devices
- 2 state that the selection of a protective device appropriate to the associated circuit or equipment depends upon
  - a prospective fault current
  - b circuit load characteristics
  - c cable current carrying capacity
  - d disconnection time limitation
- 3 list the exposed and extraneous conductive parts within a building that would form a circuit to the mass of earth or the main earthing terminal under a fault condition
- 4 list the essential requirements for a device fitted into a circuit or item of equipment to protect against over current
  - a operates automatically
  - b has a current rating related to the circuit design current
  - c has an operating current such that the disconnection time is within the design parameters
  - d has adequate breaking capacity
  - e is suitably located and identified
- 5 state the action of a fuse under fault conditions
- 6 state the need for correct 'discrimination' of devices when a number of devices are fitted between the supply and the load
- 7 state the causes of current flowing to earth in an installation, system or item of equipment
- 8 state the need to maintain a low impedance path to ensure that over current and earth fault protective devices will operate with design parameters
- 9 state the path taken by earth fault current from within the installation, back to the supply transformer and back to the fault position
- 10 state the need for supplementary protection against electric shock by the use of a RCD or RBO

# Unit 4 - 205 Installation (Buildings and structures)

## Rationale

This unit is an optional unit; it is concerned with the underlying principles related to electrical installation. It will include the understanding and use of statutory and non-statutory legislation, use of drawings and specifications the installation types, cabling and equipment which is used

There are four outcomes to this unit: The candidate will be able to

- 1 identify the relevant statutory regulations, Codes of Practice and Memoranda relevant to specific classes of electrical installation
- 2 identify the purpose and application of specifications, drawings, instructions and other data within an electrical installation
- 3 identify the different types of electrical installations and systems
- 4 describe methods of undertaking electrical installations, systems and components

## Connection with other awards

This occupational unit combines with the core units to form the Level 2 Certificate in Electrotechnical Technology

## Assessment

- 1 Practical Activities  
These will be assessed by a practical assignment set and marked by the centre to a template provided by City & Guilds
- 2 Written Tests  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper produced in accordance with the test specification.

# Outcome 1 Identify the Statutory Regulations, Codes of Practice and Memoranda relevant to specific classes of electrical installation

## Practical Activities

The candidate will be able to

- 1 follow agreed safe working practices in order to avoid creating a dangerous situation for self or others.
- 2 identify appropriate parts of the Electricity at Work Regulations, BS 7671, the IEE On-Site Guide relevant to electrical installations, Codes of Practice relevant to specific classes/types of systems, installations and equipment, and Health and Safety Executive 'Electricity at Work' booklet

## Underpinning Knowledge

The candidate will be able to:

- 1 state that the Electricity at Work Regulations concerns all aspects of electrical systems, equipment and installations that is to be or has been energised and that the EaW Regulations are statutory and therefore legally binding
  - a. explain that the EaW Regulations set standards which will reduce the risk of electric shock, burns, fire or explosion due to the use of electrical systems or equipment.
  - b. locate specific parts within the EaW Regulations that relate work based tasks in the installation within buildings and structures
  - c. state that contravention of the EaW Regulations may lead to litigation
- 2
  - a state how site based responsibility may make a person a designated 'Duty Holder' with some duties carrying responsibilities that may be categorised as being:
    - i absolute
    - ii reasonably practical
  - b state the definition of systems
- 3 state how specific sections/topics within *BS7671* impact upon electrical installations within buildings and structures
  - a selection and erection of equipment
  - b isolation and switching
  - c inspection and testing
  - d protection against fire
  - e protection against electric shock
  - f protection against overcurrent
  - g special locations
- 4 state how data from the following may be used to support electrical installations
  - a BS 7671
  - b IEE Guidance Notes
  - c IEE On Site Guide
- 5 state current wiring regulatory requirements may impact upon the electrical installation process on-site.
- 6 state the need for statutory regulation of given hazardous installations
  - a potentially explosive atmospheres
  - b storage and delivery of petroleum
- 7 outline the requirements of Codes of Practice relevant to specific systems

- a earthing
- b lightning protection

8 state the purpose/function of a device or item of equipment identified by a BS or BSEN number within BS 7671

## Outcome 2 Identify the purpose and application of specifications, drawings, instructions and other data involved with electrical installations

### Practical activities

The candidate will be able to

- 1 identify sources of technical information
- 2 interpret charts, circuit drawings, wiring diagrams and schematic diagrams to facilitate installation processes

### Underpinning knowledge

The candidate will be able to

- 1 state the types of reference data and documentation as
  - a drawings, diagrams (circuit and wiring)
  - b specifications
  - c data charts
  - d manufacturers' manuals
- 2 state that technical information may be communicated by using
  - a technical drawings
  - b memorandum
  - c operations sheets
  - d data sheets
  - e exploded views
  - f electronic data, VDUs
- 3 state the purpose of drawings and specifications in order to determine
  - a the function and purpose of the installation
  - b materials, components and equipment required
- 4 interpret drawings and reference specifications in order to establish the type and location of an electrical installation and its associated components
- 5 state general information provided by drawings as
  - a scale
  - b parts by use of symbols
  - c routes/positions
- 6 state the function of the following in respect of an installation
  - a day work sheets
  - b job sheets
  - c time sheets
  - d delivery records
  - e reports

# Outcome 3 Identify the different types of electrical installations and systems

## Practical Activities

The candidate will be able to

1. identify different types of installation, electrical systems and components

## Underpinning Knowledge

The candidate will be able to

- 1 state types of electrical installation, components and related functions
  - a Lighting - providing functional levels of illumination in buildings and structures
  - b Heating - providing space and water heating and heating or commercial and industrial applications
  - c Power - providing circuits to drive electrical equipment, systems and components
  - d Environmental control – providing circuits and components to control heat/air
  - e Emergency management systems – providing circuits to support lighting/power in the event of a failure in the primary system
  - f Security and alarm systems – providing access/intruder controls and fire alarms
  - g Closed Circuit TV, communication and data transmission systems – providing specialised cabling for communication systems
- 2 state wiring systems and wiring enclosures
  - a Single and multicore thermoplastic (PVC) and thermosetting insulated cables (non-armoured)
  - b Single and multi core thermoplastic (PVC) and thermosetting insulated cables that have steel wire or non-magnetic armour
  - c Mineral insulated cable either with or without a PVC extruded sheath
  - d Steel conduit
  - e PVC conduit
  - f Metallic cable trunking
  - g PVC cable trunking
  - h Cable tray
  - i Ladder Racking
  - j Cable basket
  - k Armoured/braided control cables
  - l Data cables
  - m Optical fibre cable
- 3 state factors determining the choice of wiring systems, wiring enclosures and electrical equipment including
  - a ambient temperature
  - b effect of moisture on insulation
  - c corrosive substances
  - d UV rays
  - e damage by animals
  - f mechanical stress and vibration damage
  - g aesthetic considerations

- 4 state the factors affecting selection of conductor size such as
  - a design current
  - b control of voltage drop
  - c regulations concerning thermal constraints and shock protection.
  
- 5 carry out calculations to determine
  - a circuit current
  - b voltage drop
  - c protective device
  
- 6 state the application and limitations of specialised types of cables.
  - a *M.I.*, *FP200* and proprietary cable such as '*Firetuf*' for fire alarm installations.
  - b cable types used in copper cabled communication networks.
  - c fibre optic cables.
  
- 7 describe the function, operation and wiring of components for electrical systems
  - a lighting
    - i switches
    - ii lamps
    - iii terminals and connections
  - b power and heating
    - i ring and radial circuits and sockets
    - ii cooking and water heating circuits
    - iii motors
    - iv industrial installations
    - iii controls – thermostats, timers, meters, switch gear
  - c alarm and emergency systems
    - i relays
    - ii detectors
    - iii controls
    - iv maintained and non maintained systems
  - d data/communication systems
    - i cables and components
  
- 8 state the special arrangements that need to be considered for
  - a bathrooms
  - b external installations
  - c flammable/explosive situations
  - d temporary and construction site installations
  - e agricultural and horticultural installations
  
- 9 state system earthing arrangements to include
  - a TN-S
  - b TN-C-S
  - c TN-C
  - d TT
  
- 10 state the arrangements for electrical systems with relevance to
  - a isolation and switching,
  - b overcurrent protection
  - c earth fault protection.

# Outcome 4 Describe methods of undertaking installations of systems and components

## Practical Activities

The candidate will be able to

1. identify working conditions at the installation site
2. recognise hazards and undertake safety procedures
3. install systems and components
4. inspect and test an installation

## Underpinning Knowledge

The candidate will be able to

- 1 state means of assessing and stating precautions necessary before commencing installation activities
  - a identify possible sources of hazards
  - b prepare work area, access equipment
  - c identify PPE required
- 2 state the procedures for ensuring any live equipment, cables or circuits may be safely and securely isolated and 'locked off'
- 3 state the need to liaise with other contractors in order to maintain a safe working environment
- 4 state the use of a work plan to
  - a identify task
  - b develop specifications, drawings
  - c check materials, tools and equipment
- 5 state the purpose and use of equipment for measuring and marking out
  - a rules, tapes
  - b gauges
  - c levels, plumbs
  - d squares
  - e scribes
- 6 state methods for measuring, marking out and fixing installation equipment
- 7 state the factors affecting the use of trunking, traywork and conduit in installations
  - a fittings, joints and terminations
  - b bends and elbow
  - c thermal movement
  - d protection of cables
  - e size and accommodation of cables
  - f fire barriers
- 8 state devices for fixing enclosures and equipment to surfaces
  - a woodscrews
  - b spring toggles
  - c girder clips
  - d crampets
  - e masonry bolts

- 9 identify suitable support and installation methods with regard to
  - a application
  - b load-bearing capacity
  - c fabric of structure
  - d environmental conditions
  - e aesthetic considerations
  
- 10 describe the support of cables in vertical or horizontal runs by means of clips, or saddles at intervals determined by size and by recommendations for spacing given within BS: 7671
  
- 11 state the use of tools and equipment for fixing and installing
  - a cable cutters, wire strippers, knives, saws, drills
  - b files, reamers, spanners, wrenches
  - c bending and forming machines
  - d adhesives
  
- 12 describe the safe use and storage of tools and equipment
  - a inspect tools before and after use
  - b use of low voltage for power tools
  
- 13 state suitable methods of restoring building fabric on completion of installation
  
- 14 state procedures for the correct disposal of waste materials
  
- 15 state requirements for successful installation as
  - a secure fixing of systems and components
  - b electrical continuity and maintenance of system integrity
  - c avoidance of damage to components and system
  
- 16 state the requirements for electrical installation testing
  - a inspection
  - b continuity of protective conductors
  - c ring final circuit
  - d polarity
  - e ensure correct operation of circuits

## Unit 5 - 207 Electrical maintenance

### Rationale

This unit is an optional unit, it is concerned with the underlying principles and techniques associated with the maintenance of electrical systems and equipment. It will include the understanding and use of regulations, specifications and schedules and the function of systems and equipment

### Outcomes

There are five outcomes to this unit. The candidate will be able to

1. demonstrate an understanding of the function and principles of electrical maintenance
2. identify the relevant statutory and non-statutory legislation associated with electrical maintenance
3. identify different types of electrotechnical systems and equipment
4. state the purpose and application of reference data and documentation associated with electrical maintenance activities
5. identify procedures associated with the undertaking of electrical maintenance.

### Connection with other awards

This occupational unit combines with the core units to form the Level 2 Certificate in Electrotechnical Technology

### Assessment

1. Practical activities  
These will be assessed by a practical assignment set and marked by the centre to a template provided by City & Guilds.
2. Written test  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper.

# Outcome1 Demonstrate an understanding of the function and principles of electrical maintenance

## Practical Activities

The candidate will be able to

- 1 Identify various electrical maintenance activities

## Underpinning knowledge

The candidate will be able to

- 1 state that there are three general categories of electrical maintenance
  - a Planned preventive – conducted at specified planned intervals before failure/breakdown occurs
  - b Breakdown – conducted when systems/equipment is replaced/repared when failure occurs
  - c Monitored – conducted through performance measurement to identify possible failure
- 2 state that, in general, the reasons for conducting a maintenance operation would include:-
  - a ensure equipment is functioning efficiently and safely
  - b reduction of running costs and down time
  - c protection of the environment
  - d ensuring satisfactory returns on investment
  - e protection of personnel
  - f prevention of damage to equipment, machines and property
- 3 understand the importance of minimising 'downtime/shut down' in order to avoid
  - a loss of production
  - b poor customer relations
  - c increased labour costs
- 4 compare the advantages and disadvantages of the types of maintenance operation
- 5 identify the factors that support a safe and effective maintenance regime
  - a planning
  - b organisation
  - c control
  - d monitoring
  - e working in accordance with
    - i Industry Codes of Practice
    - ii Relevant statutory regulations

## Outcome 2 Identify the relevant statutory and non-statutory legislation associated with electrical maintenance

### Practical activities

The candidate will be able to

1. identify appropriate parts of relevant regulations

### Underpinning knowledge

The candidate will be able to

- 1 list those generic legal requirements that are relevant to maintenance regimes, which will include
  - a Common Law requirements – duty of care to persons, property and the environment
  - b specific legal requirements – plant/installation/equipment in scope to statutory requirements to include
    - i lifts, hoists, cranes, cradle systems
    - ii electrical equipment in stated premises
  - c those legal requirements that are implied - portable appliance testing, boiler plant above 150kW
- 2 identify those Acts, Regulations, Codes of Practice or Memoranda that pertain to 1a) 1b) and 1c)
  - a Factories Act 1961
  - b Offices, Shop and Building Premises Regulations 1968
  - c Construction (Lifting Operations) Regulations 1961
  - d Cinematography Act 1908
  - e Electricity at Work Regulations 1989
  - f The Electricity Safety, Quality and Continuity Regulations (2002)
  - g Provision & Use of Work Equipment Regulations 1992
  - h Fire Precautions Act 1971 or BS5266
  - i Workplace (Health, Safety and Welfare) Regulations 1992
  - j COSHH Regulations 1994
  - k HSE70 (The Control of Legionellosis)
  - l Clean Air Act and HSE Guidance Notes PM5
  - m HSE Codes of Practice for Refrigeration, Air Conditioning Systems
  - n Building Regulations
- 3 state that the Electricity at Work Regulations concern all aspects of electrical systems, equipment relevant to maintenance programmes/regimes that is to be, or has been energised and that the EaW Regulations are statutory and therefore legally binding
  - a state that the EaW Regulations set standards which will reduce risk of electric shock, burns, fire or explosion due to the use electrical systems or equipment whilst undertaking maintenance
  - b locate specific parts within the EaW Regulations that relate to work based tasks involved in electrical maintenance
  - c state that contravention of the EaW may lead to litigation
- 4
  - a state how site based responsibilities may make a person a designated 'duty holder' with some responsibilities that may be categorised as
    - i absolute
    - ii reasonably practical
  - b understand the definition of systems in terms of
    - i process
    - ii production
    - iii building services

- 5 identify the scope of BS 7671 Requirements for Electrical Installations with respect to
  - a maintenance operations
  - b protective measures
  - c isolation and switching for mechanical maintenance
  - d equipment
  - e special locations
  - f checks and test
  - g certification and reporting
  
- 6 identify within current wiring regulations the need to
  - a use a colour coding system to differentiate between insulated conductors of single and three-phase circuits
  - b recognise the type, application and rating of protective devices
  - c provide diagrams, charts etc. relating to the installation and related equipment  
Install and/or recognise warning notices
  
- 7 identify relevant Codes of Practice related to installed systems and/or equipment to include
  - a *BS 5839* Part 1 (Fire Detection Systems)
  - b *BS 5266* Part 1 (Emergency Lighting)
  - c IS.B.N. 0717604144: Work equipment, provision and use of equipment

# Outcome 3 Identify different types of electrotechnical systems and equipment

## Practical activities

The candidate will be able to

1. identify various electrotechnical systems

## Underpinning knowledge

The candidate will be able to

- 1 identify electrotechnical systems and equipment that can be included within maintenance activities as
  - a three-phase four wire distribution systems
  - b lighting systems – lamps; luminaires
  - c heating and ventilating systems
  - d air conditioning and refrigeration
  - e drive systems
  - f security
- 2 recognise three-phase wire distribution systems in terms of
  - a provision of a three-phase supply
  - b provision of a single-phase supply
  - c load balancing
- 3 state that the function of a lighting scheme or source can be to provide
  - a a safe, functional level of illumination within a building relevant to work tasks and movement
  - b required levels and colour to enhance the display or sale of goods
  - c the facilities for CCTV and internal/external floodlighting to operate within security or decorative schemes
  - d specialist engineering inspection by U.V. sources
  - e designed levels for specific tasks i.e. Electronic assembly or heavy engineering production
  - f glare free road and street lighting
  - g floodlighting of sports stadia to meet TV transmission levels
  - h heating for the welfare of young livestock (piglets etc.) in agricultural locations
- 4 state the need for maintenance requirements for luminaries
  - a frequency of cleaning
  - b replacement
- 5 state the function of the component parts of discharge type luminaries
  - a low pressure mercury vapour lamps with thermal and electronic starters
  - b high pressure mercury vapour lamp and control equipment
  - c high pressure metal Halide lamp and control equipment
  - d low pressure sodium lamp and control gear
  - e high pressure sodium lamp and control equipment
  - f high voltage discharge signs
  - g E.L.V. and mains halogen downlighters and spotlights
  - h emergency and/or escape lighting (central battery and self-contained systems)
  - l specialised luminaries using
    - i 'black light' or woods glass
    - ii UV and infra-red sources

- 6 state the stroboscopic effect of discharge lamps and methods of how it can be prevented
- 7 state that electrical heating schemes will include
  - a embedded underfloor, ceiling panel and specialised applications
  - b space heating (off-peak storage oil-filled radiators, fan assisted appliances)
  - c water heating (storage and instantaneous)
  - d 'trace' heating of pipe lines
  - e undersoil heating for the propagation of seedlings/plants within horticultural buildings.
  - f induction furnaces and process heaters in heavy industry
  - g catering equipment, eg cooker hobs, ovens, fryers, mixers
- 8 state that environmental controls in a building will utilise
  - a temperature sensors
  - b air pressure sensors
  - c motorised valves
  - d humidifiers
  - e control heating/boiler plant
  - f air conditioning plant
  - g electronic timers, programmers, visual displays/indicators
- 9 identify underfloor heating systems as having either a withdrawable or non-withdrawable heating cable connected to 'cold tails' which then connect to control equipment.
- 10 state the need for ceiling panel and underfloor heating schemes to meet design criteria ie loading per m<sup>2</sup> in order not to exceed comfortable surface or ambient temperature limits.
- 11 state the construction and operation of space heaters
  - a Off-peak storage heaters and associated control and metering arrangements
  - b Oil-filled radiators (wall mounted or free standing)
  - c Fan assisted heaters (portable and fixed) together with 'warm-air-curtains at shop and store entrances.
- 12 state the construction and operation of water heaters
  - a electrode boilers in industry
  - b pressure and non-pressure types
  - c instantaneous heater (hand washing and showers)
  - d immersion heaters fitted into storage tanks and calorimeters
  - e understand the application of 'Trace' heating cables in order to promote the flow of liquids in pipelines or to prevent the freezing of piped liquids.
- 13 identify systems suitable for undersoil heating together with the need to comply with the current wiring regulations and the IP Code (*BSEN 60529*).
- 14 state the basic operating principles of induction furnaces and other industrial process heaters
- 15 identify the component parts, and their function, of heating/ventilating and air conditioning systems in terms of
  - a control
  - b regulating temperature
  - c warm and cold air output
- 16 state the need to correctly
  - a position, control, ventilate and duct fumes/smoke when installing or reinstating/repairing electric hobs, ovens
  - b maintain equipment equipotential bonding where installed
  - c avoid damage to sensitive electronic control and timer units when conducting certain tests

- d ensure that all portable appliances used in the work place are 'logged' and periodically tested to meet the requirements of the *IE.E* Code of Practice
- 17 identify the following electrically power driven applications
- a lifts, escalators, travellers and hoists
  - b cranes - construction sites; heavy engineering (overhead)
  - c electrically powered vehicles , fork lift trucks
  - d motor operated access doors and shutters
  - e industrial grinders, mixers and valves
  - f production and processing machines/plant
  - g pumps and compressors
- 18 identify the type of motor drives and control equipment for:
- a lifts, escalators, travellers and hoists
  - b cranes - construction sites; heavy engineering (overhead)
  - c electrically powered vehicles , fork lift trucks
  - d motor operated access doors and shutters
  - e industrial grinders, mixers and valves
  - f production and processing machines/plant
  - g pumps and compressors
- 19 identify security systems
- a fire prevention and detection
  - b emergency lighting
  - c intruder alarms
  - d hazard warning

## Outcome 4 State the purpose and application of reference data and documentation associated with electrical maintenance activities

### Practical activities

The candidate will be able to

- 1 identify systems, components and equipment from
  - a drawings to *BS8888*
  - b assembly and detail drawings
  - c circuit and wiring diagrams
  - d *BSEN* symbols and conventions
  - e flow charts

### Underpinning Knowledge

The candidate will be able to:-

- 1 understand the importance of reference data and documentation
  - a drawings, diagrams (circuit and wiring)
  - b specifications
  - c data charts
  - d manufacturers' manuals
  - e servicing records/running logs
  - f flow charts
  - g standard maintenance time records
- 2 state that technical information may be communicated by utilising
  - a technical drawings
  - b memorandum
  - c operations sheets
  - d data charts
  - e exploded views
  - f electronic data, micro-fibre, VDUs
- 3 state the purpose of part numbers or codes in manufacturers/suppliers catalogues
- 4 state the purpose of reporting procedures to include
  - a equipment/schedule/component identification
  - b description of work carried out
  - c recommendations, modifications
  - d use of maintenance performance indicators

# Outcome 5 Identify procedures associated with the undertaking of electrical maintenance

## Practical activities

The candidate will be able to

- 1 Undertake basic maintenance on electrical equipment

## Underpinning knowledge

The candidate will be able to

- 1 state the organisation requirements of a work plan
  - a definition of the task
  - b safety precautions
  - c plan shut down/isolation
  - d permit to work
  - e co-ordination for tools, equipment, spare parts
  - f documentation
  - g communication with relevant parties
  - h time/cost estimates
- 2 state the Health and Safety requirements for specific maintenance operations
- 3 state those hazards or obstructions that may impact upon the maintenance programme/regime as including
  - a restricted access, workspace and elevated locations
  - b thermal insulation/lagging such as ceramic wools, asbestos, sheet metal
  - c toxic and/or corrosive substances, irritants, dust, fumes, combustible materials
- 4 identify any specific safety instructions that may apply to the work area
  - a 'permit to work'
  - b confined spaces
  - c personal protective equipment
- 5 state the requirements for a 'permit to work' in areas restricted by
  - a high voltage equipment
  - b flammable or explosive atmospheres
  - c corrosive environments
  - d dust of fibre-laden atmospheres
- 6 describe the procedures to be followed to ensure compliance with a 'permit-to-work' related to
  - a circuit main earth application
  - b safe zones
  - c points of isolation
  - d posting of danger notices
- 7 identify work requirements imposed by the *Electrical Association Engineering Recommendations ER664* for work to be conducted in confined spaces such as tunnels, underground chambers or ducts
- 8 state the necessity for PPE and accompaniment, if, for example
  - a working 'live'
  - b entering underground chamber or tunnels where it is necessary to wear breathing apparatus, harness and safety line.

- 9 describe how to arrange for the safe isolation of pressurised systems such as hydraulic, compressed air, water, gas and steam
- 10 explain the need for and location of basic first aid and emergency equipment..
- 11 state how to isolate the work area from others by utilising
  - a fences
  - b barriers
  - c screens
  - d warning signs
- 12 state the application and safe use of hand tools relative to their
  - e strength
  - f rigidity
  - g control of movement
  - h insulation properties
  - i accuracy
  - j fit for purpose
- 13 state the safe use of portable and fixed lifting equipment to include
  - a overhead cranes
  - b block and tackle
  - c mobile hoists
  - d slings and cradling devices
- 14 state the use of access equipment to include
  - a scaffold (fixed and portable)
  - b motorised platforms (cherry pickers)
- 15 state the use of
  - a rotating, positioning and straightening devices
  - b jacking devices and hydraulic rams
  - c trolleys and hand-operated trucks for moving and positioning loads.
- 16 state the checks for electrically operated tools (110V a.c. or battery operated) prior to and after use.
- 17 state the benefits and limitations of thermal joining and bonding with adhesives compared with mechanical fastenings and terminations
- 18 state the need or safe handling and storage of tools, equipment and electrically operated tools.
- 19 state the range and application of materials for plant, equipment and components that would be met or used within the maintenance programmes or regimes to include
  - a thermoplastic
  - b thermosetting (rubber compounds)
  - c fibre glass sleeving
  - d varnish, shellac
  - e ceramics
  - f metals (conductors, structural)
  - g solvents

- 20 identify the different types of cable in general use, stating practical applications for such cables together with any limitations upon their use
- a Thermoplastic or Thermosetting insulated (non-sheathed),
  - b Flat multicore Thermoplastic or Thermosetting insulated and sheathed.
  - c Mineral insulated copper conductors and sheath.
  - d Multi-core thermoplastic (PVC)
  - e Data/communication cables
  - f PVC single wire armoured
- 21 state the factors that determine the current carrying capacity of a cable
- a Circuit Design Current
  - b Type and Rating of Protective Device
  - c Control of voltage drop
  - d Application of relevant 'correction factors
- 22 determine the appropriate type of cable for an installation given related criteria.
- 23 state the procedures for waste disposal following the completion of maintenance works, to include oils, lamps, scrap materials and metals.
- 24 state the procedures required on completion of maintenance
- a operational checks
  - b records and reporting

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# Unit 6 – 209 Highway Electrical Systems

## Rationale

This unit is an optional unit; it is concerned with the underlying principles related to the installation and maintenance of highway electrical equipment and systems. It will include the understanding and use of statutory and non statutory legislation, application of drawings and specifications, basic operating characteristics and installation techniques.

## Outcomes

This unit covers five performance outcomes, the candidate will be able to,

- 1 recognise the types of locations and limitations where highway electrical equipment may be installed
- 2 understand the fundamentals of highway electrical equipment, systems and components
- 3 identify the relevant statutory and non-statutory legislation associated with highway electrical equipment, systems and components
- 4 recognise the purpose and application of instructions and manufacturers' information involved with the installation and maintenance of highway electrical equipment, systems and components
- 5 understand approved methods of installation
- 6 select and apply fault identification and rectification techniques
- 7 select appropriate methods and use tools and instruments to restore systems equipment and components to working order.

## Connection with other awards

This occupational unit combines with the core units to form the Level 2 Certificate in Electrotechnical Technology.

## Assessment

1. Practical activities  
These will be assessed by a practical assignment set and marked by the centre to a template provided by City & Guilds.
2. Written test  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper

# Outcome 1 Recognise the types of locations and limitations where highway electrical equipment may be installed

## Practical activities

The candidate will be able to

- 1 identify various public and private locations and the types of highway electrical equipment which may be installed therein.

## Underpinning knowledge

The candidate will be able to

- 1 identify those locations or situations that are public or privately owned and the methods of use by vehicles, cyclists and pedestrians eg
  - a motorways, main traffic routes
  - b subsidiary roads/streets with pedestrian areas
  - c road junctions, roundabouts
  - d shopping malls, pedestrian precincts
  - e public parks, gardens
  - f the layout and construction of roads and footpaths
  - g site boundaries
- 2 state the benefits gained by having effective public lighting systems installed, to include
  - a main roads, residential areas, pavements, zebra crossings, shopping malls, pedestrian areas, car parks etc. to provide safe passage for vehicular and pedestrian traffic, reducing the fear of crime and assisting security.
  - b street furniture such as, traffic island bollards and traffic signs which benefit from being illuminated.
- 3 identify the limitations that act upon highway electrical systems
  - a Siting of equipment relative to buildings and existing street furniture.
  - b Types and classification of roads/streets
  - c The proximity of other 'service undertakers' plant located in and above the highway

## Outcome 2 Understand the fundamentals of highway electrical equipment systems and components

### Practical activities

The candidate will be able to

- 1 Identify the variety of highway electrical equipment, systems and components in common use.

### Underpinning knowledge

The candidate will be able to

- 1 state the basic principles of electrical circuits
  - a lighting equipment
  - b signing equipment
  - c Electricity Company ( REC ) supplies
- 2 list the variety of components and their uses that form part of a highway electrical system
  - a Luminaires
  - b Lamps
  - c Chokes/Transformers
  - d Ignitors
  - e Photo Electric Control Units
  - f Cut Outs
  - g Isolators
  - h Conductors and Insulators
- 3 list the types of discharge lamps that may form an essential part of a highway electrical system
  - a Low pressure mercury ( T8 -T12 )
  - b Low pressure mercury ( CFL )
  - c High pressure mercury vapour ( MBF )
  - d Low pressure sodium ( SOX )
  - e High pressure sodium ( SON )
  - f Metal halide ( MBI )
  - g Ceramic metal halide ( CDM )
  - h Light emitting diode ( LED )
- 4 list the types of protective devices that may form part of a highway electrical system
  - a fuses to BS 1361
  - b general purpose fuses to BS 88-2
  - c Residual Current Devices (rcds)
- 5 state the purpose of other control equipment
  - a time switches
  - b Photo Electric Control Units
  - c power factor correction capacitors
- 6 identify types of isolating and switch-disconnecting devices employed to isolate part or the whole of a Highway Electrical System.

## Outcome 3 Identify the relevant statutory and non statutory legislation associated with highway electrical equipment systems and components

### Practical activities

The candidate will be able to

- 1 identify appropriate parts of relevant Regulations

### Underpinning knowledge

The candidate will be able to do:

- 1 list those statutory regulations that are relevant to the installation and maintenance of Highway Electrical Equipment and systems
  - a The Electricity Safety, Quality and Continuity Regulations 2002
  - b The Electricity at Work Regulations 1989 (Work activities, Places of Work, etc)
  - c The Electrical Equipment (Safety) Regulations 1994
  - d The Health and Safety (Safety Signs and Signals) Regulations 1996
  - e The Management of Health and Safety at Work Regulations 1999
  - f The Provision and Use of Work Equipment Regulations 1998
  - g The Personal Protective Equipment at Work Regulations 1992
  - h The Workplace (Health, Safety and Welfare) Regulations 1992
  - i The Manual Handling Operations Regulations 1992
  - j The New Roads and Street Works Act
  - k The Control of Substances Hazardous to Health C.O.S.H.H.
- 2 list those Codes of Practice and Memorandum that are relevant to the installation and maintenance of Highway Electrical Equipment and systems
  - a H.S.E guidance H.S.G. 47 (Avoiding danger from Underground and Overhead Services)
  - b National Joint Utility Group (N.J.U.G.) The Laying of Cables in Public Highways
  - c The I.L.E. Code of Practice for Electrical Safety in Highway Electrical Operations
  - d H.S.E. Traffic Signs Manual (Temporary Signing and Guarding)
  - e Electricity Association G39/1
  - f BS 7671 ( Parts 1 and 6 )
- 3 explain the responsibility of a Duty Holder (as defined in the E.A.W Regulations as onerous legal implications)
- 4 state the need to maintain a safe working environment and follow a safe system of work
- 5 state the need to comply with work instructions, specifications, diagram or drawings that should embody any statutory regulatory requirement
- 6 ensure that prior to use or commencing work based tasks, all equipment, tools and P.P.E. complies with all H.S.E. requirements
- 7 state in detail the process of detecting buried electrical service cables by means of proprietary equipment (CAT etc)
- 8 explain how to identify, locate, retrieve and apply relevant regulatory or guidance information to a specific task (statutory, non-statutory, Codes of Practice, H.S.E. documents etc)
- 9 identify factors within the New Roads and Streets Act that can affect installation and maintenance activities

## Outcome 4 Recognise the purpose of drawings and instructions in the installation and maintenance of highway electrical equipment systems and components

### **Practical activities**

The candidate will be able to

- 1 determine the scope of the works to be undertaken following
  - a instructions/confirmation from the line manager
- 2 assess the boundaries of the work site set by
  - a nature of works
  - b location

### **Underpinning knowledge**

The candidate will be able to

- 1 interpret works instruction in order to establish the type and location of a highway electrical system to be installed/maintained
- 2 state the purpose of part numbers or codes in manufacturers'/suppliers' catalogues
- 3 state general information provided by works instruction as
  - a works location
  - b extent of works
  - c parts
  - d cable routes

# Outcome 5 Understand approved methods for installation

## Practical Activities

The candidate will be able to

- 1 identify working conditions that prevail at and around the work site to include:
  - a presence of overhead services (electricity, telephone)
  - b presence of underground services (electricity, gas, water, communications, drainage)
- 2 recognise hazards that may be commencing work on or around the site
- 3 recognise the hazards that may be created by the working environment that may include
  - a type of site
  - b confined working space
  - c presence of machinery that is operating
  - d weather conditions (rain, snow, ice, traffic pedestrian and vehicular )
- 4 install typical highway electrical equipment and components

## Underpinning knowledge

The candidate will be able to

- 1 state means of assessing and precautions necessary to meet the differing levels of risk attendant upon the variety of work sites.
  - a protection of the public from work activities on site by the use of barriers and warning signs.
  - b the risk of using access plant where overhead services exist.
  - c using safe methods of detecting and locating underground electrical services.
  - d the need to avoid the use of mechanised diggers or hand held power tools when excavating over or close to underground services.
  - e the use of proprietary cable locating devices prior to commencing any excavation work.
  - f the need for approved methods of excavation and in-filling of trenches
  - g the need for certificated or licensed personnel to operate plant
- 2 state how any live electrical equipment, cables or circuits may be safely and securely isolated, including the procedure for isolating equipment from an energy source and the need to avoid 'Live Working'
- 3 describe the items of P.P.E. required for specific tasks on-site to include:
  - a hard hats (Safety Helmets)
  - b safety footwear
  - c 'Fluorescent/Reflective' jacket or waistcoat
  - d rain suit
  - e ear protectors
  - f safety spectacles or goggles/visions
  - g fall arrest harness, lanyard and block
  - h insulated gloves/mats
- 4 state the requirement to
  - a install new cables in ducts
  - b overlay cables with warning tiles or tapes in order to comply with the Electrical Safety, Quality and Continuity Regulations
- 5 state the need to liaise with other contractors in order to maintain a safe working environment

- 6 state approved methods of installing lighting columns (having standard heights of 6m, 8m, 10m and 12m) sign/signal posts and controller/feeder cabinets to include:
  - a positioning by mechanical machines, cranes etc
  - b excavation and installation to approved foundation  
installation flanged based column to be bolted either to steel structures (bridges, flyovers) or to embedded concrete bases having fixed studs/bolts in situ
- 7 state the need to ensure lighting columns are installed correctly in order to maintain a long, safe installation life that will endure any perceived wind forces
- 8 identify from the Electrical Safety Quality and Continuity Regulations, the approved methods of in-filling trenches and marking the routes of buried cables
- 9 state that all fixings of luminaires to lighting columns or other types of installation must comply with manufacturer's instructions
- 10 list the industry approved methods of fixing luminaires, cabling and associated components
- 11 state the importance of selecting the correct type and rating of protective device
- 12 identify methods used for packaging component parts and equipment received on site
  - a bubblewrap
  - b corrugated cardboard
  - c sealed plastic bags or wraps
  - d cardboard boxes
  - e packing cases
  - f polystyrene chips, beads
  - g polystyrene moulded to component shape
- 13 state the need to avoid skin contact with some types of lamp envelopes, quartz tubes
- 14 state the need to avoid abrasion of painted or metallic finish on component parts of equipment in order to maintain aesthetics and anti-corrosion finishes
- 15 state the need to employ/adopt the correct stance when lifting objects from the ground or back of vehicle
16. identify sections from within the Manual Handling Operations Regulations that will impact upon work tasks on site
17. identify the type of lifting equipment (manual or mechanised) recognised for specific tasks, eg location of 'street furniture' such as:
  - a lighting columns with lanterns
  - b control equipment within an enclosure (feeder pillar or signal controller cabinet )
- 18 identify the appropriate type of access plant to facilitate the safe handling of luminaires, component parts together with effective and efficient fixing and termination of equipment and cabling

# Outcome 6 Select and apply fault identification and rectification Techniques

## Practical Activities

The candidate will be able to

- 1 utilise safe methods for undertaking fault identification
- 2 determine faults in highway electrical systems and equipment

## Underpinning knowledge

The candidate will be able to

- 1 identify highway electrical systems and equipment
- 2 state the safe working procedures to be applied before undertaking fault identification
  - a isolating devices are identified and operated
  - b voltage indication equipment is 'proved' prior to verifying effective isolation
  - c isolation device secured in OFF position
  - d warning notices posted
  - e all relevant safety and functional checks are completed prior to restoration of supply
- 3 state the basic principles of undertaking fault identification as
  - a knowledge and understanding of relevant highway electrical systems and equipment
  - b optimum use of personal and others experience and expertise of systems and equipment
  - c use of a logical approach
- 4 list the stages of logical fault diagnosis and rectification
  - a collection and collation of data
    - i information on events leading up to the fault occurring
    - ii information from verbal and written reports
  - b analysis of evidence and use of standard procedures to identify the cause of faults
  - c interpretation of test results
  - d functional checks and test to verify rectification and restoration as per appropriate regulations
- 5 list circumstances where faults may occur in a lighting system
  - a wiring
  - b cable terminations
  - c accessories/controls (eg switches, contactors)
  - d instrumentation/metering
  - e protective devices
  - f luminaires
  - g flexible cable/cords
  - h components
- 6 state typical symptoms as
  - a complete loss of supply
  - b localised loss of supply
  - c overload or fault current devices operating
  - d insulation failure
  - e component failure

- 7 state the factors which may effect rectification
  - a access to system/equipment

## Outcome 7 Select appropriate methods and use tools, equipment and instruments to restore highway electrical systems, equipment and components to working order

### Practical Activities

The candidate will be able to

- 1 apply faulty component identification and rectification techniques
- 2 determine appropriate procedures for re commissioning of lighting systems, components and equipment and restore system, equipment, component to working order
- 3 demonstrate safe and efficient practices

### Underpinning knowledge

The candidate will be able to

- 1 list relevant sources of information to facilitate re commissioning
  - a Works instruction
  - b BS:7671
  - c manufacturers' instructions
  - d relevant statutory legislation
- 2 state procedures for dealing with report forms and documentation
- 3 state the importance of
  - a verifying test instruments
  - b regular calibration
  - c use of documentary evidence
- 4 state how to carry out functional checks and tests to verify rectification and restoration of system and equipment including as appropriate
- 5 list procedures for the disposal of waste materials and leaving site in a safe and clean condition
- 6 state the process for completion after rectification in terms of
  - a responsibilities of relevant personnel
  - b documentation

# Unit 7 - 211 Installing Instrumentation and Associated Equipment

## Rationale

This unit is an optional unit; it is concerned with the underlying principles related to instrumentation and display devices. It will include the understanding and use of statutory and non statutory legislation, use of drawings and specifications and the functions and installation needs.

## Outcomes

This unit covers five performance outcomes, the candidate will be able to

- 1 recognise the function and application of display devices/instrumentation
- 2 identify the relevant statutory and non statutory legislation associated with the installation of display devices/instrumentation
- 3 state the purpose and application of manufacturers instructions and specifications involved with the installation of display devices/instrumentation and associated equipment
- 4 identify installation methods used in conjunction with display/instrumentation devices
- 5 describe the environmental effects that may effect display device performance and integrity

## Connections with other awards

This occupational unit combines with the core units to form the Level 2 Certificate in Electrotechnical Technology

## Assessment

- 1 Practical activities  
These will be assessed by a practical assignment set and marked by the centre to a template provided by City & Guilds.
- 2 Written test  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper

# Outcome 1 Recognise the function and application of display devices/instrumentation

## Practical Activities

The candidate will be able to

- 1 identify various display devices for particular requirements

## Underpinning knowledge

The candidate will be able to

- 1 state the different functions that display devices fulfil to include
  - a display/measurement by the use of sensors
  - b recording for permanent retention
  - c control in conjunction with servo-mechanisms
- 2 state that the terminology relevant to the selection and effective operation of display devices includes
  - a range – operating limits
  - b rating – recommended conditions within which the equipment operates
  - c reliability – ability to provide identical responses or repeated applications
  - d response – time taken to reach final output from a given input
  - e resolution – ability to display a value relative to the smallest detected input
  - f sensitivity – relationship between a change in the output to the change in the input
  - g tolerance – largest amount of error that can occur during operation
- 3 state that display devices can serve the following functions
  - a measurement of linear and/or rotational motion
    - i levels
    - ii height
    - iii weight
    - iv volume
  - b flow
    - i current
    - ii voltage
    - iii power
  - c pressure
  - d temperature
- 4 state the operation of the two main types of recording instruments
  - a xyplotter
  - b servo chart
- 5 state that display devices are of two types
  - a analogue
  - b digital
- 6 state the basic operating principles of 7 and 16 digit display devices utilising either light emitting diodes (LEDs) or liquid crystal technology

## Outcome 2 Identify the relevant statutory and non statutory legislation associated with the installation of display devices/instrumentation

### Practical Activities

The candidate will be able to

- 1 identify appropriate parts of the Electricity at Work Regulations, IEE On-site Guide, BS 7671 and Codes of Practice relevant to installation of display devices
- 2 work to the procedure for safe working practice as set out in the Health and Safety Executive 'Electricity at Work' booklet

### Underpinning Knowledge

The candidate will be able to

- 1 state that the Electricity at Work Regulations concerns all aspects of electrical systems equipment and/or display devices/instrumentation that is to be, or has been energised and that the EaW Regulations are statutory and therefore legally binding
  - a explain that the EaW Regulations set standards which will reduce the risk of electric shock, burns, fire or explosion due to the use of electrical systems or equipment whilst installing display devices/instrumentation
  - b locate specific parts within the EaW Regulations that relate to work based tasks involved in the installation and connection of equipment and associated display devices
  - c state that contravention of the EaW may lead to litigation
- 2
  - a state how site based responsibilities may make a person a designated 'Duty Holder' with some duties carrying responsibilities that may be categorised as
    - i absolute
    - ii reasonably practical
  - b state the definition of 'systems'
- 3 state how specific sections/topics within BS 7671 impact upon the installation of display devices, instruments and associated equipment, to include
  - a protective devices
  - b interconnecting cabling between display devices and associated equipment
  - c compliance with the index of protection (IP) code (BSEN 60529)
  - d provision of isolation devices
  - e labelling
  - f connections and terminations
  - g electrical continuity
- 4 state how data from the following may be used to support the installation of display devices and associated equipment
  - a BS 7671
  - b IEE Guidance Notes
  - c IEE On Site Guide

- 5 state how BS 7671 regulatory requirements may impact upon the installation of display devices and associated equipment with reference to
  - a location
  - b environmental conditions
  - c access and general lighting
  - d ambient temperature
  - e cable routing to equipment being monitored
  
- 6 state the status and purpose of the following codes and standards that apply to the components and equipment interconnected to instrumentation
  - a DEMKO
  - b SEMKO
  - c NEMCO
  - d KEMA
  - e OVE
  - f F1
  - g SEV
  - h UL
  - u BS EN 60947-3
  - k DE 0660
  
- 7 state the need for approved types of terminals and terminations to meet high levels of quality and durability in order to meet codes and standards that include
  - a IEC 898-1
  - b CSA (LR39927)
  - c TIA
  - d EIA
  - e CECC
  
- 8 state the need for an identification system for interconnecting cables which includes
  - a colour coding
  - b marker ties
  - c marker plates
  - d snap on PVC numerical markers
  
- 9 state that a number of national and international standards oversee the quality of varying types of cable
  - a BS 6500
  - b CSA TEW
  - c UL 1015
  - d UL 1028
  - e UL 1283
  
- 10 state the code of practice and standards that impact upon earthing to include
  - a BS EN 60439-1
  - b BS 7671
  - c BS EN 80310
  - d BS 4444
  - e BS 7430

## Outcome 3 Identify the purpose and application of manufacturers' instructions and specifications involved with the installation of display devices/instrumentation and associated equipment

### Practical activities

The candidate will be able to

- 1 reference drawings, specifications and manufacturers' instructions to identify required tools, components and equipment
- 2 interpret drawings, circuit diagrams, wiring diagrams and schematic diagrams to facilitate installation and assembly processes

### Underpinning knowledge

The candidate will be able to

- 1 state the types of reference data and documentation
  - a drawings, diagrams (circuit and wiring)
  - b specifications
  - c data charts
  - d manufacturers' manuals
  - e servicing records/logs
- 2 state that technical information may be communicated using
  - a technical drawings
  - b memorandum
  - c operations sheets
  - d data sheets
  - e exploded views
  - f electronic data VDUs
- 3 state how a schedule of equipment may be compiled.
- 4 state the purpose of part numbers or codes in manufacturers'/suppliers' catalogues.
- 5 state the purpose of drawings and/or specifications in order to determine
  - a the function and characteristics of instrumentation equipment
  - b materials, component parts and instrumentation requirements
- 6 state general information provided by drawings as
  - a scale
  - b general tolerances
  - c surface finishes
  - d warning notices
  - e parts by use of symbols

## Outcome 4 Identify installation methods and techniques associated with cables, connectors for display devices/instrumentation

### Practical activities

The candidate will be able to

- 1 identify and undertake appropriate installation methods using, wiring systems, cables and connectors for display devices/instrumentation

### Underpinning knowledge

The candidate will be able to

- 1 describe the various types of wiring systems
  - a single and multicore thermoplastic (pvc) – non armoured and armoured
  - b mineral insulated cable
  - c steel conduit
  - d pvc conduit
  - e metallic cable trunking
  - f pvc cable trunking
  - g cable tray
  - h cable basket
  - i armoured/braided control cables
  - j category and data cabling
  - k optical fibre cabling
- 2 state the cable types used to interconnect display devices and associated components
  - a tri-rated
  - b control cables to 18 core-VDE coded
  - c braided control cable
  - d high performance 'flex light'
  - e screened ribbon cable
  - f screened data transmission
  - g copper braid (flat) earth straps
- 3 state the application of the BS 7671 in respect of current carrying capacity and the selection of cables
- 4 state the need for protective earth conductors
- 5 list common types of cable termination
  - a tag
  - b tunnel
  - c screw
  - d lug (crimped/soldered)
  - e pin
  - f insulation displacement
  - g bus-bar

- 6 state the factors which affect the types of termination
  - a circuit design current
  - b conductor type and current rating
  - c size of conductor (mm<sup>2</sup>)
  - d type of equipment being supplied
  - e physical space around terminations
  
- 7 list methods of interconnection
  - a wire wrapping
  - b soldering
  - c crimping
  - d bolts/clamps
  - e pinching screws
  
- 8 state types of connections
  - a edge connectors
  - b plugs and sockets
  - c quick connect (spring loaded levers)
  - d boot lace
  - e crimp terminals
  - f electro tap splices
  - g cable mount
  - h multi pin
  - i pads onto PCB
  
- 9 state the tools and equipment available and applications for
  - a measuring and marking out
  - b cutting, connecting and jointing
  
- 10 state the need for the safe handling and storage of tools and equipment
  
- 11 state requirements for successful terminations as
  - a adequately mounted or supported to avoid vibration and mechanical stress/strain
  - b electrical continuity
  - c prevention of overheating
  - d avoidance of damage to component parts
  
- 12 state the benefits of quick and simple disconnection/reconnection to facilitate replacement of component parts.
  
- 13 state the precautions to avoid risk of damage to electrostatic sensitive equipment
  - a safe handling
  - b discharge of static using earth straps
  - c use of packaging to avoid
    - i dust/fibres
    - ii moisture ingress
    - iii over temperature
  
- 14 state procedures for waste disposal following the completion of activities
  
- 15 state the purpose of risk assessments and method statements

## Outcome 5 Describe the environmental factors that may effect display device performance and integrity

### Practical activities

The candidate will be able to

- 1 identify situations where performance may be effected
- 2 carry out remedial action to maintain optimum performance

### Underpinning knowledge

The candidate will be able to

- 1 state the adverse effects on installed equipment, components and display devices caused by
  - a over voltage
  - b under voltage
  - c harmonic currents
  - d protective conductor currents
  - e high frequency oscillators
  - f electrostatic charge
  - g electromagnetic interference
  - h impact
  - i vibration
- 2 state the adverse effects on installed equipment, components and display devices caused by environmental factors
  - a ambient temperature
  - b foreign bodies – dust/fibre
  - c condensation
  - d humidity
  - e corrosion
  - f acoustic and shock protection
- 3 state visual inspection procedures for ensuring that installation and assembly meet appropriate conditions
  - a structural integrity
  - b secure joints and fastenings

# Unit 8 - 213 Electrotechnical Panel Building

## Rationale

This unit is an optional unit; it is concerned with the underlying principles related to electrical panels. It will include the understanding and use of statutory and non-statutory legislation, applications of drawings and specifications, basic operational characteristics and building and installation techniques

## Outcomes

There are four learning outcomes to this unit the candidate will be able to

- 1 recognise the function and application of electrical panels
- 2 recognise the relevant statutory and non-statutory legislation associated with electrical panels
- 3 identify the purpose and application of instructions and specifications associated with the building of panels
- 4 identify panel building and installation techniques

## Connection with other awards

This occupational unit combines with the core units to form the Level 2 Certificate in Electrotechnical Technology.

## Assessment

1. Practical activities  
These will be assessed by a practical assignment set and marked by the centre to a template provided by City & Guilds.
2. Written test  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper.

# Outcome 1 Recognise the types and functional requirements of electrical panels

## Practical activities

The candidate will be able to

1. identify various types of panels
2. identify the different types of insulators, connectors, instruments, indicators and equipment that form an essential part of the panel assembly and the function they serve.

## Underpinning knowledge

The candidate will be able to

- 1 describe an electrotechnical panel as a multi-functional enclosure containing an electrical system for switchgear, power distribution, control components, instrumentation and their component parts and their accessories.
- 2 state the various types of conductor systems installed in panels and state the benefits and limitations accrued in their use
  - a Identify the cable types used to interconnect switchgear in the panels to include
    - i Tri-rated *BS6231*, CSA, TEW and UL Codes
    - ii Control cable up to 18 core – VDE Code
    - iii Braided control cable
    - iv High Performance ‘flexlite’
    - v Colour coded ribbon cable – UL coded
    - vi Screened ribbon cable – UL coded
    - vii Screened Data Transmission – UL coded
    - viii Copper braid (flat) earth straps
    - ix Insulated mains copper bus-bar
    - x Bare copper bus-bars
  - b State the temperature limitation of thermoplastic (PVC) insulation, unless rated at 90°C
  - c State that panel door mounted instrumentation and control equipment are best served by flexible conductors suitably supported.
  - d State installed cables must be rated to carry the design current.
  - e State the need for screened cable to avoid electromagnetic interference
  - f State the need for substantial protective (earth) conductors
  - g State the benefits of having a bus-bar (insulated) or un-insulated onto which multiple connections of conductors can be made.
- 3 state the different insulators and insulation material that serve a number of uses in the construction of electrical components, identifying the advantages and limitations associated with each type and material.
  - a Identify standard cable insulation to include
    - i 70°C thermoplastic (general purpose PVC) installed in steel/PVC conduits and trunking to and from panels.
    - ii 90°C thermoplastic (PVC) used as flexible leads to equipment and door mounted equipment.
    - iii 85°C thermosetting (Rubber) used as flexible leads to equipment and door mounted equipment.
    - iv Magnesium Oxide in mineral Insulated cable supplying mains intake at panel or to equipment from panel.

- b identify insulation material used in the construction of flexible conduit enclosures to include
    - i Standard nylon
    - ii Polypropylene
    - iii Polyethylene
    - iv Polyamide
  - c identify insulation material used for cable trunking in panels to include
    - i Self-extinguishing PVC
    - ii Polyphrenylen-Oxide (NORYL)
    - iii Blue PVC
    - iv Polypropylene
  - d identify insulation material used for equipment (relays, timers, PLCs, switches, meters) connected to a panel
    - i High impact moulded thermoplastic
    - ii Polycarbonate
    - iii Acrylic
    - iv A.B.S
    - v Polystyrene
  - e state that the type of insulation used for cables is determined by not only the ambient temperature but the conductor operating temperature.
- 4 state the application and limitation of use for flexible conduit enclosures in panels to include
- a Standard nylon – has temperature range up to 105°C, halogen free, Medium duty
  - b Polypropylene – has temperature range up to 90°C, halogen free
  - c Polyethylene – has temperature range up to 55°C, low physical/mechanical strength, not zero halogen rated
  - d Polyamide – has temperature range up to 90°C, halogen free – light duty applications
  - e High screen (LFH) with leaded steel and paper layers protected with LFH sheath screens against radio frequency
- 5 state the application and limitation of use for cable trunking used as an enclosure/support for inter-connecting cables in panels
- a Self-extinguishing with either open or closed slots – has maximum operating temperature of 60°C, incorporates pre-punched fixing slots to ease chassis mounting
  - b Polyphrenylen-oxide (NORYL) is also self-extinguishing, but is halogen free and is rated as a limited fire hazard, temperature rating up to 120°C
  - c Blue PVC is used to indicate 'intrinsically safe wiring' is enclosed, temperature range is limited to 60°C
  - d Polypropylene has a self-adhesive backing, low flammability rating and is halogen free as well as being self-extinguishing, operating temperature limited to 70°C
- 6 state that the equipment within the panel and that which is mounted on the door is generally enclosed in high impact moulded thermoplastic, but other materials used include Polycarbonate, Acrylic, A.B.S. or polystyrene– operating temperature for indicating instruments is commonly limited to 50°C in order to maintain both the integrity and accuracy of the instruments.
- 7 state the various electrical connectors relevant to the type of cable installed, identifying the advantages and limitations for those selected.
- a Identify the common types of cable termination, to include
    - i screw
    - ii lug
    - iii pin
    - iv insulation displacement

- b identify methods of inter-connection, to include
    - i wire wrapping
    - ii soldering
    - iii crimping
    - iv bolts/clamps
  - c identify types of connectors, to include:-
    - i. D. connectors
    - ii edge connectors
    - iii plugs and sockets (panel)
    - iv quick connect (spring loaded levers)
    - v panel mount connectors
    - vi bootlace
    - vii crimp terminals (rings, spade, pins, blades)
    - viii electro-tap splices
    - ix cable mount (tension or screw)
- 8 state that the type of terminations onto which the conductors are to be connected, is appropriate to
- a circuit design current
  - b conductor type and current rating
  - c physical size of conductor
  - d type of equipment/circuit being supplied or connected into (data, power etc.)
  - e physical space around the terminations
- 9 state the physical process/es involved with each of the termination methods listed.
- 10 state that every electrical termination should be:-
- a adequately mounted or supported in order to avoid mechanical stress/strain
  - b electrically continuous and mechanically strong
  - c of such construction that over-heating will not occur
  - d be free of vibration
  - e made, if using a thermally heated process (soldering) in such a manner to avoid heat damage to adjacent component parts
- 11 state the advantages gained by having connection/termination types and methods that allow quick and simple disconnection/reconnection to facilitate replacement of component parts
- 12 identify the different types of instruments, indicators and equipment that form an essential part of the panel assembly.
- a list the common types of signals that are used in measurement systems as being
    - i analogue
    - ii digital
  - b list the general categories of display and recording devices that may be built into a panel
    - i analogue displays
    - ii digital displays
    - iii recorder units
    - iv computers and data loggers
- 13 state the working principles of a moving coil meter in a display device
- a voltmeters
  - b ammeters
  - c multi-meters
  - d certain specialist applications

- 14 describe the working principles and identify the advantages of the moving coil based instrument as being
  - a accuracy
  - b linear scale
  - c adaptable for use as multi-range display device
  - d built in damping
  - e low cost and reliable
- 15 state that the moving coil display device cannot be used on a.c. supplies (without adaptation)
- 16 state that the moving iron type of display device measure a.c. or d.c voltages or currents.
- 17 state that the non-linear scale is suitable for use when the signal may surge suddenly.
- 18 identify the advantages of the moving iron display device as being:-
  - a its universal use
  - b ability to indicate directly the r.m.s. value of an a.c. signal
- 19 state that the disadvantages of the moving iron instrument include:-
  - a inaccuracy
  - b non-linear scale
  - c damping arrangements required
- 20 describe the working principles of a digital type display device that form characters using either a 'seven-segment' display or a 'sixteen segment' display
- 21 state that digital type instruments display values as a number, and alphabetic characters by the use of either; light emitting diodes (L.E.D.s) or Liquid Crystal Displays
- 22 list other indicating instruments built into a panel as including
  - a maximum load in kW, kVA
  - b power factor (p.f.)
  - c frequency (Hz)
  - d temperature ( $^{\circ}$ C)
  - e reactive power (kVAr)
  - f displacement power factor (DPF)
- 23 state the purpose of switches, indicators, isolators as standard units built into the panel front
- 24 state the benefits accrued from connecting Programmable Logic Controllers into panel circuitry
- 25 explain the function and operating principles of current transformers and potential transformers
- 26 state the use of colour coding of cables used within panels that operate at E.L.V. and L.V. a.c together with d.c circuitry.

## Outcome 2 Recognise the relevant statutory and non-statutory legislation associated with electrical panels

### Practical activities

The candidate will be able to

1. identify the relevant requirements of the Electricity at Work Regulations, BS 7671, British Standards and codes of practice and memoranda that relate to work based tasks involved in the building/assembly of cubicle switchgear and control panels
2. work to the procedure for safe working practice as set out in the Health and Safety Executive '*Electricity at Work*' booklet

### Underpinning knowledge

The candidate will be able to:-

- 1 state the Electricity at Work Regulations as being a legal framework that covers all aspects of electrical systems and equipment that is to be, or has been, energised and that the EAW Regulations are statutory and therefore legally binding
  - a explain that the EaW Regulations set standards which will reduce the risk of electric shock, burns, fire or explosion due to the use of electrical systems or equipment whilst installing panels
  - b locate specific parts within the EaW Regulations that relate to work based tasks involved in the building and connection of panels
  - c state that contravention of the EaW may lead to litigation
- 2
  - a state how site based responsibility may make a person a designated 'Duty Holder' with some duties carrying responsibilities that may be
    - i absolute
    - ii reasonably practical
  - b State the definition of 'system'
- 3 state how specific sections/topics within BS 7671 impact upon electrical panel building
  - a protective devices
  - b inter-connecting cabling, supports and enclosures
  - c compliance with the *IP Code*
  - d provision of isolation devices
  - e labelling
  - f connections and terminations
  - g electrical continuity
- 4 state how data from the following may be used to support the panel building process
  - a BS 7671
  - b IEE Guidance Notes
  - c IEE On Site Guide
- 5 state how current regulatory requirements may impact upon the installation of a 'panel' with reference to
  - a location
  - b environmental conditions
  - c access and general lighting
  - d cable routing and entry

- 6 state the need for statutory regulation of given hazardous locations or installation of a panel
  - a potentially flammable/explosive atmosphere
  - b storage and delivery of petroleum
  - c dust or fibre laden atmosphere
  
- 7 outline the requirements of Codes of Practice relevant to
  - a earthing
  - b colour coding of cables
  - c temperature/humidity control
  
- 8 state the purpose/function of a given device or items of equipment identified by a *BS* or *BSEN* number

## Outcome 3 Identify the purpose and application of manufacturers instructions and specifications involved with panel building

### Practical activities

The candidate will be able to:-

- 1 identify components/equipment from given drawings and/or specification.
- 2 utilise a manufacturer's/supplier's catalogue to identify required components or equipment by part, number or code

### Underpinning knowledge

The candidate will be able to:-

- 1 state the types of reference data and documentation as
  - a drawings, diagrams (circuit and wiring)
  - b specifications
  - c data charts
  - d manufacturers' manuals
- 2 state that technical information may be communicated by utilising
  - a technical drawings
  - b memorandum
  - c operations sheets
  - d data sheets
  - e exploded views
  - f electronic data, VDUs
- 3 state the purpose and importance of drawings and/or specifications in determining
  - a the function and characteristics of a panel
  - b materials, component parts, instruments and equipment requirements
- 4 state how dimensions of identified components from the schedule facilitate and/or dictate the layout, spacing and screening of components when constructing a panel
- 5 state that information that may be gleaned from a drawing will include
  - a unit of measurement and scale used.
  - b general tolerance
  - c finishes
  - d warning notices
- 6 state how to identify and locate component parts by the use of symbols from *BSEN 6061* shown on electrical/electronic drawings
- 7 state that all components/equipment listed must be identified by the part number or code used by
  - a company
  - b manufacturer
  - c national standard

# Outcome 4 Identify panel building methods and techniques

## Practical activities

The candidate will be able to

1. read and interpret specifications in order to organise panel building and assembly activities.
2. interpret layout diagrams, circuit diagrams, schematic diagrams, wiring diagrams and block diagrams.
3. identify, using manufacturers' or suppliers' catalogues, the component parts required to build a 'typical' enclosure for a panel; to include:
  - a Steel tube systems
  - b Extruded aluminium structural beams
  - c Proprietary systems such as 'flexlink'
  - d Preformed, moulded, fittings and correction fitments
  - e DIN Rails for supporting components
  - f Foot plates for free standing panel assemblies

## Underpinning knowledge

The candidate will be able to:-

- 1 state the purpose of compiling a schedule of components/equipment.
  - a explain how the total quantity of components/equipment may be 'taken off' a given drawing
  - b utilise a manufacturer's/supplier's catalogue to identify required components or equipment by part number or code.
  - c explain how dimensions of identified components from the schedule facilitate the layout, spacing and screening of components when constructing a panel.
- 2 identify conductor handling/support systems together with associated equipment.
  - a state the need to route, support and enclose inter-connecting cables in order to
    - i prevent tensile stress and strain on conductor terminations
    - ii present an easy and convenient method of installation that also facilitates modification
    - iii facilitate the tracing and/or replacement/upgrading of a conductor
- 3 identify and explain how cable support systems commonly used in panel building would be utilised
  - a slotted (open) panel trunking with snap on lid
  - b slotted (closed) panel trunking with snap on lid
  - c spiral wrap/binding
  - d cable clamps (for ribbon cables)
  - e self-adhesive cable clips
  - f cable ties
  - g lacing cord
  - h flexible plastic conduit
- 4 explain the advantages and limitations of cable support in respect of
  - a flexibility
  - b ambient temperature
  - c electromagnetic compatibility
  - d screening ELV/LV, a.c/d.c.
  - e mechanical protection

- 5 identify cable identification methods
  - a marker ties
  - b marker plates
  - c P.V.C. snap-on markers
  - d tie-on cable markers
  - e hand held printer systems
  
- 6 identify glands, bushes, grommets, and cleats with part numbers, using manufacturers' or suppliers' catalogues.
  
- 7 state the various methods of assembling the main body of a panel and the factors affecting assembly
  - a explain that panel enclosures and associated component parts must be of a type that is compatible to the environment in which the panel is installed
    - i resists corrosion, weather
    - ii unaffected by high humidity or ambient temperatures
    - iii enclosure meets the *BSEN 60529 Index of Protection Code* relevant to the presence of moisture, dust
  - b state the design criteria that dictates whether a panel is custom built on-site from component parts or bought in from a Panel Building specialist
  - c explain the need to ensure compatibility of the panel, exposed indicator meters and enclosure with the environment in which the panel is to be installed.
  
- 8 state the specific requirements of plant control or processes that dictate whether the control panel is
  - a built into the plant/machine line
  - b located away from the process or machine
  - c a free-standing cubicle type panel or mounted either on the machine or plant/equipment.
  
- 9 identify the materials and methods of producing panel enclosures
  - a Steel – pressed or assembled from component parts
  - b Reinforced plastic/glass fibre-moulded
  - c Polycarbonate – moulded, formed
  
- 10 state the methods of fixing display devices, indicators, switches to a panel front, to include
  - a snap fit bezel
  - b cut out with proprietary clamps
  - c studs with washers/nuts
  - d locknuts to retain spindles/shafts
  
- 11 state the types and application of tools and equipment to undertake
  - a measurement and marking out
  - b material removal (cutting and drilling)
  - c jointing
  - d finishing
  
- 12 state the safety factors to be utilised in respect of
  - a using Class III electrically powered hand tools
  - b cutting, drilling sheet materials
  - c using thermal cutting equipment
  - d working with solvents, paints
  
- 13 state appropriate personal protective equipment to be worn relevant to a specific task or series of tasks to be undertaken, List possible factors that can cause hazards in a panel building/installation
  - a human error, carelessness and improper behaviour
  - b lack of training, supervision
  - c faulty machinery and tools
  - d untidy, dirty, badly lit environment
  - e obstacles in or overhanging walkways

- f moving materials, equipment or plant .
- 14 state the precautions to be taken prior to and during inspection.
  - a be aware of the safety of persons in the vicinity of the panel
  - b avoidance of damage to installed equipment/components
  - c ensure isolation of the panel
- 15 state visual inspection procedures for ensuring installation and assembly of panel to meet appropriate conditions
  - a structural integrity
  - b joints secure and protected against mechanical damage
  - c labels and notices in place
- 16 state procedures for the disposal of waste on completion of activities

# Unit 9 – 215 Electrical Machines repair and rewind

## Rationale

This unit is an optional unit. It is concerned with underlying principles related to electrical machines. It will include an understanding of legislation, interpretation of specifications and functions and operational requirement.

There are four learning outcomes to this unit. The candidate will be able to

- 1 demonstrate an understanding of the function and application of electrical machines and motors
- 2 identify legislation relevant to electrical machines
- 3 recognise the purpose and application of manufacturers' data and specifications associated with electrical machines
- 4 recognise approved methods of installation and repair on electrical machines

## Connection with other awards

This occupational unit combines with the core units to form the Level 2 Certificate in Electrotechnical Technology.

## Assessment

1. Practical activities  
These will be assessed by a practical assignment set and marked by the centre to a template provided by City & Guilds.
2. Written test  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper

# Outcome 1 Demonstrate an understanding of the types and application of electrical machines

## Practical activities

The candidate will be able to

- 1 identify the different types of electrical machines as
  - a d.c. machines
  - b a.c. single phase motors
  - c a.c. three phase motors
  - d single phase transformers
  - e three phase transformers
- 2 identify the construction materials and component parts of electrical machines

## Underpinning knowledge

The candidate will be able to

- 1 state the types of electrical machines as
  - a static machines – (transformers, magnetic coils)
  - b rotating machines – (motors and generators)
- 2 state the constructional features, component parts and materials used for electrical machines to include.
  - a field/magnetic coils
  - b windings
  - c conductors
  - d insulation/varnish
  - e commutator
  - f brushes
  - g laminations
  - h shafts
- 3 identify the main features of d.c. machines as
  - a a magnetic field system
  - b conductors mounted on the armature
  - c the function of the commutator and the brush-gear
  - d means of rotating the armature
- 4 state the basic operating principles for the following d.c. machines:
  - a series
  - b shunt
  - c compound
  - d separately excited
- 5 state the basic operating principles of a.c single-phase motors
- 6 state the basic principle of operation of an a.c. three-phase induction arrangement
- 7 identify a.c. three-phase motors as
  - a cage type
  - b wound

- 8 state that a.c. motors have starting arrangements that include
- a direct-on-line
  - b star-delta
  - c auto-transformer
  - d rotor resistance
  - e soft-start
- 9 state the applications of the starting arrangements:
- a direct-on-line
  - b star-delta
  - c auto-transformer
  - d rotor resistance
  - e soft-start
10. state the operating principles of the following types of single phase a.c. transformers:
- a step down double wound
  - b step up double wound
  - c isolating transformers
  - d isolating transformer as a SELV safety source
  - e step down centre tapped
  - f auto-transformer
  - g current transformer
  - h potential transformer
  - i instrument transformers
- 11 identify the different types of three phase transformer:
- a star-star
  - b delta-star
  - c star-star auto transformer
- 12 state how the rating of an electrical machine is affected by the class of insulation used in the winding assembly

## Outcome 2 Identify legislation relevant to the rewind and repair of electrical machines

### Practical activities

The candidate will be able to

- 1 locate specific regulations within codes of practice, HSE regulations and the Electricity at Work Regulations that relate to work based tasks involved in dismantling, assembly, disconnection and reconnection of electrical machines.
2. follow safe working practices in order to avoid creating a dangerous situation for self or others.

### Underpinning knowledge

The candidate will be able to

- 1 state that the Electricity at Work Regulations concerns all aspects of electrical systems and electrical machines and that as such the Regulations are legally binding
  - a state that the Regulations set standards which will reduce the risk of electric shock, burns, fire or explosion due to the use of electrical systems or equipment whilst working on electrical machines
  - b locate specific parts within the EaW Regulations that relate to work based tasks involved with electrical machines
  - c state that contravention of the EaW can lead to litigation
- 2
  - a state how site based responsibilities may make a person a designated 'Duty-Holder' with some duties carrying responsibilities that may be categorised as
    - i absolute
    - ii reasonably practical
  - b state the definition of systems
  - c recognise the importance of the need to comply with EaW for
    - i location
    - ii isolation
    - iii access and lighting
- 3 state the purpose of the procedure for Safe Working Practice as set out within the Health and Safety Executive 'Electricity at Work' booklet.
- 4 state that the purpose of Codes of Practice is to provide an information base which when allied to approved working practices will ensure that electrical machines perform to required parameters and standards of safety.
- 5 identify that the following Codes of Practice are relevant to the workshop and work based tasks related to electrical machines
  - a Management of health and safety at work  
Code of Practice IS.B.N. 0717604128
  - b Workplace health, safety and welfare  
Code of Practice IS.B.N. 0717604136
  - c Work equipment, provision and use of work equipment  
Code of Practice IS.B.N. 0717604144
  - d Restriction of exposure to radiation  
Code of Practice IS.B.N. 0118856057
  - e Control of substances hazardous to health  
Code of Practice IS.B.N. 0717608190

- 6 identify that the following H.S.E. Regulations are relevant to the workshop and work based tasks related to electrical machines
- a C.O.S.H.H. Regulations (all embracing)
  - b Guide to the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations IS.B.N. 0717604322
  - c Evaporating and other ovens IS.B.N. 0118834339
  - d Compressed air safety IS.B.N. 0118855824
  - e Noise at work (Guides 1-8) IS.B.N. 0118854305 and 0717664543
  - f The protection of persons against ionising radiations arising from any work activity IS.B.N. 0717605086
  - g Electricity at work, safe working practices IS.B.N. 07176
  - h The maintenance, examination and testing of local exhaust ventilation IS.B.N. 0717608131
  - i Personal Protective Equipment at Work Regulations IS.B.N. 0717604152

## Outcome 3 Recognise the use of documentation, reference data, manufacturers' data and specifications associated with activities on electrical machines

### Practical activities

The candidate will be able to

- 1 identify the machine by examination of the rating plate and reference to manufactures manuals, handbooks, data sheets, wall charts
- 2 retrieve maintenance or other records and test results from previous repair works for a given machine.
- 3 compile a database, in the absence of any manufacturer's data, by measurement, weighing together with dynamic and static tests (mechanical/electrical).
- 4 interpret wiring diagrams and specifications for assembly activities
- 5 identify component requirements

### Underpinning knowledge

The candidate will be able to

- 1 state the importance of reference data and documentation
  - a drawings, diagrams (winding connections, layouts and wiring)
  - b specifications
  - c data charts
  - d manufacturers' manuals
  - e servicing records/logs
- 2 state that technical information may be communicated by utilising
  - a technical drawings
  - b memorandum
  - c operations sheets
  - d data sheets
  - e exploded views
  - f electronic data, VDUs
- 3 state the information available from the machine rating plate
- 4 state the purpose of parts numbers or codes in manufacturers'/suppliers' catalogues
- 5 identify types of drawings and diagrams as:
  - a wiring diagrams
  - b circuit diagrams
  - c winding layout drawings
  - d winding and terminal connection diagrams
  - e assembly and detail drawings.

## Outcome 4 Carryout handling and installation/dismantling of electrical machines

### Practical activities

The candidate will be able to

- 1 plan a safe sequence of installation/dismantling operations including isolation from supply
2. identify the variety of powered lifting equipment that is appropriate and available for the weight of the electrical machine to be moved
- 3 specify services, equipment and tools and specialist equipment (pulley and bearing pullers etc) required
- 4 undertake industry approved methods of installation/dismantling electrical machines, relevant to the function of the equipment or plant to be driven or operated

### Underpinning Knowledge

The candidate will be able to

- 1 state the importance of conducting an assessment of the workplace including
  - a isolation procedures
  - b use of test instruments
  - c warning notices
- 2 list the substances that would normally be present in an electrical machine workshop and the possible harmful effects
  - a dust
  - b solvents used for cleaning
  - c varnishes
  - d cellulose based paints
  - e lubricants
- 3 state that when dust or vapours are present in an oxygen rich atmosphere, fire or explosion may occur given a source of ignition
- 4 state the importance of maintaining a dust-free environment by use of a vacuum or a low pressure air line and the need for periodic air sampling to ensure control of dust or vapours in the work areas
- 5 state the need to work within the legal requirements within the COSHH Regulations
- 6 state the importance of safety in the movement of loads (electrical machines)
- 7 state that any load above 25kg will require mechanical/powered lifting equipment
- 8 list the recognised rules for manual handling with emphasis upon
  - a stance - straight back and upright, bend knees and let the legs do the work.
  - b keep arms straight and close to the body
  - c balance the load by using both hands
  - d avoid sudden movements and twisting of the spine
  - e take account of the centre of gravity of the load
  - f clear any obstacles from the vicinity
  - g avoid injury to other people when moving loads
  - h use gloves to avoid injuries from rough edges

- i additional care required when moving loads which are wrapped and/or greased.
- 9 state that the common hazards associated with manual movement of loads will include
    - a Back injuries caused by awkward movement or incorrect stance
    - b Severe pains in the hand, wrist, arm or neck
  - 10 list the safety rules that impact upon the use of powered lifting equipment to include
    - a never exceed the maximum safe working load (SWL) indicated on the lifting equipment
    - b avoid swinging, twisting and 'shock' loading of the equipment
    - c correctly position the lifting hook or cradle as near as is possible to the centre of gravity of the load in order to maintain balance
    - d not to push or pull the load in an endeavour to obtain balance
    - e avoid moving suspended loads in the vicinity of people who are not involved in the task.
    - f load always to be lowered carefully into position to avoid damage and ensure stability once removed from lifting equipment
  - 11 state the different types of equipment suitable for the movement of electrical machines
    - a heavy duty sack truck/flat bed truck
    - b turntable trucks (platform)
  - 12 state the use of the different types of lifting equipment
    - a chain block
    - b workshop jib crane
    - c hydraulic lifting table
    - d hydraulic pallet truck
    - e electric hoist
    - f overhead gantry travelling crane
    - g forklift truck
    - h the importance of maintaining all lifting equipment and retention of all relevant testing equipment
  - 13 state the use of manufacturer's data in [assembly](#)/dismantling
  - 14 state how to identify electrical machine winding layouts and connections in terms of
    - a Start/Run (Single-phase ac motors)
    - b Star-Delta (Three-phase motors and transformers)
    - c Wound rotors
    - d Type of d.c. machine (Series; Shunt; Compound)
  - 15 state how a manufacturer's machine specification will set
    - a type of insulation used for windings
    - b type of bearings used/fitted
    - c type of enclosure relative to environment in which machine is or is to be installed
    - d duty rating (continuous, intermittent etc)
    - e temperature and altitude limitations
    - f speed of rotation
    - g type of windings fitted to machine
    - h type of mounting (flange, resilient, standard for fixing to slide rails, bed plates etc)
    - i types of varnishes used to protect installed winding assemblies
    - j winding treatment to combat
      - i humidity
      - ii chemical attack
      - iii dust/grit
      - iv extreme climate conditions
    - k conventional terminal markings

- 16 state the purpose of
- a 'bed plates'
  - b slide rails
- 17 state the importance of
- a ensuring that machines are rigidly fixed and vibration free
  - b accurately levelling and aligning driving machines equipment
  - c 'lining up' pulleys on the driving and driven machines
  - d correct tensioning of belt drives
- 18 state the general rules for efficiency in [assembly](#)/dismantling
- a correct sequence of operations
  - b removal of pulley ,retaining rods, end plates, rotor/shaft assembly
  - c prevention of ingress of dust/dirt
  - d keeping all component parts of the machine in a clean, safe environment until the machine is to be installed/re-assembled
- 19 state that completion checks and inspection should include ensuring that machine fixings are secure and meet torque settings if relevant.

## Further information

Further information regarding centre/scheme approval or any aspect of assessment of the award should be referred to the relevant City & Guilds regional/national office:

Region	Telephone	Facsimile
City & Guilds London and South East	020 7294 8139	020 7294 2419
City & Guilds Southern	020 7294 2677	020 7294 2412
City & Guilds South West	01823 722200	01823 444231
City & Guilds East Anglia	01480 308300	01480 308325
City & Guilds East Midlands	01773 842900	01773 833030
City & Guilds West Midlands	0121 503 8900	0121 359 7734
City & Guilds North East	0191 402 5100	0191 402 5101
City & Guilds North West	01925 897900	01925 897925
City & Guilds Yorkshire	0113 380 8500	0113 380 8525
City & Guilds Northern Ireland	028 9032 5689	028 9031 2917
City & Guilds Scotland	0131 226 1556	0131 226 1558
City & Guilds Wales	02920 748600	02920 748625

City & Guilds Head Office – Customer Relations	020 7294 2800	020 7294 2400
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Website <http://www.cityandguilds.com>

