

Basic Technical Training (Onshore/Offshore)

Basic Electric Standard

Foreword

This document has been developed in the project ATTP (Adapting a Transparent Training Programme for wind energy) with the support from EU Lifelong Learning Programme, Leonardo da Vinci. The Standard has been made together with global wind turbine owners and manufacturers (Vestas, Siemens, ENERCON, Gamesa and DONG Energy).

This Standard describes the requirements for Basic Technical Training in the wind industry that are recommended by ATTP. Where national legislation sets higher requirements for the training, the Training Provider shall incorporate these requirements in the training programme.

In this document the learning outcomes and the single elements of the lessons are all described according to Blooms taxonomy, please see appendix A.

All together there are the following appendixes to this document:

- A. Blooms Taxonomy Action Verbs
- B. Basic Electrical Test
- C. Checklist for Learning Outcomes

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List of abbreviations

BTT	Basic Technical Training
WTG	Wind Turbine Generator
PPE	Personal Protection Equipment
LOTO	Lock out tag out
ATTP	Adapting a Transparent Training Programme for wind energy

Introduction

This module is part of a course of training that prepares candidates for work in the Wind Power Industry both on and off shore. It is not a stand-alone qualification but can be delivered independently of the other modules.

Target Group

The Basic Electric module is targeted at candidates who have no previous experience of electrical systems but may also be used to up skill candidates who have some knowledge of electrical systems in other spheres not specifically wind turbines.

Section 1 –The Basic Technical Training (BTT) - Basic Electric

1.1 Duration of the BTT Module Basic Electric

The optimal total time for completing this Module is estimated to be 24 hours, including meals and breaks.

The practical skills shall be trained and demonstrated, and all elements of the course shall be covered by demonstration where possible.

If this training is part of a program of longer duration, the total contact time per day shall not exceed 8 hours and the total training day shall not exceed 10 hours. The total training day includes contact time, refreshment and meal breaks and travel between training sites where applicable. It shall be ensured that everybody is given the opportunity to share their opinions and experiences where possible.

Ensure that participants with prior experience share their experiences in a way that is constructive for the entire class.

The course will still be taught as per lesson plan whether the participant has prior experience or not.

1.2 Target group for the Module Basic Electric

The Basic Technical Training (BTT) is designed to provide participants with the basic technical skills that – together with the required safety courses - will enable the participants to work onsite, supervised by an experienced technician.

The basic Electric Training module is designed to provide personnel with the basic skills that will enable them to maintain the Electrical systems of wind turbines. It is designed to accommodate individual work both onshore and offshore, supervised by an experienced technician.

1.3 Participant prerequisites for the Basic Electric

There are no prerequisites for this module but some sort of practical mechanical or electrical technical background would be useful.

All personnel working in the wind service industry shall be medically fit and capable of performing work under demanding situations. This includes being able to

- Work at heights
- Work in a wind turbine environment
- Not suffer from seasickness (offshore)

Personnel in the wind service industry must be able to read and write to a sufficient standard to be able to carry out instructions and complete the required documentation. Furthermore it is an advantage if participants are able to read, speak and write English.

Participants must have undertaken a pre-induction process to ensure they are aware of the working conditions and demands in the industry.

1.4 Aims and objectives of the Module “Basic Electric”

The aims of this course are to give the participants the knowledge and skills to carry out basic electrical maintenance tasks (supervised by an experienced technician), using safe working procedures and the correct PPE.

The objectives of the BTT Module Basic Electric are to ensure that:

- a) The participants will have the general knowledge about Electrical Systems and the symbols, which are used in Electrical Circuit Diagrams. They will be able to interpret these diagrams and to identify several electrical components.
- b) The participants will have knowledge about the correct and safe use of tools and test equipment and will therefore be able to comply with the regulations.
- c) The participants will have the knowledge to describe the electrical hazards in a WTG.
- d) The participants will have the knowledge and the skills to use safety procedures specific for electrical systems and to use the necessary PPE.
- e) Participants will be able to describe the importance of lock out tag out and to demonstrate the correct procedure for the lock out tag out process.
- f) The participants will demonstrate knowledge of function of relays, diodes, rectifiers, capacitors, transformers, generators, power cables, circuit breakers, power converters, lightning arrester circuits and earthing circuits.
- g) The participants will have the knowledge about the different sensors used in the Electrical System, their position and function. With that knowledge they will be able to check the sensors for functionality.

1.5 Learning outcomes of the BTT Module Basic Electric

Lesson 1 Introduction

30 min

The aim of this lesson is to give the participants the required information to make them aware of the course content and the facilities involved. The participants will know what to expect and what is expected of them.

To successfully complete this Module participants shall be aware of:

- 1) Who the instructor and other participants are
- 2) Facilities
- 3) The aims and main learning objectives

- 4) On-going assessment
- 5) Motivation on the course

Note: The administrative part of the registration must be carried out before the course commences.

Lesson 2 Direct current introduction

120 min

The aim of this lesson is to give the participants sufficient knowledge about basic Electrical systems.

To successfully complete this Module, participants shall be able to:

- 1) Describe the main electrical magnitudes and give their units.
- 2) Understand the fundamentals of Ohm's Law and be able to carry out exercises using the formula.
- 3) Understand the difference between power and energy.
- 4) Understand the role of appointed persons.

Lesson 3 Alternating current introduction.

120 min.

The aim of this lesson is to give the basic knowledge about alternating current and electrical theory.

To successfully complete this Module, participants will be able to:

- 1) Understand the principles of alternating current.
- 2) Interpret and demonstrate understanding of a basic circuit diagram and how to connect it
- 3) Distinguish between AC and DC.

Lesson 4 Electrical measuring instruments.

180 min

The aim of this lesson is to give the participants knowledge about the correct and safe use of measuring equipment.

To successfully complete this Module, participants will be able to:

- 1) Identify the parameter symbols in the multimeter.
- 2) Use a multimeter in the correct way to measure current, voltage, resistance, capacity, and diodes and to carry out a continuity test.

Lesson 5 Electrical hazards.

120 min.

The aim of this lesson is to give the participants the knowledge to describe the electrical hazards in a WTG.

To successfully complete this Module, participants will be able to:

- 1) Explain the effect on the body of an electrical contact.
- 2) Outline direct and indirect contact situations.
- 3) Identify hazards related to cables in a wind turbine.
- 4) Describe hazards related to a HV transformer / compartments.
- 5) Explain the electrical hazards of the electrical components in cabinets.
- 6) Describe the electrical hazards related to the busbars.
- 7) Describe the hazards related to electrical boxes/junctions.
- 8) Identify the earthing systems.
- 9) Understand the UPS system risks.
- 10) Relate electrical hazards and switchgear protection systems and how to reset them.
- 11) Identify the overvoltage protection systems and its function.

Lesson 6 Personal safety procedures.

75 min.

The aim of this lesson is to give the participants the knowledge and the skills to use safety procedures specific for electrical systems.

To successfully complete this Module, participants will be able to:

- 1) Understand the meaning of safety signs.
- 2) Use The 5 safety rules.
- 3) Explain the difference between direct and indirect contact protections.
- 4) Understand an IP code.

Lesson 7 Personal Protective Equipment.

30 min.

The aim of this lesson is to train the participants to choose the right PPE and tools for working with electricity in a WTG, their correct usage and their test before use.

To successfully complete this Module, participants will be able to:

- 1) Explain which PPE and tools must be used for electrical work.
- 2) Demonstrate how to make a proper inspection of PPE.

Lesson 8 Prevention of unexpected start-up.

30 min.

The aim of this lesson is to train the participants the importance of lock out tag out when working in a WTG.

To successfully complete this Module, participants will be able to:

- 1) Explain the importance of lock out tag out.
- 2) Identify the lock out and tag out tools and tags and how to use them.

Lesson 9 Components, symbols and diagrams.

405 min.

The aim of this lesson is to give basic knowledge of electrical and electronic components.

To successfully complete this Module, delegates will be able to:

- 1) Predict the function of the Contactors in the system.
- 2) Predict the function of the Relays in the system.
- 3) Predict the function of the Switches in the system.
- 4) Describe the function of the Diodes in the system.
- 5) Describe the function of the Rectifiers in the system.
- 6) Understand the function of the Capacitor bank in the system.
- 7) Predict the function of the Generators and motors in the system.
- 8) Predict the function of the Circuit breakers in the system.
- 9) Identify the main elements of an electric circuit in a diagram and assemble the electric panel
- 10) Identify the measuring points of an installation in the diagram and in the electric panel.
- 11) Understand a processor control system.
- 12) Identify the elements of a WTG electric diagram.

Lesson 10 Sensors.

60 min.

The aim of this lesson is to enable the participants to be able to recognize the different sensors in an electric circuit.

To successfully complete this Module, participants shall be able to:

- 1) Identify the different types of sensors and their symbols.
- 2) Describe the function of the wind sensors.
- 3) Describe the function of a temperature sensor and test it.
- 4) Describe the function of a yaw sensor.
- 5) Describe the function of a pressure sensor.
- 6) Describe the function of a PTC relay.

Lesson 11 Theory test

60 min.

The aim of this lesson is to test the participants' theoretical knowledge of electric systems, and to discuss the result of the test with the participants.

A proposal for the theoretical theory test is shown in appendix B (in Spanish at the moment, but will be translated into English before the project ends).

Lesson 12 Evaluation

15 min.

The aim of this lesson is to summarize the Module and to give the participants the opportunity to conduct an open-minded review of the training and the instructor.

To successfully complete this Module, participants shall be able to demonstrate:

- 1) Active participation in the evaluation.

1.6 Participant Performance Assessment

Assessment of learning outcomes:

Participants will be assessed according to the learning outcomes stated in section 1.5 by means of

- direct observation including supplementary oral questions when appropriate
- a written test to cover the electric theory.

At least 70% of the questions in the written test must be answered correctly for passing the test.

The direct observation is to be conducted by practical scenarios as well as by theoretical discussions.

Appendix C includes a checklist, which the training staff might use for the direct observation of each participant.

Each participant is to demonstrate:

- a) Safe working procedures for electric work
- b) Correct and proper methods of working with electric systems

The formal assessment shall be in accordance with the written theoretical test and the Practical Assessment Measures in section 3.5.

Training provider shall have a documented procedure in place for dealing with persons not meeting the stated learning outcomes.

1.7 Timetable, BTT Module Basic Electric

The order in which the elements of the training Module are delivered may vary.

Lesson		Element		Approximate Duration
1	Introduction	1.1	Introduction	
		1.2	Facilities	
		1.3	Aims and main learning objectives	
		1.4	On-going assessment	
		1.5	Motivation	
			TOTAL	30 min
2	Direct current introduction	2.1	Electric magnitudes	
		2.2	Ohm's Law	
		2.3	Electric power and energy	
		2.4	Appointed Persons	
			TOTAL	120 min
3	Alternating current introduction	3.1	Alternating current	
		3.2	Diagram interpretation/Basic AC/DC	
		3.3	AC/DC	
			TOTAL	120 min
4	Electrical measuring instruments	4.1	Multimeter parameters description	
		4.2	Digital instrument/multimeter*	
			TOTAL	180 min
5	Electrical hazards	5.1	Effect of electric current	
		5.2	Direct and indirect contacts.	
		5.3	Cables	
		5.4	HV transformer/ compartments	
		5.5	Electrical components in cabinets	
		5.6	Busbars	
		5.7	Electrical boxes/junctions	
		5.8	Earthing system	
		5.9	UPS	
		5.10	Switchgear	
		5.11	Overvoltage protections	
			TOTAL	120 min
6	Personal safety procedures	6.1	Safety signs	
		6.2	The 5 safety rules*	
		6.3	Direct and indirect contact protections*	
		6.4	IP Codes	
			TOTAL	75 min
7	Electrical PPE	7.1	Types of PPE	
		7.2	Proper inspection of the PPE*	
			TOTAL	30 min

8	Prevention of unexpected start-up	8.1 Importance of LOTO 8.2 Lock out tag out procedure*	
		TOTAL	30 min
9	Components, symbols and diagrams	9.1 Contactors* 9.2 Relays* 9.3 Switches* 9.4 Diodes 9.5 Rectifiers 9.6 Capacitor bank 9.7 Generators and motors* 9.8 Circuit breakers* 9.9 Symbols and diagrams* 9.10 Measuring points* 9.11 Processor Control System 9.12 The Electrical WTG system	
		TOTAL	405 min (6 ¾ hours)
10	Sensors	10.1 Types and symbols 10.2 Wind sensors 10.3 Temperature* 10.4 Yaw sensor 10.5 Pressure sensor 10.6 PTC relay	
		TOTAL	60 min
11	Electrical Theory Test	Test	
		TOTAL	60 min
12	Evaluation	Summary and evaluation Certificates	
		TOTAL	15 min
GRAND TOTAL			1245 Min (20 ¾ Hours)

*The element includes a practical workshop for the participants

1.8 ELEMENTS, BTT Module Basic electric.

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Lesson 1: Introduction

ELEMENT 1.1 Introduction

Training staff is to **give**:

- 1) A short presentation of himself including his background as an instructor

Participants are to **give**:

- 2) A short introduction of themselves including (former) job function and expectations of the course.

Training staff is to **explain**:

- 3) The programme of the Module including times of breaks and meals.

ELEMENT 1.2 Facilities

Training staff is to **explain**:

- 1) General description of the on-site facilities (Administration, dining area, restrooms, toilets, etc-)

ELEMENT 1.3 Aims and main objectives

Training staff is to **explain**

- 1) Scope and main objectives of the module

ELEMENT 1.4 On-going assessment

Training staff is to **explain**:

- 1) The reasons for the on-going assessment.
- 2) Control Measures and their use.

ELEMENT 1.5 Motivation

Training staff is to **explain**:

- 1) The importance of personal involvement.

Lesson 2: Direct current introduction

ELEMENT 2.1 Electric magnitudes

Training staff shall **explain**:

- 1) The basic concept between the current flow and the resistance.
- 2) Electrical current definition and units.
- 3) Voltage definition and units.
- 4) Resistance definition and units. Variable resistance (PT100-temp).
- 5) Capacitor definition and units.

Participants shall **engage in discussions** of

- 1) Relationship between current, voltage and resistance.

ELEMENT 2.2 Ohm's Law

Training staff shall **explain**:

- 1) Practical examples of Ohm's law.

Participants shall **engage in discussions** of

- 2) Relationship between current, voltage and resistance.

Participants shall **apply**

- 3) Ohm's Law exercises

ELEMENT 2.3 Electric power and energy

Training staff shall **explain**:

- 1) What electric power is.
- 2) What electric energy is.

Participants shall **engage in discussions** of

- 3) Difference between power and energy

ELEMENT 2.4 Appointed Persons

Training staff shall **explain**:

- 1) Why it is important, that only instructed and appointed persons are allowed to handle the electrical equipment.
- 2) How and when the participants ought to be instructed and appointed persons.

Lesson 3: Alternating current introduction

ELEMENT 3.1 Alternating current.

Training staff is to **explain**:

- 1) The theory behind alternating current.
- 2) Capacitors in AC.

ELEMENT 3.2 Diagram interpretation/Basic

Training staff is to **explain**:

- 1) Electric system used in electric circuit diagrams.

Training staff is to **show**:

- 2) Basic electrical circuits function.

Participants are to **engage in discussions** of:

- 3) Symbols in electrical circuit diagram.
- 4) Basic electrical circuits assembly.

ELEMENT 3.3 AC/DC

Training staff is to **explain**:

- 1) Difference between alternating and direct current.
- 2) How alternating current is converted to direct current.

Lesson 4: Electrical measuring instruments

ELEMENT 4.1 Multimeter parameters description

Training staff is to **explain**:

- 1) Symbols and how to select it on the multimeter.
- 2) VAC and VDC.
- 3) A and mA.
- 4) Ohms / continuity
- 5) Diode

ELEMENT 4.2 Digital instrument/multimeter

Training staff is to **explain and demonstrate:**

- 1) Describe and show the symbols and how to select it on the multimeter:
- 2) How to measure it.
How to measure current (AC/DC).
How to measure resistance.
How to measure capacitance.
How to take measurements on a diode.
What continuity is and how to measure it.

Participants shall **practice and demonstrate:**

- 3) How to select the symbols on the multimeter and how to select the right measuring category.
- 4) How to get the value of a resistance with the multimeter.

Lesson 5: Electrical hazards

ELEMENT 5.1 Effect of the electric current

Training staff is to **explain and demonstrate:**

- 1) The effects on the body due to contact with electricity.

Participants are to **engage in discussions** of:

- 2) Voltage safety limits.
- 3) Relation between current and contact time.

ELEMENT 5.2 Direct and indirect contacts.

Training staff is to **explain and demonstrate:**

- 1) When and how a direct contact happens.
- 2) When and how an indirect contact happens.

Participants are to **explain and recognize:**

- 3) Some direct contact.
- 4) Some indirect contact.

ELEMENT 5.3 Cables

Training staff is to **explain and demonstrate:**

- 1) The reliability and the quality of a cable.
- 2) Show examples of reliable and unreliable cables.

Participants are to **engage in discussions** of:

- 3) Type and quality of cables.

ELEMENT 5.4 HV transformer / compartments

Training staff is to **explain:**

- 1) The possible hazards related to a high voltage on the transformer.
- 2) Different examples of possible hazards.

Training staff is to **show:**

- 3) An operating transformer.

Participants are to **engage in discussions** of:

- 4) Awareness of high voltage on the transformer.

ELEMENT 5.5 Electrical components in cabinets

Training staff is to **explain**:

- 1) The possible hazards related to the electrical components.

Participants are to **engage in discussions** of:

- 2) Awareness of the possible hazards related to the electrical components.

ELEMENT 5.6 Busbars

Training staff is to **explain**:

- 1) The possible hazards related to different types of busbars.

Participants are to **engage in discussions** of:

- 2) The possible hazards related to busbars.

ELEMENT 5.7 Electrical boxes/junctions

Training staff is to **explain**:

- 1) The possible hazards related to different electrical boxes/junctions

Participants are to **engage in discussions** of:

- 2) The possible hazards related to electrical boxes/junctions

ELEMENT 5.8 Earthing system

Training staff is to **explain and demonstrate**:

- 1) The function of an earthing system.
- 2) How to ground the WTG and some of the electrical compartments.
- 3) Show an example of an earthing system.

Participants are to **identify**:

- 4) Different examples of earthing systems.

ELEMENT 5.9 UPS

Training staff shall **explain**:

- 1) Function of the UPS.
- 2) Different types of UPS.
- 3) Position in the system.

Participants are to **engage in discussions** of:

- 4) Risks related to the UPS system.

ELEMENT 5.10 Switchgear

Training staff shall **explain**:

- 1) Function of the different types of switchgear.
- 2) Different types of switchgear.
- 3) Position of the different types in the system.

Training staff is to **show and explain**:

- 4) How to recognise the different types of switchgear regarding voltage and function.
- 5) Which kind of protection each kind of switchgear offers.
- 6) How to reset switchgears.

Participants are to **engage in discussions** of

- 7) The correct switchgear type in order to get a particular kind of protection.

ELEMENT 5.11 Overvoltage protections.

Training staff shall **explain**:

- 1) Function of the Lightning and transient protection.
- 2) Different types of Lightning and transient protection.
- 3) Position in the system.

Training staff is to **show and explain**:

- 4) Different types of overvoltage protections.
- 5) How to reset the overvoltage protections.

Participants are to **operate**:

- 6) Resetting the overvoltage protections.

Lesson 6 Personal safety procedures

ELEMENT 6.1 Safety signs

Training staff is to **explain**:

- 1) The meaning of the different safety signs.
- 2) Show examples of safety signs on different locations in the WTG.

Participants are to **recognise**:

- 3) Different safety signs' meanings.

ELEMENT 6.2 The 5 safety rules

Training staff is to **explain and demonstrate**:

- 1) The 5 safety rules: Disconnection, Secure isolation, Prove dead, Earth and short-circuit, Cover and close off adjacent live parts.

Participants shall **practice and demonstrate**:

- 2) The 5 safety rules.

ELEMENT 6.3 Direct and indirect contact protections

Training staff shall **explain and demonstrate**:

- 1) The different types of protections against direct contacts.
- 2) The different types of protections against indirect contacts.

Training staff and participants shall **practice and demonstrate**:

- 3) How both direct and indirect contacts protections work.

Participants shall **describe**:

- 4) The difference between direct and indirect contacts protections.

ELEMENT 6.4 IP codes

Training staff shall **explain and show**:

- 1) The different degrees of protection of the different equipment and devices.
- 2) The meaning of the IP codes.

Participants shall **identify**:

- 3) The protection provided by equipment with an IP code.

Lesson 7 Electrical PPE

ELEMENT 7.1 Types of PPE.

Training staff is to **explain and show**:

- 1) The usage of approved rubber gloves.
The usage of approved insulated mats.
The usage of approved insulated footwear.
The usage of approved insulated tools and the different classes.
The usage of approved test equipment and test leads and their classification.

Participants shall to **engage in discussions of**:

- 2) Types of PPE.
- 3) Different classes of insulated tools.

ELEMENT 7.2 Proper inspection PPE.

Training staff is to **explain**:

- 1) Approved rubber gloves and their validity.
Approved insulated mats and their validity.
Approved insulated footwear and their validity.
Approved insulated tools and their validity.
Approved test equipment and test leads and their validity

Participants shall **practice and demonstrate**.

- 2) Identifying the validity of several types of PPE.

Lesson 8 Prevention of unexpected start-up.

ELEMENT 8.1 Importance of lock out tag out

Training staff is to **explain**:

- 1) The importance of lock out tag out.

Participants are to **engage in discussions of**:

- 2) Why it is important to prevent unexpected start-up.

ELEMENT 8.2 Lock out tag out procedure.

Training staff shall **demonstrate**:

- 1) The correct procedure for lock out tag out.

Participants shall **practice and demonstrate**:

- 2) The correct use of tools and tags and the procedure for lock out tag out.

Lesson 9: Components symbols and diagrams.

ELEMENT 9.1 Contactors.

Training staff shall **explain and demonstrate**:

- 1) Function of the contactors.
- 2) Symbol of contactors.
- 3) Position in the circuit.

Training staff and participants shall **demonstrate**:

- 4) Different contactors.
- 5) How a contactor works.
- 6) Position of contactors in an electrical panel.
- 7) Assembly of contactors in an electrical panel.

ELEMENT 9.2 Relays.

Training staff shall **explain and demonstrate**:

- 1) Function of the Relays.
- 2) Symbol of relays.
- 3) Position in the circuit.

Training staff and participants shall **demonstrate**:

- 4) Position of relays in electrical panels.
- 5) Assembly of relays in an electrical panel.

ELEMENT 9.3 Switches

Training staff shall **explain and demonstrate**:

- 1) Function of the Switches.
- 2) Symbols of different switches.
- 3) Position in the circuit.

Training staff and participants shall **demonstrate**:

- 4) Position of the different switches in electrical panels.
- 5) Assembly of different switches in electrical panels.

ELEMENT 9.4 Diodes

Training staff shall **explain and demonstrate**:

- 1) Function of the diodes.
- 2) Symbol of diodes.
- 3) Position in the circuit.

Training staff shall **show and demonstrate**:

- 4) Diodes.

ELEMENT 9.5 Rectifiers

Training staff shall **explain and demonstrate**:

- 1) Function of the rectifiers.
- 2) Symbol of rectifiers.
- 3) Position in the circuit.

Training staff shall **show and demonstrate**:

- 4) Rectifiers.

ELEMENT 9.6 Capacitor bank.

Training staff shall **explain and demonstrate**:

- 1) Function of the capacitors.
- 2) Symbol of the capacitor bank.
- 3) Position in the circuit.

Training staff shall **show and demonstrate**:

- 4) Capacitor bank.

ELEMENT 9.7 Generators and motors

Training staff shall **explain and demonstrate**:

- 1) Function of the generators and motors.
- 2) Symbols.
- 3) Position in the circuit.

Training staff and participants shall **show and demonstrate**:

- 4) Connect a motor to the electrical panel.

ELEMENT 9.8 Circuit breakers.

Training staff shall **explain and demonstrate**:

- 1) Function of the Circuit breakers.
- 2) Symbols.
- 3) Position in the circuit.

Training staff and participants shall **demonstrate**:

- 4) Position of the different circuit breakers in electrical panels.
- 5) Assembly of different switches in electrical panels.

ELEMENT 9.9 Symbols and diagrams.

Training staff shall **explain and demonstrate**:

- 1) The symbols that represent each element of an electric circuit.
- 2) The symbol of the main element in a diagram.
- 3) Show the symbol of the same element in different diagrams.

Training staff and participants shall **demonstrate**:

- 4) Interpretation of different electric diagrams.
- 5) Assembly of electrical panels following electric basic diagrams.

ELEMENT 9.10 Measuring points.

Training staff shall **explain and demonstrate**:

- 1) The accurate measuring points in a circuit.

Training staff and participants shall **demonstrate**:

- 2) Identifying accurate measuring points, using the numbers in a diagram.
- 3) How to check continuity in an electrical panel.
- 4) How to measure voltage in an electrical panel.
- 5) How to measure current in an electrical panel.

ELEMENT 9.11 Processor Control System

Training staff shall **explain**:

- 1) Function of the Processor Control System.
- 2) Different types of Processor Control Systems.
- 3) Position in the system.

ELEMENT 9.12 The electrical WTG system

Training staff shall **explain**:

- 1) The main diagram of a WTG.
- 2) The diagrams elements of a TWG description.

Participants shall **identify**:

- 3) The elements of an electrical diagram of a WTG.

Lesson 10: Sensors

ELEMENT 10.1 Types and symbols.

Training staff shall **explain and demonstrate**:

- 1) A general classification of the sensors used in the electrical systems.

- 2) The symbols of the sensors.

Participants shall **engage in discussions** of:

- 3) Different types, locations and functions of sensors.

ELEMENT 10.2 Wind sensors.

Training staff shall **explain and demonstrate**:

- 1) Function of the wind sensor
- 2) Different types of wind sensors
- 3) Position in the system

Participants shall **engage in discussions** of:

- 4) Different types, locations and functions of sensors.

ELEMENT 10.3 Temperature.

Training staff shall **explain and demonstrate**:

- 1) Function of the temperature sensor.
- 2) Different types of temperature. PT100-TC. NTC
- 3) Position in the system.

Participants shall **engage in discussions** of:

- 4) Different types, locations and functions of sensors.

Participants shall **test**:

- 5) How a PT 100 or a NTC sensor functions when installed.

ELEMENT 10.4 Yaw sensor.

Training staff shall **explain and demonstrate**:

- 1) Function of the yaw sensor.
- 2) Different types of the yaw sensor.
- 3) Position in the system.

Participants shall **engage in discussions** of:

- 4) Different types, locations and functions of sensors.

ELEMENT 10.5 Pressure sensor.

Training staff shall **explain and demonstrate**:

- 1) Function of the pressure sensor
- 2) Different types of the pressure sensor
- 3) Position in the system

Participants shall **engage in discussions** of:

- 4) Different types, locations and functions of sensors.

ELEMENT 10.6 PTC Relay.

Training staff shall **explain and demonstrate**:

- 1) Function of the PTC Relay
- 2) Position in the system

Participants shall **engage in discussions** of:

- 3) Different types, locations and functions of sensors.

Section 2 - Resources for Basic Electric

2.1 Trainer/Participant Ratio

(a) The ratio shown for theory sessions indicates the maximum number of participants that shall attend the course

(b) The ratio shown for practical sessions indicates the maximum number of participants to be supervised by one instructor during each practical workshop

(c) Practical sessions must always be supervised by an instructor, while supervision of an instructor is not mandatory to all theoretical sessions

Unit	Sessions	Ratio
BTT Basic Electrics	Theory	1:12
	Practical	1:6

2.2 Facilities

It is important to ensure that the full range of facilities is made available to ensure that the participants benefit most from their training. The following criteria shall be adhered to.

Administration arrangements appropriate for the enrolment and certification of participants and all aspects of the delivery of training shall be in accordance with this document.

Theory training area(s) shall be designed to enable each participant to see, hear and participate fully in the taught subject matter.

A room is required that has projection facilities, a white board and desks for the participants to write on.

Practical training area(s) shall be designed to enable each participant to see, hear and participate fully in the taught subject matter.

A practical workshop is required that has enough space to accommodate 6 candidates, with a respective work area each of approximately 3 square meters.

2.3 Equipment

A workshop with at least 6 workbenches where electrical panels have to be assembled and mechanical measurement can be facilitated using:

- a) The required PPE for electrical work: gloves, overalls, glasses and others.

- b) Tester.
- c) Multimeter.
- d) Clamp Meter.
- e) Ammeter box.
- f) 1,5 and 2,5mm² electrical wire .
- g) Different value resistances.
- h) Controllable power source (9, 12 and 24 Volts).
- i) Electrical panel structures.
- j) Lamps with different power: 25 W, 40 W, 60 W and 100 W and holders.
- k) Switches.
- l) Sheets connection manholes, corrugated tube clamps.
- m) Capacitors of different measures.
- n) Diodes.
- o) Slotted Duct.
- p) DIN rail standard.
- q) Terminals for rail.
- r) Hose 5 x 2.5 mm².
- s) Push buttons for two surface elements.
- t) Two pushbuttons for painting. One NO (normally open) green and one NC (normally closed) red.
- u) Four drivers for box (three green and yellow, are used to indicate the status of the contactors
- v) Several 3 Pole breaker switches.
- w) Several monopole breaker switches.
- x) Contactors coil 230 V.
- y) Thermal relay suitable for the rated motor current.
- z) Circuit-breaker suitable for the rated motor current.
- aa) Three-phase motor.
- bb) PTC sensors.
- cc) NTC sensors.
- dd) Sensor heater.

Section 3 - Administration and Certification

3.1 Participant Performance Assessment

Participants shall be assessed according to the learning outcomes by means of direct observation including oral questions where appropriate, and by a theoretical test.

Training Providers shall have a documented procedure in place for dealing with persons not meeting the stated learning outcomes.

3.2 Certification

Training Providers are responsible for issuing a certificate directly to the participant upon completion of the programme and to a sponsoring company when required. Each certificate shall indicate that the participant has been assessed according to the learning outcomes and shall contain the following:

- (a) Training Provider's name
- (b) Full course title
- (c) Name of the participant
- (d) Course dates
- (e) Training Provider's signature

3.3 Records

The Training Provider shall keep a record of the participants that have completed the BTT Module Basic Electrical for a period of min. 5 years.

On request from a relevant body, The Training Provider shall be able to verify the training and competence records of any participant by name.

3.4 Measures

The Trainer keeps the Control Measures Forms until the completion / evaluation of the Module. If a participant fails to meet the demands, they shall attend a new BTT Module Basic Electrical.

3.5 Control Measures

Please find the Control Measures Form on next page.

Practical Assessment Measures

Name: _____

Course: BTT Module Basic Electric

Date: _____

Training Provider: _____

Scenario Organisation	Violation of Assessment Measures			0-2 Passed/ 3 Failed	Instructor Remarks
Aware of personal and group safety at all times					
Organized and utilized correct equipment for given scenario					
Organized individuals and groups as required					
Scenario Management					
Established and maintained control of the exercise scenario at all times					
Fully participated in the exercise scenario					
Followed directions when required					
Demonstrate correct and safe manual handling in exercise scenario					

Knowledge and Understanding					
Applied subject knowledge correctly in given scenario					
Demonstrated understanding of subject					
Total Marks	0 – 9	Pass			
	10 – 27	Fail			

Instructor: _____ Pass/ Fail (Delete as appropriate)

The practical Assessment Measures Form is a final evaluation tool for the instructors to assess participants during practical elements. It allows measurement of the number of violations in regard to safety, competency, or attitude. It can be used as a progressive evaluation tool to discuss the performance of a participant in guiding them to success and it also serves as supporting documentation when the participant fails the module.