

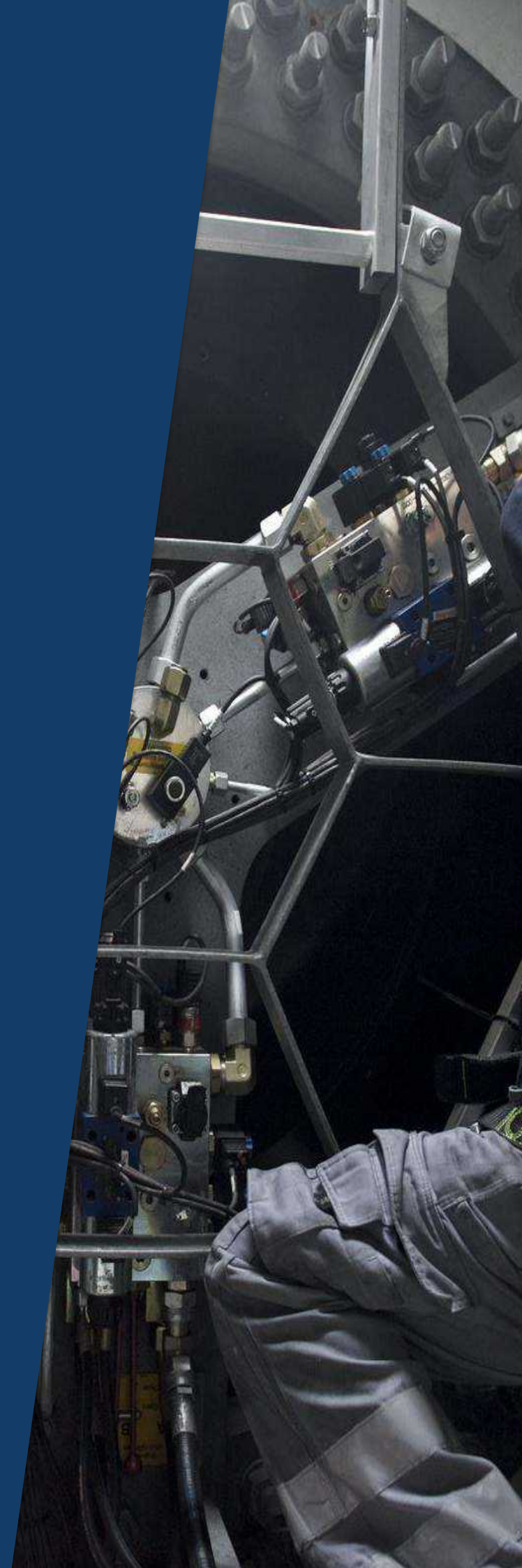


GLOBAL WIND
ORGANISATION

Basic Technical Training (BTT)

V6.0

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2021-04-01_BTT_V06

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1 List of Abbreviations

ANSI	American National Standards Institute
AS/NZS	Australia and New Zealand Standard
BTT	Basic Technical Training
BWH	Basic Working at Height
CO ₂	Carbon Dioxide
CSA	Canadian Standards Association
EN	European Standards
GWO	Global Wind Organisation
LOTO	Lock Out Tag Out
PPE	Personal Protective Equipment
MES	Marine Evacuation Systems
WTG	Wind Turbine Generator



2 Terms and Definitions

The purpose of this section is to avoid different interpretations of these terms depending on whoever is reading the standard.

Human factors	Human factors refers to an established science that uses many disciplines (like anatomy, physiology, physics and biomechanics) to understand how people perform under different circumstances and environments
Feedback	Instructor's feedback should focus on what the participant must adjust to perform correctly. Feedback may involve dialogue, where the participant reflects on his/her understanding or performance.
Group discussion	Learning activity involving all participants. Group discussions may be conducted in smaller groups. The instructor should step back and only interfere to facilitate the experience exchange between participants. Optimal group size is 4 participants.
Engage in discussions	Instructor has to create discussions involving the participants.
Function	Purpose. What is it doing? What can it be used for?
Hazard	A hazard is any source of potential damage, harm or adverse health effect on something or someone.
Installation	<ol style="list-style-type: none"> 1. Preparation 2. Pre-assembly 3. Assembly
Operation	How does it work?
Practice	The participants apply what they are learning
Risk	A risk is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard
Use	How to operate it? How to make it work?



3 Change Log – Version 6

Amendment date	April 2021	Approved by & date	
Version	6	Description of changes	
<p><u>Taxonomy alignment throughout</u></p> <ul style="list-style-type: none"> - To be aligned with the reviewed GWO Taxonomy, all learning objectives have been updated with action verbs that reflect the new taxonomic levels (basic, intermediate and advanced level). - Additionally, learning activities have been added to the standard to match the updated learning objectives e.g. learning activities that focus on participant engagement have been added for all intermediate level learning objectives to reflect the reviewed GWO Taxonomy. <p><u>Updates to equipment lists for mechanical and electrical modules</u></p> <ul style="list-style-type: none"> - Overall, the changes are two additions to the mechanical equipment list (hydraulic tools for torque and tension with electrical pumps and an impact gun) and specifications of the quantity of key equipment currently listed in the two modules' equipment lists. <p><u>Changes to section "Understanding GWO learning objectives"</u></p> <ul style="list-style-type: none"> - The section Understanding GWO learning objectives has been updated to reflect the reviewed GWO Taxonomy <p><u>Delegates to participants</u></p> <ul style="list-style-type: none"> - <i>The Delegates</i> have been changed to <i>The Participants</i>, as participant is the proper designation for a person participating in an activity. <p><u>Human factors</u></p> <ul style="list-style-type: none"> - Added as an introductory element in all the modules in the standard to initiate the participants' focus on how human performance and taking responsibility influences a safe work environment, and to prepare for the continued focus on human factors during practical training and exercises. <p><u>Name and activity change for the <i>Evaluation</i> lesson to <i>Training review</i></u></p> <ul style="list-style-type: none"> - The naming of the <i>Evaluation</i> lesson has been changed to <i>Training review</i> to align with the other GWO standards and to facilitate a focus on the participants' reflections on the learning outcomes and the instructor's feedback. <p><u>Activity change for the introduction lesson</u></p> <ul style="list-style-type: none"> - To align with the other GWO standards, the activities in the introduction lesson has been changed to enable the participants in engaging in the training safely and motivated while recognizing what is expected of them during the training <p><u>Name and activity change for the <i>Evaluation</i> lesson to <i>Training review</i></u></p> <ul style="list-style-type: none"> - The naming of the <i>Evaluation</i> lesson has been changed to <i>Training review</i> to align with the other GWO standards and to facilitate a focus on the participants' reflections on the learning outcomes and the instructor's feedback. 			



Content changes

Mechanical Module

- Element 2.1.1 inserted 'Main bearing ...' to the list of main components
- Elements 6.1.1 & 6.2 added safety emphasis on using hydraulic tools and correct use of pressure charts

Electrical module

- Element 3.1.1 added "Explain the dangers of electricity:..."
- Element 3.1.2 added "(including late effects)"
- Element 3.2.2 added "Explain the basic difference of hazards between High Voltage and Low Voltage"
- Element 3.2.3 added "Show examples of HV safety signs and HV restricted areas (e.g. HV transformer...)"
- Element 3.3.2 added "Explain what can happen when a tool is used without protective earth and GFCI/RCD and the consequence of improper grounding on tools or equipment"
- Element 3.3.3 added "Explain identify double isolated tools and that they do not require grounding"
- Element 3.3.4 added "Explain the importance of grounding an external generator in accordance with manufacturer's manual, local legislation and company rules"
- Element 3.3.7 added "Compare the consequences of getting a shock on a circuit protected by a GFCI and on a circuit without GFCI".



4 Scope

This standard has been developed in response to the demand for recognizable Basic Technical Training in the industry and has been prepared in co-operation between the members of GWO based on risk assessments and factual incident and accident statistics pertaining to the installation, service and maintenance of wind turbine generators and wind power plants.

This standard describes the requirements for **Basic Technical Training** modules that are recommended by the members of GWO. The standard covers 4 modules:

- 1) Hydraulic
- 2) Mechanical
- 3) Electrical
- 4) Installation

The members of the Global Wind Organisation (GWO) recognise trained persons as being able to safely perform basic hydraulic, mechanical, electrical and installation tasks under the supervision of an experienced technician.

GWO members agree that everyone working on one of their properties (Wind Turbine Generators, sub stations, etc.) shall complete Basic Technical Training courses relevant for their assignments. All work shall be done in teams of at least 2 competent persons. Exemptions from the above can be made based on internal company rules.

This standard has been developed by the GWO Training Committee. The standard was based on the EU-funded project “Adapting a Transparent Training Programme”, completed in 2014.



5 General Requirements for GWO Training

Upon completion of the Global Wind Organisation (GWO) Basic Technical Training (BTT), participants will possess an awareness of the hazards encountered when working on hydraulic, mechanical, electrical and installation systems, and how to control and mitigate these hazards, preparing candidates for working both on and offshore in the wind power industry.

These training modules can be delivered independently of one another or as stand-alone training. The installation module is not part of the mandatory BTT training, and it is up to the duty holder to decide if this should be mandatory training.

5.1 Overview

The GWO Basic Technical Training is divided into the following four modules:

- 1) Hydraulic
- 2) Mechanical
- 3) Electrical
- 4) Installation

5.2 Target Group

The Basic Technical Training modules are targeted at candidates who have no previous experience of hydraulic, mechanical, electrical or installation systems, but may also be used to upskill candidates who have some knowledge but not of its application in wind turbines.

5.3 Aims and Objectives

This BTT Training shall enable participants to be able to perform basic hydraulic, mechanical, electrical and installation tasks under the supervision of an experienced technician.

This course will not make the participant a trained person who is allowed to perform hydraulic, mechanical, electrical or installation work without supervision.

5.4 Duration of BTT Modules

The total contact time for completing the stand-alone modules in this basic technical training standard is estimated to be **32 hours**. This is based on the time estimates given in the module timetables and summarised in table 5-41 & 5-42 below.

The training provider must not exceed the times per day given in table 5-7 below.



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The training provider must ensure that sufficient time is allowed for participants with prior experience to share their experiences related to the modules of the basic technical training standard in a way that is constructive for the entire class.

Durations stated in the table below are meant as an orientation for anyone delivering the training. Small variations are acceptable as far as they do not compromise the achievement of the objectives for all participants.

If the following modules are delivered as part of a complete training, the common elements of introduction and evaluation may be combined, reducing the total contact time. How this may be achieved is suggested in the timetables for each module

Modules	Duration (*Effective time) As stand-alone training	Duration (*Effective time) As part of combined training
Mechanical	13.67 hours	13.67 hours
Electrical	9.92 hours	9.50 hours
Hydraulic	8.92 hours	8.50 hours
TOTAL		31.67 hours

Table 5-41 - Duration of GWO BTT Modules

Modules	Duration (*Effective time) As stand-alone training	Duration (*Effective time) As part of combined training
Mechanical	13.67 hours	13.67 hours
Installation	17.67 hours	17.25 hours
TOTAL		30.92 hours

Table 5-42 - Duration of GWO Mechanical and Installation Modules

	Maximum duration per day
Contact time	8 hours
Total training day	10 hours

Table 5-43 - Maximum durations for training days

Note: Contact time includes delivery of course lesson content, practical exercises, and activities directly related to these.

The total training day includes contact time, meals and breaks and travel between training sites (where applicable).

Within the module timetables, the approximate duration of each of the lesson is given. The training provider may choose to deliver elements of the training according to other timetables, as long as the total duration is not reduced, and practical elements are not reduced in length. Theoretical elements may be delivered during the practical exercises when feasible.

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

If the Mechanical, Electrical and Hydraulic modules are delivered as a combined training, the total contact time is estimated as at least 4 days of training (at least 31 hours 40 minutes of effective training time).



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If the Mechanical and Installation modules are delivered as a combined training, the total contact time is estimated as at least 4 days of training (at least 30 hours 55 minutes of effective training time).

If delivered as separate modules, the effective training time for each module is as follows:

- 1) The Mechanical module is estimated as a 2-day course (at least 13 hours and 40 minutes).
- 2) The Electrical and Hydraulic modules are estimated as 1.5-day courses (at least 9 hours 55 minutes for the Electrical module and at least 8 hours 55 minutes for the Hydraulic module).
- 3) The Installation module is estimated as a 2.5-day course (at least 17 hours and 40 minutes).

It shall be ensured that everybody is given the opportunity to share their opinions and experiences where possible. Additionally, it shall be ensured that participants with prior experience share their experiences in a way that is constructive for the entire class.

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

5.5 Validity Period

The Basic Technical Training is an enduring qualification, so a validity period does not apply to this training. This is based on the assumption that the participant is actively working in a wind turbine environment. If there is an extended period of absence from applying the skills, retraining and recertification may be required according to national legislation and company policy.

A maximum interval between successful completion of the BTT Hydraulic, Mechanical, Electrical and Installation modules does not apply. This is based on the assumption that the participant is actively working in a wind turbine environment. If there is an extended period of absence from applying the skills, retraining and recertification may be required according to national legislation and company policy.

5.6 Course Codes

Module	Course Code
BTT Mechanical	BTTM
BTT Electrical	BTTE
BTT Hydraulic	BTTH
BTT Installation	BTTI

Table 5-6 - GWO BTT module course codes

5.7 Participant Prerequisites for the BTT

All personnel participating in Basic Technical Training shall be medically fit and capable of fully participating.



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Training providers shall have a procedure that requires participants to sign a statement stating that they are medically fit to participate in the safety training, that they do not suffer from any medical illness, and that they are not under the influence of any narcotic substance or alcohol.

The Requirements for Training Providers Annex 2: Medical Self-Assessment Form shall be used if no other equivalent procedure is in place.

Participants' signatures testifying to their medical fitness shall be collected prior to the start of the Basic Technical Training course.

Furthermore, participants shall have created a personal participant profile in WINDA, and provide their own WINDA ID prior to completing the BTT training.

There is only a prerequisite to attend the Installation module, hence, the participant must have completed the Mechanical module before attending the Installation training. There are no prerequisites for the remaining modules, but some sort of practical mechanical or electrical maintenance background would be useful.

Furthermore, 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. It is an advantage if participants are able to read, speak and write English.

5.8 Physical Demands

BTT modules do not have any specific expected physical demands.

However, if there is any doubt regarding the medical fitness of any participant, the training provider shall stop training the participant, and seek a physician's advice.

Note: Practical exercises shall be designed and delivered solely to meet this standard, and shall not place any physical or mental demands on the participants other than those required to meet this standard.



6 General Resources Required to Deliver BTT Modules

The training provider shall ensure that staff, facilities and equipment are in place to support the training of participants.

6.1 Instructor/Participant Ratio

The ratio shown for the theory session indicates the maximum number of participants attending the modules. Other ratios indicate the maximum number of participants to be supervised by an instructor during each activity.

Modules	Session	Instructor – Participant Ratio
All BTT Modules	Theory	1:12
	Practical	1:8

Table 6-1 - GWO BST Instructor to participant ratios

6.2 Practical Training Facilities

A practical workshop is required that has enough space to accommodate 8 participants, with a respective work area each of approximately 3 square metres.

6.3 Equipment

The equipment required for the delivery of the BTT modules is shown in Annex 1.

6.4 Handouts

Handouts must be given to the participants containing, as a minimum:

- 1) Electrical symbols mentioned in the BTT Standard
- 2) Hydraulic symbols mentioned in the BTT Standard
- 3) Formulas used (Pascal's Law, Ohm's Law, Torque...)

These handouts could be used as reference for the participants during the entire course and also during the test at the end.

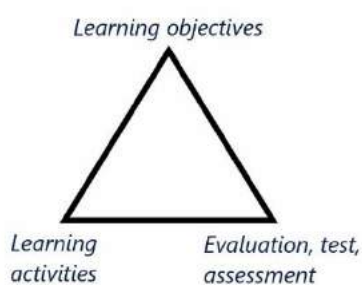


7 Understand GWO Learning Objectives

7.1 Learning objectives

Learning objectives describe what the participant should know and be able to do when the training is completed.

The learning objectives are based on the mitigating precautions analysed in the risk assessment, and are the foundation of the learning activities, the course contents and what the participant performance assessment must be based upon.



Coherence between the learning objectives, the learning activities and the assessment is essential. The purpose of this coherence is twofold. Firstly, this coherence ensures that learning activities are directly focused on reaching the learning objectives. Secondly, this coherence ensures that assessment of how well the learning objectives are met is done in close coherence with the abilities the participant has practiced during the learning activities and in a comparable environment to the participant's subsequent work in the wind industry.

Enabling learning objectives are further sub-specifications of the learning objectives. Enabling objectives are what the instructor should be concentrating on when observing the participants performance and development *in action*. Furthermore, evaluation should be focused on the enabling objectives as well as on the learning objectives.

Ability is what is performed and presented during real-life exercises as well as in the real work situation, and is the sum of experiences, knowledge, skills and attitudes. To be able to focus training on building up the necessary abilities, the learning objectives are described according to the taxonomy in the three domains: Knowledge, Skills and Ability.

7.2 Taxonomy

The GWO Taxonomy offers:

- 1) Guidance and support for training providers when designing both focused and assessable learning activities from the stated learning objectives.
- 2) Guidance and inspiration for instructors when executing learning activities and when assessing the participants' learning outcome.
- 3) Digital advice when feasible.
- 4) Instructions and guidance for auditors when auditing in the pedagogical and didactic scope.



Learning objectives are presented in three taxonomic levels: Basic, Intermediate and Advanced level. The three levels in each domain are described as follows:

	Knowledge	Skills	Ability
3) Advanced level	The participant understands a topic in a holistic view, where risks, advantages and disadvantages are considered, forming the background for reflected assessments or decisions for action.	The participant can experiment and refine his or her skills, as well as reflect and evaluate on the behaviour and reactions in relevant situations.	Can adapt and act responsibly in new ways, pay attention to the safety of fellow workers, and propose development of safety procedures. Safety-awareness and responsibility are an instinctive part of ability.
2) Intermediate level	The participant can account for how things are done, or can explain how a piece of equipment or a tool is used.	The participant can test the applicability of the skill, and distinguish between relevant and less relevant situations to apply the skill in.	The participant can act independently , is able to identify connections and risks in work related situations, and can take initiative and responsibility for feasible mitigating actions on the job.
1) Basic level	The participant can describe a topic, name its constituent parts or simply refer to it. Basic knowledge is observed by a one-dimensional objective: "I can state a fact".	Basic cognitive and practical skills required to apply relevant instructions and procedures to solve routine problems using simple rules and tools.	The participant can act independently in familiar work situations.

The taxonomy levels in the learning objectives are defined by a reasonable number of precise and explained action verbs. These action verbs are presented in a progression of increasing complexity - beginning on the basic level, where the participant can recognise or name a tool or a procedure, and ending at the advanced level, where the participant can take responsibility and even assist fellow workers on the work site.

The taxonomy and the presentation of action verbs in the progressive order imply that the previous taxonomic competences are already achieved.

Learning objectives in this standard are followed by an indication of the taxonomy level and domain in brackets e.g. (Skills, advanced level)



7.3 Summing up the learning objectives

A specific action verb indicates a taxonomic complexity level that calls for specific learning activities for the participant to reach the decided learning objectives.

During the learning activity, the participant shall practice doing what the action verb indicates.

In addition to this, the instructor's evaluation *in action*, as well as the evaluation at the end of a module or a training, becomes transparent, when the participant's ability to meet the learning objectives is assessed by comparing the participant's performance with the action verbs and contents of the learning objective.



8 Administration and Certification of Modules

8.1 Participant Performance Assessment

The participants will be assessed separately on each module according to the learning objectives, by means of direct observation and supplementary oral questions where appropriate (formative evaluation). Furthermore, the participants will be subjected to a written phase test on each module according to the learning objectives (summative evaluation).

The written tests can consist of multiple-choice or descriptive answer questions, and shall be set at the same taxonomy level as the objective that they are testing.

The multiple-choice test must be conducted in accordance with the following criteria:

- 1) There shall be at least one question for each lesson in the module with a minimum of 10 questions for each stand-alone module.
- 2) There shall be a time limit of 1½ minutes per question.
- 3) The tests must be individual.
- 4) The participants shall not communicate with each other during the test
- 5) The participants shall not communicate with any persons via email, telephone, Skype (or similar) or social media during the test
- 6) Where a participant does not understand the meaning of a question or a multiple-choice option, the instructor shall be allowed to help the participant to understand the meaning of the question or the multiple-choice options. The instructor shall not give the participant the correct answers to any test questions.
- 7) Participants may use:
 - a. Training material.
 - b. Handouts.
 - c. Own notes
- 8) Participants may not use:
 - a. Mobile phones (except for calculator).

The multiple-choice test questions cannot be used at any other time during the training in such a way that the participants could recognise that they will be test questions at the end.

At least 70% of the questions in the written test must be answered correctly in order to pass the corresponding module.

In the event that a participant fails the test, the instructor will have a discussion with the participant in order to find out the reason for this. If the reason was due to the misunderstanding of a question or due to language difficulties, the instructor can mark a question as correct, provided that the participant is able to demonstrate the right level of understanding. This must be properly documented by the instructor and kept together with the tests, control measures, evaluations, etc.



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Throughout each of the BTT modules, the instructor will use the participant performance assessment form (see annex 1 of the Requirements for Training Providers) to evaluate the participant's knowledge and skills, with a high focus on evaluating the participant's safety awareness.

The instructor shall keep a participant performance assessment form (or adaptation) for each participant until the completion/evaluation of each BTT training module.

The participant performance assessment form (or adaptation) is a final evaluation tool for the instructors to assess participants during practical elements. It allows measurement of the number of violations regarding safety, competency or attitude.

The participant performance assessment form shall be used as a progressive evaluation tool to discuss the performance of a participant in guiding them to success. It also serves as supporting documentation if a participant passes or fails the module.

Training providers may adapt the participant performance assessment form to other media.

Training providers must have a documented procedure in place for dealing with participants not meeting the stated learning outcomes.



GLOBAL WIND
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Mechanical Module (BTTM)



9 The BTT Mechanical Module

9.1 Aims and objectives of the BTT Mechanical Module

The aim of this BTT Mechanical Module is to give the participants the knowledge and skills to carry out basic mechanical tasks (supervised by an experienced technician), using safe working procedures and the correct PPE.

After having successfully completed the BTT Mechanical Module, participants will be able to:

- 1) **Describe** the main components, mechanical systems and basic operation of wind turbines (Knowledge, basic level)
- 2) **Discuss** risks and hazards associated with mechanics (Knowledge, intermediate level)
- 3) **Explain** the principles of bolted and welded connections and their inspection (Knowledge, intermediate level)
- 4) **Apply** manual tightening and measuring tools (Skills, intermediate level)
- 5) **Perform** the correct use of hydraulic torque and tensioning tools (Skills, intermediate level)
- 6) **Recognise** the principles of a gearbox (Knowledge, basic level)
- 7) **Recognise** the function of the brake systems (Knowledge, basic level)
- 8) **Perform** inspection of brake systems (Skills, intermediate level)
- 9) **Recognise** the function of the yaw system and how to inspect it (Knowledge, basic level)
- 10) **Recognise** the function of the cooling system (Knowledge, basic level)
- 11) **Perform** inspection of the cooling system (Skills, intermediate level)
- 12) **Recognise** the function of the lubrication system (Knowledge, basic level)
- 13) **Perform** inspection of the lubrication system (Skills, intermediate level)

9.2 Duration of the BTT Mechanical Module

The total contact time for completing this BTT mechanical module is estimated to be 13.67 hours. This is based on the time estimate given in the module timetable.

The training provider must not exceed the times per day given in table 9-2 below.

The training provider must ensure that sufficient time is allowed for participants with prior experience to share their experiences related to the module in a way that is constructive for the entire class.



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	Maximum duration per day
Contact time	8 hours
Total training day	10 hours

Table 9-2 - Maximum duration for training days

Note: Contact time includes completion of course lesson content, practical exercises and activities directly related to these.

The total training day includes contact time, meals and breaks, and travel between training sites (where applicable).

9.3 Equipment

The equipment required for training as listed in Annex 1 must be available and must fulfil national legal requirements in the country where the training is taking place.

9.4 BTT Mechanical Module Timetable

Within the module timetables, the approximate duration of each of the lessons is given. The training provider may choose to deliver elements of the training according to other timetables, as long as the total duration is not reduced, and practical elements are not reduced in length. Theoretical elements may be delivered during the practical exercises when feasible.

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

Lesson		Element		Approx. duration
1	Introduction	1.1	Safety instructions and emergency procedures	
		1.2	Facilities	
		1.3	Introduction	
		1.4	Aim and objectives	
		1.5	On-going assessment	
		1.6	Motivation	
		1.7	Human factor	
		TOTAL		
2	Mechanical introduction	2.1	Main components of the structure	
		2.2	Main mechanical systems	
		2.3	How a turbine works	
		TOTAL		
3	Mechanical Safety	3.1	Why mechanical safety?	
		3.2	Safety signs	
		3.3	Types of PPE	



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		3.4	The importance of appropriate isolation	
TOTAL				30 min.
4	The principles of bolted and welded connections	4.1	The principles of bolt connections	
		4.2	The locations of important bolted and welded connections	
		4.3	Inspection of welded connections	
		4.4	Bolt connections and correct tightening tools	
TOTAL				80 min.
5	Use of manual tightening and measuring tools	5.1	Metric system	
		5.2	Selecting and using the correct manual tightening tools	
		5.3	Correctly setting and using a torque wrench	
		5.4	Feeler gauges	
		5.5	Callipers	
		5.6	Dial gauge	
TOTAL				70 min.
6	Hydraulic Torque and Tension	6.1	Using a hydraulic torque wrench	
		6.2	Using a hydraulic tensioning tool	
TOTAL				300 min.
7	Gearbox	7.1	The function and operating principles	
		7.2	Inspection of the gearbox	
TOTAL				30 min.
8	Braking system	8.1	The function of the mechanical and the aerodynamic brake	
		8.2	Inspection of the mechanical brake system	
TOTAL				40 min.
9	Yaw System	9.1	The function of the yaw system	
		9.2	Inspection of the yaw system	
TOTAL				30 min.
10	Cooling System	10.1	Components requiring cooling and why	
		10.2	Inspection of the cooling systems	
TOTAL				30 min.
11	Lubrication System	11.1	Components requiring lubrication and why	
		11.2	Inspection of the lubrication systems	
TOTAL				75 min.
12	Summary and Theoretical test	12.1	Summary	
		12.2	Theoretical test	
TOTAL				30 min.
13	Training review	13.1	Training review	
TOTAL				15 min.
GRAND TOTAL				820 min.



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Table 9-4 – GWO BTT Mechanical Module timetable

9.5 Learning outcomes of the BTT Mechanical Module

The learning outcomes specified for the BTT Mechanical Module are:

Lesson 1 - INTRODUCTION

30 min.

The aim of this lesson is to enable the participants on the GWO BTT Mechanical Module training to engage in the training safely and with motivation, while recognising what is expected of them during the training

NOTE: If this module is delivered combined with other BTT modules to the same participants, the redundant introductory elements shall not be repeated.

After successfully completing this lesson of the BTT Mechanical Module, participants will be able to:

- 1) **Describe** the module content and the facilities involved to ensure a clear understanding of what is expected during the module (Knowledge, basic level)
- 2) **Name** and point out local emergency procedures and facilities (Knowledge, basic level)
- 3) **Describe** the relevant human factors and the implications thereof (Knowledge, basic level)

ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Learning objectives:

- 4) The participants can **recognise** the safety instructions, rules and emergency procedures (Knowledge, basic level)
- 5) The participants **show an interest or curiosity** in the safety and emergency procedures (Ability, basic level)

The instructor shall:

1.1.1 Explain and ask involving questions concerning:

- a. safety instructions according to internal procedures
- b. emergency procedures and emergency exits in the areas where the participants can be expected to be located during the module

The participants shall:

1.1.2 Engage in answering the above questions

ELEMENT 1.2 - FACILITIES



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Learning objective:

- 6) The participants can **recognise** the facilities at the training location (Knowledge, basic level)

The instructor shall:

- 1.2.1 Give a general description of the facilities at the location (administration, dining area, restrooms and toilets, etc.)

The participants shall:

- 1.2.2 Note relevant facilities and ask questions when in doubt about facilities

ELEMENT 1.3 - INTRODUCTION

Learning objective:

- 7) The participants **show an interest** in fellow participants and the programme of the BTT Mechanical Module (Ability, basic level)

The instructor shall:

- 1.3.1 Explain and ask involving questions about the programme of the BTT Mechanical module, including breaks and meal times
- 1.3.2 Give a short introduction about themselves, including their backgrounds as instructors
- 1.3.3 Ask for participants' expectations of the training and their learning outcome

The participants shall:

- 1.3.4 Give a short introduction of themselves, including their job function, and share their expectations of the training and learning outcome expectation for the training

ELEMENT 1.4 - AIM AND OBJECTIVES

Learning objective:

- 8) The participants can **recognise** the scope and main objectives of the BTT Mechanical Module (Knowledge, basic level)

The instructor shall:

- 1.4.1 Explain the scope and main objectives of the BTT Mechanical Module
- 1.4.2 Involve participants through questions about the participants' understanding and individual experiences relevant to the BTT Mechanical Module

The participants shall:



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- 1.4.3 Engage in answering questions, and share experiences relevant to the BTT Mechanical Module

ELEMENT 1.5 - ONGOING ASSESSMENTS

Learning objective:

- 9) The participants can **recognise** the reasons for the ongoing assessment, and **recognise** how the GWO participant assessment form will be used throughout the module (Knowledge, basic level)

The instructor shall:

- 1.5.1 Explain the reasons for the on-going assessment
1.5.2 Explain the GWO participant assessment form and how it will be used
1.5.3 Ask for the participants' thoughts on the assessment procedure presented

The participants shall:

- 1.5.4 Engage in discussions and share thoughts on the assessment procedure

ELEMENT 1.6 - MOTIVATION

Learning objective:

- 10) The participants **show a willingness** to be personally involved in the learning activities throughout the BTT Mechanical Module (Ability, basic level)

The instructor shall:

- 1.6.1 Explain and facilitate discussions on:
a. the importance of personal involvement in the module
b. the need for the BTT mechanical module when working in the wind industry

The participants shall:

- 1.6.2 Engage themselves in discussions about the importance of personal involvement in the module and the need for the BTT mechanical module when working in the wind industry

ELEMENT 1.7 - HUMAN FACTORS

Learning objectives:

- 11) The participants can **describe** the relevant human factors and the implications thereof (Knowledge, basic level)
12) The participants **show an interest and willingness** to focus on human factors during the following practical exercises (Ability, basic level)



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The instructor shall:

- 1.7.1 Present how human factors have an influence on accidents in the wind industry
- 1.7.2 Lead a discussion about the role of the individual in improving human performance, and how this improvement can benefit safety when working in the wind industry, by considering factors like:
 - a. Attention and perception
 - b. Group behaviour and peer pressure
 - c. Fitness and health
 - d. Domestic and work-related stress
 - e. Workload (both overload and underload)
 - f. Fatigue
 - g. Time pressure and deadlines
 - h. Alcohol, medication and substance abuse

The participants shall:

- 1.7.3 Engage in discussions and share understandings about the human factor influence on accidents when working in the wind industry

Lesson 2 - MECHANICAL INTRODUCTION

60 min.

The aim of this lesson is to give the participants an introduction to wind turbines.

ELEMENT 2.1 - MAIN COMPONENTS OF THE STRUCTURE

Learning objective:

- 13) The participants can **describe** the main components in a wind turbine (Knowledge, intermediate level)

The instructor shall:

- 2.1.1 Explain the basic function and location of the:
 - a. Foundation & Transition piece
 - b. Tower sections
 - c. Nacelle
 - d. Main bearing
 - e. Rotor and blades



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f. Platforms, ladders and lift

2.1.2 Facilitate discussions with the participants about the main components of the structure of a wind turbine

a. Foundation & Transition piece

b. Tower sections

c. Nacelle

d. Main bearing

e. Rotor and blades

f. Platforms, ladders and lift

The participants shall:

2.1.3 Engage in discussions about the main components of the structure of a wind turbine

ELEMENT 2.2 - MAIN MECHANICAL SYSTEMS

Learning objective:

14) The participants can **discuss** the function, main components and location of the main mechanical systems in a wind turbine (Knowledge, intermediate level)

The instructor shall:

2.2.1 Present the basic function, main components and location of the:

a. Pitch system

b. Yaw system

c. Main shaft

d. Gearbox

e. Coupling

f. Generator

2.2.2 Facilitate group discussions that challenges the participants to see the connection between the above mechanical systems and the main components of the structure of the wind turbine, which have been discussed earlier in the lesson.

The participants shall:

2.2.3 Engage in a group discussion and share understandings about the connection between the above mechanical systems and the main components of the structure of the wind turbine

The instructor shall:



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- 2.2.4 Give constructive feedback on the participant groups' discussions

ELEMENT 2.3 - HOW A TURBINE WORKS

Learning objective:

- 15) The participants can **describe** how a wind turbine works (Knowledge, basic level)

The instructor shall:

- 2.3.1 Explain how the turbine uses the wind to produce electricity
- 2.3.2 Define and explain wind speed and direction
- 2.3.3 Describe the basic aerodynamics of the blade
- 2.3.4 Explain control of the rotor speed using the blade regulation system
- 2.3.5 Facilitate discussions with the participants about energy, wind speed and wind direction

The participants shall:

- 2.3.6 Engage in discussions about energy, wind speed and wind direction

Lesson 3 - MECHANICAL SAFETY

30 min.

The aim of this lesson is to enable participants to handle mechanical hazards in a wind turbine.

ELEMENT 3.1 - WHY MECHANICAL SAFETY?

Learning objectives:

- 16) The participants can **discuss** the safety risks and hazards in mechanical systems (Knowledge, intermediate level)
- 17) The participants can **explain** the importance of Mechanical Safety (Knowledge, intermediate level)

The instructor shall:

- 3.1.1 Facilitate group discussions on the safety risks and hazards in mechanical systems (e.g. bruises, squeezing, rotation, fluids, trapping, slipping, pinching)
- 3.1.2 Explain the importance of working according to approved working practices (through e.g. the use of storytelling or scenarios)
- 3.1.3 Show the consequences of not following approved working practices (e.g., pictures, stories or scenarios of injuries related to mechanical incidents)
- 3.1.4 Explain the need for Safety Data Sheets (SDS)



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- 3.1.5 Ask the participants relevant questions about safe working procedures, identifying the necessary PPE and appropriate tools when working with mechanics.

The participants shall:

- 3.1.6 Engage in a group discussion on the safety risks and hazards in mechanical systems
- 3.1.7 Explain in their own words and share understandings about safe working procedures, identifying the necessary PPE and appropriate tools when working with mechanics.

The instructor shall:

- 3.1.8 Give constructive feedback on the participants' group discussion and explanations about the safety risks and hazards in mechanical systems and the importance of mechanical safety

ELEMENT 3.2 - SAFETY SIGNS

Learning objectives:

- 18) The participants can **describe** different safety signs and their meanings (Knowledge, basic level)
- 19) The participants can **recognise** the importance of adhering to safety signs (Knowledge, basic level)

The instructor shall:

- 3.2.1 Explain how to identify different signs for mechanical danger (e.g. rotating parts, pinch point, helmet mandatory)
- 3.2.2 Show examples of safety signs on different locations in the WTG (e.g. rotating parts, pinch point, helmet mandatory)
- 3.2.3 Show the consequences of not adhering to safety signs in the WTG through e.g. stories, pictures or examples (injuries related to mechanics)
- 3.2.4 Facilitate discussions about different safety signs and their meanings

The participants shall:

- 3.2.5 Engage in discussions about different safety signs and their meanings

ELEMENT 3.3 - TYPES OF PPE

Learning objective:

- 20) The participants can **describe** the required PPE for working with mechanics (Knowledge, basic level)

The instructor shall:

- 3.3.1 Explain and demonstrate examples of the usage and inspection of PPE suitable for mechanical work
- 3.3.2 Ask the participants relevant questions about the required PPE for working with mechanics



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The participants shall:

- 3.3.3 Describe in their own words and share understandings about the required PPE for working with mechanics

ELEMENT 3.4 - THE IMPORTANCE OF APPROPRIATE ISOLATION

Learning objectives:

- 21) The participants can **discuss** the importance of proper isolation when working with mechanics (Knowledge, intermediate level)
- 22) The participants can **recognise** the importance of emergency stop buttons in a WTG, and how mechanical systems will react when an emergency stop button is pressed (Knowledge, basic level)

The instructor shall:

- 3.4.1 Facilitate group discussions with the participants about the importance of using appropriate isolation when working with mechanics
- 3.4.2 Show the importance of emergency stop buttons in the wind turbine
- 3.4.3 Describe typical examples of how mechanical systems will react when an emergency stop button is pressed

The participants shall:

- 3.4.4 Engage in a group discussion about the importance of using appropriate isolation and why it is important to prevent unexpected start-up

The instructor shall:

- 3.4.5 Give constructive feedback on the participants' group discussion

Lesson 4 - THE PRINCIPLES OF BOLTED AND WELDED CONNECTIONS

80 min.

The aim of this lesson is to give participants an understanding of bolted and welded connections and their inspection.

ELEMENT 4.1 - THE PRINCIPLES OF BOLT CONNECTIONS

Learning objective:

- 23) The participants can **discuss** the principles of bolted connections (Knowledge, intermediate level).

The instructor shall:



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- 4.1.1 Explain how to identify different types of bolts according to:
 - a. Dimensions
 - b. Thread type
 - c. Material and treatments (hot dip galvanized, electroplated, stainless steel, pre-lubricated...)
 - d. Quality
- 4.1.2 Explain how bolt strength is proportional to the size of the bolt and dependent on material and quality
- 4.1.3 Explain the function of and types of washers
- 4.1.4 Explain the importance of bolt thread lubrication
- 4.1.5 Explain the importance of the same temperature for all set components
- 4.1.6 Define and explain torque and tension
- 4.1.7 Explain the principles of angular tightening
- 4.1.8 Show the importance of correct tightening (e.g. collapsing towers, electrical fires)
- 4.1.9 Facilitate group discussions on:
 - a. Bolts, threads, lubricants, strengths of materials and temperature influences
 - b. Force and torque

The participants shall:

- 4.1.10 Engage in a group discussion and share understandings about bolts, threads, lubricants, strengths of materials and temperature influences
- 4.1.11 Engage in a group discussion and share understandings about force and torque

The instructor shall:

- 4.1.12 Give constructive feedback on the participant groups' discussions about bolted connections

ELEMENT 4.2 - THE LOCATIONS OF IMPORTANT BOLTED AND WELDED CONNECTIONS

Learning objective:

- 24) The participants can **describe** the location of important bolted and welded connections (Knowledge, basic level)

The instructor shall:

- 4.2.1 Explain the connections between sections of the tower
- 4.2.2 Explain the platforms in the tower
- 4.2.3 Explain the ladders and guard rails inside and outside the tower



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- 4.2.4 Show and explain an example of a bolted connection and a welded connection
- 4.2.5 Explain bolted connections holding cranes
- 4.2.6 Explain bolted connections with the Fall Arrester system
- 4.2.7 Explain bolted connections on the rotor, coupling, gearbox and generator
- 4.2.8 Ask the participants relevant questions about the location of important bolted and welded connections

The participants shall:

- 4.2.9 Describe in their own words and share understandings about the location of important bolted and welded connections

ELEMENT 4.3 - INSPECTION OF WELDED CONNECTIONS

Learning objective:

- 25) The participants can **describe** how to visually inspect a welded connection (Knowledge, basic level)

The instructor shall:

- 4.3.1 Explain how to perform visual inspections of welded connections and document the findings (e.g. paint damage, corrosion, cracks...)
- 4.3.2 Ask the participants relevant questions on how to perform visual inspections of welded connections and document the findings

The participants shall:

- 4.3.3 Describe in their own words and share understandings about how to perform visual inspections of welded connections and document the findings

ELEMENT 4.4 - BOLT CONNECTIONS AND CORRECT TIGHTENING TOOLS

Learning objective:

- 26) The participants can **describe** how to tighten and inspect bolt connections (Knowledge, basic level)

The instructor shall:

- 4.4.1 Explain how to tighten a bolt connection (torque and tension) using a torque wrench and hydraulic tightening tools
- 4.4.2 Explain how to inspect if a bolt is loose (visual inspection or with tightening tools)
- 4.4.3 Ask the participants relevant questions on how to tighten and inspect bolt connections

The participants shall:



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- 4.4.4 Describe in their own words and share understandings about how to tighten and inspect bolt connections

Lesson 5 - USE OF MANUAL TIGHTENING AND MEASURING TOOLS

90 min.

The aim of this lesson is to enable the participants to use manual tightening and measuring tools.

ELEMENT 5.1 - METRIC SYSTEM

Learning objective:

- 27) The participants can **recognise** the basic units of the metric system (Knowledge, basic level)

The instructor shall:

- 5.1.1 Explain the key units used in the metric system for:

- a. Temperature
- b. Length
- c. Weight
- d. Speed
- e. Torque
- f. Tension
- g. Volume
- h. Pressure

ELEMENT 5.2 - SELECTING AND USING THE CORRECT MANUAL TIGHTENING TOOLS

Learning objectives:

- 28) The participants can select and **apply** the correct manual tightening tools (Skills, intermediate level)
- 29) The participants can **discuss** the importance of and how to perform a pre-use check on tools (Knowledge, intermediate level)

The instructor shall:

- 5.2.1 Present the types of manual tightening tools (spanners, sockets, screwdrivers)
- 5.2.2 Facilitate group discussions on the importance and performance of a pre-use check on tools
- 5.2.3 Demonstrate the correct application and size of a manual tightening tool
- 5.2.4 Show the consequences of incorrect manual tightening tool use (e.g. through examples or storytelling)



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5.2.5 Demonstrate how to use an electrical impact gun (awareness of not surpassing bolt torque)

5.2.6 Facilitate practice for the participants in selecting and using manual tightening tools

The participants shall:

5.2.7 Engage in a group discussion about the importance and performance of a pre-use check on tools

5.2.8 Practice selecting and using manual tightening tools

The instructor shall:

5.2.9 Give constructive feedback on the participants' discussions about pre-use check on tools and the participants' selection and use of manual tightening tools

ELEMENT 5.3 - CORRECTLY SETTING AND USING A TORQUE WRENCH

Learning objectives:

30) The participants can **apply** a torque wrench correctly (Skills, intermediate level)

31) The participants can **recognise** the importance and performance of a pre-use check on tools (Knowledge, basic level)

The instructor shall:

5.3.1 Explain the function of a torque wrench

5.3.2 Show the importance of pre-use checks and calibration in terms of safety and quality

5.3.3 Demonstrate how to set and use the torque wrench

5.3.4 Facilitate practice for the participants in setting and using torque wrenches

The participants shall:

5.3.5 Practice setting and using torque wrenches

The instructor shall:

5.3.6 Give constructive feedback on the participants' setting and use of torque wrenches

ELEMENT 5.4 - FEELER GAUGES

Learning objectives:

32) The participants can **apply** feeler gauges (Skills, intermediate level)

33) The participants can **recognise** the importance of pre-use checks in terms of safety and quality (Knowledge, basic level)

The instructor shall:



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- 5.4.1 Explain the function of feeler gauges
- 5.4.2 Show the importance of pre-use checks in terms of safety and quality
- 5.4.3 Demonstrate how to use feeler gauges
- 5.4.4 Demonstrate how to care for feeler gauges to prevent damage
- 5.4.5 Facilitate practice for the participants in the correct use and care of feeler gauges

The participants shall:

- 5.4.6 Practice the correct use and care of feeler gauges

The instructor shall:

- 5.4.7 Give constructive feedback on the participants' use and care of feeler gauges

ELEMENT 5.5 - CALLIPERS

Learning objectives:

- 34) The participants can **apply** a calliper (Skills, intermediate level)
- 35) The participants can **recognise** the importance of pre-use checks in terms of safety and quality (Knowledge, basic level)

The instructor shall:

- 5.5.1 Explain the function of callipers
- 5.5.2 Show the importance of pre-use check in terms of safety and quality
- 5.5.3 Demonstrate how to use callipers
- 5.5.4 Demonstrate how to care for callipers to prevent damage
- 5.5.5 Facilitate practice for the participants in the correct use and care of callipers (thicknesses, internal diameters and depth)

The participants shall:

- 5.5.6 Practice the correct use and care of callipers (thicknesses, internal diameters and depth)

The instructor shall:

- 5.5.7 Give constructive feedback on the participants' use and care of callipers

ELEMENT 5.6 - DIAL GAUGES

Learning objectives:

- 36) The participants can **apply** and **take care** of a dial gauge (Skills, intermediate level)



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- 37) The participants can **recognise** the importance of pre-use checks in terms of safety and quality (Knowledge, intermediate level)

The instructor shall:

- 5.6.1 Explain the function of a dial gauge
- 5.6.2 Show the importance of pre-use checks in terms of safety and quality
- 5.6.3 Demonstrate how to use a dial gauge
- 5.6.4 Demonstrate how to care for dial gauges to prevent damage
- 5.6.5 Facilitate practice for the participants in the correct use and care of a dial gauge

The participants shall:

- 5.6.6 Practice the correct use and care of a dial gauge

The instructor shall:

- 5.6.7 Give constructive feedback on the participants use and care of a dial gauge

Lesson 6 - HYDRAULIC TORQUE AND TENSION

300 min.

The aim of this lesson is to enable the participants to be able to use hydraulic tightening tools.

ELEMENT 6.1 - USING A HYDRAULIC TORQUE WRENCH

Learning objectives:

- 38) The participants can **explain** and mitigate the hazards and risks of using hydraulic tools (Knowledge, intermediate level)
- 39) The participants can **apply** a hydraulic torque tool (Skills, intermediate level)

The instructor shall:

- 6.1.1 Describe the hazards and risks of using hydraulic tools (through e.g. the use of storytelling and examples)
- 6.1.2 Ask the participants relevant questions about the hazards and risks of using hydraulic tools, and how to mitigate these hazards and risks
- 6.1.3 Describe the components of a hydraulic torque wrench kit (pump, hoses and head)
- 6.1.4 Explain how to inspect the hydraulic torque wrench kit, including pump, hoses, head and sockets
- 6.1.5 Demonstrate the correct use of a hydraulic torque wrench kit



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- 6.1.6 Demonstrate the correct use of pressure charts to emphasise the relationship between pressure and torque
- 6.1.7 Facilitate practice for the participants in inspecting and using a hydraulic torque wrench kit correctly

The participants shall:

- 6.1.8 Explain in their own words and share understandings about the hazards and risks of using hydraulic tools and how to mitigate these hazards and risks
- 6.1.9 Practice how to inspect the hydraulic torque wrench kit including pump, hoses, head and sockets
- 6.1.10 Practice using a hydraulic torque wrench kit correctly

The instructor shall:

- 6.1.11 Give constructive feedback on the participants' inspection and use of a hydraulic torque wrench kit

ELEMENT 6.2 - USING A HYDRAULIC TENSIONING TOOL

Learning objective:

- 40) The participants can **apply** a hydraulic tensioning tool (Skills, intermediate level)

The instructor shall:

- 6.2.1 Describe the components of a hydraulic tensioning tool kit (pump, hose and puller)
- 6.2.2 Explain and demonstrate the correct use of a hydraulic tensioning tool kit
- 6.2.3 Demonstrate the correct use of pressure charts to emphasise the relationship between pressure and tension
- 6.2.4 Facilitate practice for the participants in using a hydraulic tensioning tool kit correctly

The participants shall:

- 6.2.5 Practice the correct use of a hydraulic tensioning tool kit

The instructor shall:

- 6.2.6 Give constructive feedback on the participants use of a hydraulic tensioning tool kit

Lesson 7 - GEARBOX

30 min.

The aim of this lesson is to give the participants basic knowledge about the gearbox.

ELEMENT 7.1 - FUNCTION AND OPERATING PRINCIPLES



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Learning objectives:

- 41) The participants can **recognise** the function and operating principles of the gearbox (Knowledge, basic level)
- 42) The participants can **describe** the hazards associated with the gearbox (Knowledge, basic level)
- 43) The participants can **describe** the importance of appropriate isolation/locking techniques (Knowledge, basic level)
- 44) The participants can **describe** the correct PPE (Knowledge, basic level)

The instructor shall:

- 7.1.1 Explain the main function of the gearbox
- 7.1.2 Explain the operation of the gearbox
- 7.1.3 Facilitate discussions with the participants about:
 - a. the hazards associated with the gearbox
 - b. the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
 - c. the correct PPE

The participants shall:

- 7.1.4 Engage in discussions about the hazards associated with the gearbox
- 7.1.5 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 7.1.6 Engage in discussions about the correct PPE

ELEMENT 7.2 - INSPECTION OF THE GEARBOX

Learning objectives:

- 45) The participants can **recognise** how to check hoses and seals (Knowledge, basic level)
- 46) The participants can **describe** the importance of the right oil level (Knowledge, basic level)
- 47) The participants can **describe** the importance of listening for abnormal noise from the gearbox (Knowledge, basic level)

The instructor shall:

- 7.2.1 Explain the checking of hoses, and what to look for
- 7.2.2 Explain the checking of seals, and what to look for
- 7.2.3 Facilitate discussions on the importance of the right oil level and listening for abnormal noise from the gearbox



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The participants shall:

- 7.2.4 Engage in discussions about the importance of the right oil level
- 7.2.5 Engage in discussions about listening for abnormal noise from the gearbox

Lesson 8 - BRAKING SYSTEMS

40 min.

The aim of this lesson is to give the participants basic knowledge of the braking systems.

ELEMENT 8.1 - THE FUNCTION OF THE MECHANICAL AND THE AERODYNAMIC BRAKES

Learning objectives:

- 48) The participants can **recognise** the function and operation of the mechanical and the aerodynamic brakes (Knowledge, basic level)
- 49) The participants can **describe** the hazards associated with the mechanical and the aerodynamic brakes (Knowledge, basic level)
- 50) The participants can **describe** the importance of appropriate isolation/locking techniques (Knowledge, basic level)
- 51) The participants can **describe** the correct PPE (Knowledge, basic level)

The instructor shall:

- 8.1.1 Explain the function of the mechanical brake
- 8.1.2 Explain the function of the aerodynamic brake
- 8.1.3 Explain the consequences of them not functioning
- 8.1.4 Explain the operating principle of the mechanical brake
- 8.1.5 Explain the operating principle of the aerodynamic brake (e.g. stall, pitch etc.)
- 8.1.6 Facilitate discussions with the participants about:
 - a. the hazards associated with the mechanical and aerodynamic brakes (e.g. discussions on how the hazards of the mechanical and aerodynamic brakes compare to the hazards of the gearbox)
 - b. the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
 - c. the correct PPE

The participants shall:

- 8.1.7 Engage in discussions about the hazards associated with the mechanical and aerodynamic brakes



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- 8.1.8 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. risk of moving parts, pressurized systems)
- 8.1.9 Engage in discussions about the correct PPE

ELEMENT 8.2 - INSPECTION OF THE MECHANICAL BRAKE SYSTEM

Learning objective:

- 52) The participants can **perform** the inspection of the mechanical brake system (Skills, intermediate level)

The instructor shall:

- 8.2.1 Explain how to check the disc surface for wear and scuffing due to excess friction
- 8.2.2 Explain how to check the disc brake pads for wear
- 8.2.3 Facilitate practice for the participants in checking the thickness of the brake pads and measuring the thickness of the brake disc

The participants shall:

- 8.2.4 Practice checking the thickness of the brake pads
- 8.2.5 Practice measuring the thickness of the brake disc

The instructor shall:

- 8.2.6 Give constructive feedback on the participants' checking of the thickness of the brake pads and measurement of the thickness of the brake disc

Lesson 9 - YAW SYSTEM

30 min.

The aim of this lesson is to give participants the basic knowledge of the yaw system.

ELEMENT 9.1 - THE FUNCTION OF THE YAW SYSTEM

Learning objectives:

- 53) The participants can **recognise** the function and operation of the yaw system (Knowledge, basic level)
- 54) The participants can **describe** the hazards associated with the yaw system (Knowledge, basic level)
- 55) The participants can **describe** the importance of appropriate isolation/locking techniques (Knowledge, basic level)



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56) The participants can **describe** the correct PPE (Knowledge, basic level)

The instructor shall:

- 9.1.1 Explain the function of the yaw system
- 9.1.2 Explain the operation of the components in the yaw system (yaw motors, yaw gears, wind sensor, twist sensor and yaw bearing)
- 9.1.3 Facilitate discussions with the participants about:
 - a. the hazards associated with the yaw system (e.g. through discussions about how the hazards of the yaw system compare to the hazards of the gearbox and the mechanical and aerodynamic brakes)
 - b. the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
 - c. the correct PPE

The participants shall:

- 9.1.4 Engage in discussions about the hazards associated with the yaw system
- 9.1.5 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 9.1.6 Engage in discussions about the correct PPE

ELEMENT 9.2 - INSPECTION OF THE YAW SYSTEM

Learning objective:

57) The participants can **describe** how to perform the inspection of the yaw system (Knowledge, basic level)

The instructor shall:

- 9.2.1 Describe typical inspections tasks in the yaw system
 - a. Lubrication
 - b. Torque
 - c. Noise
 - d. Brake pad and disc inspection
- 9.2.2 Ask the participants relevant questions about typical inspections tasks in the yaw system

The participants shall:

- 9.2.3 Describe in their own words and share understandings about typical inspections tasks in the yaw system



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Lesson 10 - COOLING SYSTEM

30 min.

The aim of this lesson is to give the participants basic knowledge of the cooling system.

Learning objectives:

- 58) The participants can **recognise** which components in a WTG have to be cooled and why (Knowledge, basic level)
- 59) The participants can **describe** the consequences of inadequate cooling (Knowledge, basic level)
- 60) The participants can **describe** the hazards associated with the cooling system (Knowledge, basic level)
- 61) The participants can **describe** the importance of appropriate isolation/locking techniques (Knowledge, basic level)
- 62) The participants can **describe** the correct PPE (Knowledge, basic level)

The instructor shall:

- 10.1.1 Explain how heat is produced in the different systems and components (e.g. gearbox, generator, hydraulic system...)
- 10.1.2 Explain that heat can be transferred from component to component
- 10.1.3 Explain overheating problems
- 10.1.4 Facilitate discussions with the participants about:
 - a. the consequences of inadequate cooling
 - b. the hazards associated with the cooling system (e.g. discussions on how the hazards of the cooling system compare to the hazards of the gearbox, the mechanical and aerodynamic brakes, and the yaw system)
 - c. the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
 - d. the correct PPE

The participants shall:

- 10.1.5 Engage in discussions about the consequences of inadequate cooling
- 10.1.6 Engage in discussions about the hazards associated with the cooling systems
- 10.1.7 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 10.1.8 Engage in discussions about the correct PPE

ELEMENT 10.2 - INSPECTION OF THE COOLING SYSTEMS



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Learning objectives:

- 63) The participants can **perform** the visual inspection of the cooling system (Skills, intermediate level)
- 64) The participants can **recognise** the importance of checking the cooling liquid and checking the cleanliness of the heat exchanger (Knowledge, basic level)
- 65) The participants can **describe** the importance of documenting any damage found (Knowledge, basic level)
- 66) The participants can **use** the correct PPE for inspection of the cooling systems (Skills, intermediate level)

The instructor shall:

- 10.2.1 Explain how to perform a visual inspection of cooling systems (e.g. pin holes, cracks, cuts, friction marks, leaks)
- 10.2.2 Show the importance of checking the cooling liquid
- 10.2.3 Explain how to check the cleanliness of the heat exchanger
- 10.2.4 Show the importance of documenting any damage found
- 10.2.5 Facilitate practice for the participants in the visual inspection of cooling systems, and documenting the findings and the correct use of PPE

The participants shall:

- 10.2.6 Practice the visual inspection of cooling systems and documenting the findings
- 10.2.7 Practice the correct use of PPE

The instructor shall:

- 10.2.8 Give constructive feedback on the participants' visual inspection of cooling systems and documentation of the findings and correct use of PPE

Lesson 11 - LUBRICATION SYSTEM

75 min.

The aim of this lesson is to give the participants basic knowledge of the lubrication system.

ELEMENT 11.1 - COMPONENTS REQUIRING LUBRICATION, AND WHY

Learning objectives:

- 67) The participants can **recognise** which components in a WTG must be lubricated and why (Knowledge, basic level)



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- 68) The participants can **describe** the consequences of inadequate lubrication (Knowledge, basic level)
- 69) The participants can **describe** the hazards associated with lubrication systems (Knowledge, basic level)
- 70) The participants can **describe** the importance of appropriate isolation/locking techniques (Knowledge, basic level)
- 71) The participants can **describe** the correct PPE (Knowledge, basic level)

The instructor shall:

- 11.1.1 Explain why components need lubrication (e.g. gearbox, bearings...)
- 11.1.2 Explain how oil and grease reduce friction and lower the production of heat
- 11.1.3 Explain that oil and grease pumps can be used to keep the bearings, teeth, gears, etc. lubricated to reduce friction and corrosion
- 11.1.4 Facilitate discussions with the participants about:
 - a. the consequences of inadequate lubrication
 - b. the hazards associated with the lubrication system (e.g. discussions on how the hazards of the lubrication system compare to the hazards of the gearbox, the mechanical and aerodynamic brakes, the yaw system and the cooling system)
 - c. the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
 - d. the correct PPE

The participants shall:

- 11.1.5 Engage in discussions about the consequences of inadequate lubrication
- 11.1.6 Engage in discussions about the hazards associated with the lubricating systems
- 11.1.7 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 11.1.8 Engage in discussions about the correct PPE

ELEMENT 11.2 - INSPECTION OF THE LUBRICATION SYSTEMS

Learning objectives:

- 72) The participants can **perform** the visual inspection of the lubrication system (Skills, intermediate level)
- 73) The participants can **recognise** the importance of ensuring the right amount and type of lubricant (Knowledge, basic level)
- 74) The participants can **recognise** the importance of documenting any damage found (Knowledge, basic level)



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75) The participants can **use** the correct PPE for the inspection of the lubrication system (Skills, intermediate level)

The instructor shall:

- 11.2.1 Explain how to perform a visual inspection of lubrication systems (e.g. pin holes, cracks, cuts, friction marks, leaks)
- 11.2.2 Explain the importance of ensuring the right amount and type of lubricant (lubricant samples)
- 11.2.3 Show the importance of documenting any damage found
- 11.2.4 Facilitate discussions about the oil cleanliness rating and its impact on component performance
- 11.2.5 Facilitate practice for the participant in the visual inspection of lubricating systems, the documentation of the findings, and the correct use of PPE

The participants shall:

- 11.2.6 Engage in discussions about the oil cleanliness rating and its impact on component performance
- 11.2.7 Practice visual inspection of lubricating systems, and document the findings
- 11.2.8 Practice the correct use of PPE

The instructor shall:

- 11.2.9 Give constructive feedback on the participants' visual inspection of lubrication systems and documentation of the findings and correct use of PPE

Lesson 12 - SUMMARY AND THEORETICAL TEST

30 min.

The aim of this lesson is to summarize the BTT module and to conduct a theoretical test with the participants.

ELEMENT 12.1 - SUMMARY

Learning objective:

76) The participants can **recall** the objectives that have been covered within this module.

The instructor shall:

- 12.1.1 Summarise the BTT module, referring to the objectives.



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ELEMENT 12.2 - THEORETICAL TEST

After having successfully completed this BTT Mechanical module, participants will be able to:

- Pass the final test

The instructor shall:

- 12.2.1 Introduce the test to the participants, explaining the rules to be followed during the test
- 12.2.2 Conduct the test with the participants

The participants shall:

- 12.2.3 Conduct the test

The instructor shall:

- 12.2.4 Check and give feedback about the participants' test result
- 12.2.5 In the event that a participant fails the test, conduct an interview with the participant according to "Participants Performance Assessment" section.

Lesson 13 - TRAINING REVIEW

15 min.

The aim of this lesson is to enable the participants to reflect on and process their learning outcome and key takeaways from the module, aiming to achieve a high learning transfer from the module to his/her way of working.

ELEMENT 13.1 - TRAINING REVIEW

The instructor shall:

- 13.1.1 Re-present the overall aims and learning objectives of the module for the participants' comparison of their learning outcomes and the achievement of their previously stated expectations for the module

The participants shall:

- 13.1.2 Reflect on their learning outcome and key takeaways from BTT Mechanical Module, aiming to achieve a high learning transfer from the module to his/her way of working by means of e.g.:
 - a. Group discussions or walk & talk
 - b. Questions & answers in class, or where suitable

Note: The instructor may additionally conduct a local evaluation of the training.



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ELEMENT 13.2 - FEEDBACK SESSION

The instructor shall:

- 13.2.1 Give an overall feedback and feed forward on the participants' learning outcome inspired by the training as well as from the training-review-session.
- 13.2.2 Encourage the participants to examine and grow awareness of which specific elements in their own WTG type/WTG environment differ from the training scenario environment (to visualize and enhance learning transfer) and to discuss with colleagues about how the BTT content, methods and techniques are similar or different to the local specific conditions identified after the module completion.



GLOBAL WIND
ORGANISATION

Electrical Module (BTTE)



10 Module 2 - The BTT Electrical Module

10.1 Aims and objectives of the BTT Electrical Module

The aim of this BTT Electrical Module is to give the participants the knowledge and skills to carry out basic electrical tasks (supervised by an experienced technician), using safe working procedures and the correct PPE.

After having successfully completed the BTT Electrical Module, participants will be able to:

- 1) **Explain** the basics of electricity (Knowledge, intermediate level)
- 2) **Explain** risks and hazards associated with electrical work (Knowledge, intermediate level)
- 3) **Recognise** the function and symbol of electrical components (Knowledge, basic level)
- 4) **Explain** the function of different types of sensors (Knowledge, intermediate level)
- 5) **Explain** and interpret a simple electrical diagram, and **perform** assembly of it on a circuit (Knowledge, intermediate level / Skills, intermediate level)
- 6) **Perform** correct and safe measurements (Skills, intermediate level)

10.2 Duration of the BTT Electrical Module

The total contact time for completing this BTT electrical module is estimated to be 9.92 hours. This is based on the time estimate given in the module timetable.

The training provider must not exceed the times per day given in table 9-2 below.

The training provider must ensure that sufficient time is allowed for participants with prior experience to share their experiences related to the module in a way that is constructive for the entire class.

	Maximum duration per day
Contact time	8 hours
Total training day	10 hours

Table 9-2 - Maximum duration for training days

Note: Contact time includes completion of course lesson content, practical exercises and activities directly related to these.

The total training day includes contact time, meals and breaks, and travel between training sites (where applicable)



10.3 Equipment

The equipment required for training as listed in Annex 1 must be available and must fulfil national legal requirements of the country where the training is taking place.

10.4 BTT Electrical Module Timetable

Within the module timetables, the approximate duration of each of the lessons is given. The training provider may choose to deliver elements of the training according to other timetables, as long as the total duration is not reduced and practical elements are not reduced in length. Theoretical elements may be delivered during the practical exercises when feasible.

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



Lesson		Element		Approx. duration
1	Introduction	1.1	Safety instructions and emergency procedures	
		1.2	Facilities	
		1.3	Introduction	
		1.4	Aim and objectives	
		1.5	On-going assessment	
		1.6	Motivation	
		1.7	Human factor	
		TOTAL (as stand-alone)		
(if done after another BTT module)				5 min.
2	Introduction to electricity	2.1	Direct current	
		2.2	Ohm's Law	
		2.3	Alternating current	
		2.4	Alternating current/direct current	
		TOTAL		
3	Electrical safety	3.1	Why electrical safety?	
		3.2	Low/High voltage	
		3.3	PE and GFCI/RCD	
		3.4	Stored energy	
		3.5	Static electricity	
		3.6	Safety signs	
		3.7	Types of PPE	
		3.8	The importance of appropriate isolation	
		TOTAL		
4	Electrical components	4.1	Resistors	
		4.2	Batteries	
		4.3	Switches	
		4.4	Contactors	
		4.5	Relays	
		4.6	Diodes	
		4.7	Bridge rectifiers	
		4.8	Capacitors	
		4.9	Transformers	
		4.10	Generators and motors	
		4.11	Fuses and circuit breakers	
		4.12	Processor control systems	
		TOTAL		
5	Sensors	5.1	Introduction to sensors	
		5.2	Wind sensors	



		5.3	Temperatures	
		5.4	Position sensors	
		5.5	Other sensors	
TOTAL				90 min.
6	Electrical circuits	6.1	Symbols and diagrams	
		6.2	Assembly of an electrical circuit	
TOTAL				120 min.
7	Electrical measuring instruments	7.1	Symbols and settings on electrical measuring instruments	
		7.2	How to measure with electrical measuring instruments	
		7.3	Measuring points	
TOTAL				70 min.
8	Summary and Theoretical test	8.1	Summary	
		8.2	Theoretical test	
TOTAL				30 min.
9	Training	9.1	Training review	
TOTAL				15 min.
GRAND TOTAL				595 min.
(if done after Mechanical)				570 min.

Table 10-4 - GWO BTT Electrical module timetable

10.5 Learning outcomes of the BTT Electrical Module

The learning outcomes specified for the BTT Electric Module are:

Lesson 1 - INTRODUCTION

30 min. (5 min. if done after other BTT module)

The aim of this lesson is to enable the participants on the GWO BTT Electrical Module training to engage in the training safely and with motivation, while recognising what is expected of them during the training

NOTE: If this module is delivered combined with other BTT modules to the same participants, the redundant introductory elements shall not be repeated.

After successfully completing this lesson of the BTT Electrical Module, participants will be able to:

- 1) **Describe** the module content and the facilities involved to ensure a clear understanding of what is expected during the module (Knowledge, basic level)
- 2) **Name and point out** local emergency procedures and facilities (Knowledge, basic level)



- 3) **Describe** the relevant human factors and the implications thereof (Knowledge, basic level)

ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Learning objectives:

- 4) The participants can **recognise** the safety instructions, rules and emergency procedures (Knowledge, basic level)
- 5) The participants **show an interest or curiosity** in the safety and emergency procedures (Ability, basic level)

The instructor shall:

1.1.1 Explain and ask involving questions concerning:

- a. safety instructions according to internal procedures
- b. emergency procedures and emergency exits in the areas where the participants can be expected to be located during the module

The participants shall:

1.1.2 Engage in answering the above questions

ELEMENT 1.2 - FACILITIES

Learning objective:

- 6) The participants can **recognise** the facilities at the training location (Knowledge, basic level)

The instructor shall:

1.2.1 Give a general description of the facilities at the location (administration, dining area, restrooms and toilets, etc.)

The participants shall:

1.2.2 Note relevant facilities and ask questions when in doubt about facilities

ELEMENT 1.3 - INTRODUCTION

Learning objective:

- 7) The participants **show an interest** in fellow participants and the programme of the BTT Electrical Module (Ability, basic level)

The instructor shall:

1.3.1 Explain and ask involving questions about the programme of the BTT Electrical Module, including breaks and meal times



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- 1.3.2 Give a short introduction about themselves, including their backgrounds as instructors
- 1.3.3 Ask for participants' expectations of the training and of their learning outcome

The participants shall:

- 1.3.4 Give a short introduction about themselves, including job function, and share their expectations of the training and learning outcome expectation for the training

ELEMENT 1.4 - AIM AND OBJECTIVES

Learning objective:

- 8) The participants can **recognise** the scope and main objectives of the BTT Electrical Module (Knowledge, basic level)

The instructor shall:

- 1.4.1 Explain the scope and main objectives of the BTT Electrical Module
- 1.4.2 Involve participants by means of questions about the participants' understandings and individual experiences relevant to the BTT Electrical Module

The participants shall:

- 1.4.3 Engage in answering questions and share experiences relevant to the BTT Electrical Module

ELEMENT 1.5 - ONGOING ASSESSMENTS

Learning objective:

- 9) The participants can **recognise** the reasons for the ongoing assessment, and **recognise** how the GWO participant assessment form will be used throughout the module (Knowledge, basic level)

The instructor shall:

- 1.5.1 Explain the reasons for the on-going assessment
- 1.5.2 Explain the GWO participant assessment form and how it will be used
- 1.5.3 Ask for the participants thoughts on the assessment procedure presented

The participants shall:

- 1.5.4 Engage in discussions on the assessment procedure

ELEMENT 1.6 - MOTIVATION

Learning objective:



- 10) The participants **show a willingness** to be personally involved in the learning activities throughout the BTT Electrical Module (Ability, basic level)

The instructor shall:

1.6.1 Explain and facilitate discussions on:

- a. the importance of personal involvement in the module
- b. the need for the BTT Electrical Module when working in the wind industry

The participants shall:

- 1.6.2 Engage themselves in discussions about the importance of personal involvement in the module and need for the BTT Electrical Module when working in the wind industry

ELEMENT 1.7 - HUMAN FACTORS

Learning objectives:

- 11) The participants can **describe** the relevant human factors and the implications thereof (Knowledge, basic level)
- 12) The participants **show an interest** and **willingness** to focus on human factors during the following practical exercises (Ability, basic level)

The instructor shall:

- 1.7.1 Present how human factors have an influence on accidents in the wind industry
- 1.7.2 Lead a discussion about the role of the individual in improving human performance, and how this improvement can benefit safety when working in the wind industry, by considering factors like:
 - a. Attention and perception
 - b. Group behaviour and peer pressure
 - c. Fitness and health
 - d. Domestic and work-related stress
 - e. Workload (both overload and underload)
 - f. Fatigue
 - g. Time pressure and deadlines
 - h. Alcohol, medication and substance abuse

The participants shall:

- 1.7.3 Engage in discussions and share understandings about the human factor influence on accidents when working in the wind industry



Lesson 2 - INTRODUCTION TO ELECTRICITY

70 min.

The aim of this lesson is to give the participants basic knowledge about electricity.

ELEMENT 2.1 - DIRECT CURRENT

Learning objective:

- 13) The participants can **explain** what direct current is (Knowledge, intermediate level)

The instructor shall:

- 2.1.1 Explain electrical current definition and units
- 2.1.2 Describe the basic concept between the current flow and the resistance
- 2.1.3 Explain voltage definition and units
- 2.1.4 Explain resistance definition and units. Variable resistance (PT100-temp)
- 2.1.5 Ask the participants relevant questions about what direct current is

The participants shall:

- 2.1.6 Explain in their own words and share understandings about what direct current is

The instructor shall:

- 2.1.7 Give constructive feedback on the participants' explanations about what direct current is

ELEMENT 2.2 - OHM'S LAW

Learning objectives:

- 14) The participants can **describe** the relationship between current, voltage and resistance (Knowledge, basic level)
- 15) The participants can **apply** Ohm's Law (voltage, current & resistance) (Knowledge, intermediate level)

The instructor shall:

- 2.2.1 Explain practical examples of Ohm's Law (current, voltage and resistance) using a simple circuit diagram of battery and resistor
- 2.2.2 Facilitate discussions with the participants about the relationship between current, voltage and resistance
- 2.2.3 Create a learning activity where the participants can practice the use of Ohm's Law

The participants shall:



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2.2.4 Engage in discussions on the relationship between current, voltage and resistance

2.2.5 Practice the use of Ohm's Law

The instructor shall:

2.2.6 Give constructive feedback on the participants' use of Ohm's Law

ELEMENT 2.3 - ALTERNATING CURRENT

Learning objective:

16) The participants can **explain** what alternating current is (Knowledge, intermediate level)

The instructor shall:

2.3.1 Explain the theory behind alternating current

2.3.2 Explain the location of AC in a basic electrical circuit diagram

2.3.3 Ask the participants relevant questions about what alternating current is

The participants shall:

2.3.4 Explain in their own words and share understandings about what alternating current is

The instructor shall:

2.3.5 Give constructive feedback on the participants' explanations about what alternating current is

ELEMENT 2.4 - ALTERNATING CURRENT/DIRECT CURRENT

Learning objective:

17) The participants can **discuss** the difference between direct and alternating current (Knowledge, intermediate level)

The instructor shall:

2.4.1 Facilitate group discussions with the participants on the difference between alternating and direct current.

The participants shall:

2.4.2 Engage in a group discussion about the difference between direct and alternating current

The instructor shall:

2.4.3 Give constructive feedback on the participants' group discussion about the difference between direct and alternating current



Lesson 3 - ELECTRICAL SAFETY

70 min.

The aim of this lesson is to give the participants the necessary awareness, knowledge and understanding to handle electrical hazards in a wind turbine.

ELEMENT 3.1 - WHY ELECTRICAL SAFETY?

Learning objectives:

- 18) The participants can **explain** the dangers of electricity and the effects of electricity on the human body (Knowledge, intermediate level)
- 19) The participants can **recognise** the importance of Electrical Safety (Knowledge, basic level)
- 20) The participants can **describe** the relation between current and contact time (Knowledge, basic level)

The instructor shall:

- 3.1.1 Explain the dangers of electricity:
 - a. Difficult to detect (invisible)
 - b. Potential to be deadly or life-altering
- 3.1.2 Explain the effects (including late effects) of electricity on the human body
- 3.1.3 Show the importance of working according to approved working practices (through e.g. storytelling, examples or scenarios)
- 3.1.4 Ask the participants relevant questions about how the dangers and effects of electricity are different to other hazardous energies, such as mechanics and hydraulics
- 3.1.5 Facilitate discussions about the relationship between current and contact time

The participants shall:

- 3.1.6 Explain in their own words and share understandings about how the dangers and effects of electricity are different to other hazardous energies, such as mechanics and hydraulics
- 3.1.7 Engage in discussions about the relationship between current and contact time

The instructor shall:

- 3.1.8 Give constructive feedback on the participants' explanations about how the dangers and effects of electricity are different to other hazardous energies, such as mechanics and hydraulics

ELEMENT 3.2 - LOW / HIGH VOLTAGE

Learning objectives:



- 21) The participants can **recognise** the definitions of low and high voltage (Knowledge, basic level)
- 22) The participants can **describe** the risks and hazards of low and high voltage (Knowledge, basic level)
- 23) The participants can **recognise** HV safety signs and HV restricted areas (Knowledge, basic level)
- 24) The participants can **recognise** the requirement of having HV training before performing any HV work (Knowledge, basic level)

The instructor shall:

- 3.2.1 Define low and high voltage (dependent on the country)
- 3.2.2 Explain the basic difference between hazards of high voltage and low voltage
- 3.2.3 Show examples of HV safety signs and HV restricted areas (e.g. HV transformer, HV transformer room, switchgear, HV cable, substation...)
- 3.2.4 Explain the requirement for HV training before performing any HV work
- 3.2.5 Facilitate discussions with the participants about the risks and hazards of low and high voltage

The participants shall:

- 3.2.6 Engage in discussions about the risks and hazards of low and high voltage

ELEMENT 3.3 - PE AND GFCI/RCD

Learning objectives:

- 25) The participants can **explain** the function, importance and symbol of GFCI/RCD and PE (Knowledge, intermediate level)
- 26) The participants can **recognise** how to identify double isolated tools and that they do not require grounding (Knowledge, basic level)
- 27) The participants can **recognise** the importance of grounding an external generator in accordance with the manufacturer's manual, local legislation and company rules (Knowledge, basic level)
- 28) The participants can **recognise** examples of and **explain** the symbol of GFCI/RCD and PE (Knowledge, basic level)
- 29) The participants can **recognise** that not all circuits on a wind turbine are protected by GFCI/RCD's (Knowledge, basic level)
- 30) The participants can **recognise** the relationship between current and contact time (Knowledge, basic level)
- 31) The participants can **recognise** and **compare** the consequences of receiving a shock on a circuit protected by a GFCI and on a circuit without GFCI (Knowledge, basic level)

The instructor shall:

- 3.3.1 Explain the function and importance of GFCI/RCD and protective earth in tools and equipment.



- 3.3.2 Explain what can happen when a tool is used without protective earth and GFCI/RCD, and the consequence of improper grounding on tools or equipment in e.g. different situations:
 - a. Situation, where there is no PE and, no GFCI/RCD
 - b. Situation, where there is PE but, no GFCI/RCD
 - c. Situation, where there is both PE and GFCI/RCD
- 3.3.3 Explain how to identify double isolated tools and that they do not require grounding.
- 3.3.4 Explain the importance of grounding an external generator in accordance with the manufacturer's manual, local legislation and company rules.
- 3.3.5 Show examples of and explain the symbol of GFCI/RCD and PE.
- 3.3.6 Explain that not all circuits on a wind turbine are protected by GFCI/RCD's.
- 3.3.7 Compare the consequences of receiving a shock on a circuit protected by a GFCI and on a circuit without GFCI.
- 3.3.8 Test the participants' understanding of PE and GFCI/RCD (e.g. with a questionnaire or multiple-choice questions about PE and GFCI/RCD)

The participants shall:

- 3.3.9 Provide answers to the test about PE and GFCI/RCD

The instructor shall:

- 3.3.10 Give constructive feedback on the results of the participants' answers, explain the reasons why the answers were correct or incorrect, and e.g. show the realistic consequences of a correct or incorrect answer to provide the participants with a sense of the real-world consequences

ELEMENT 3.4 - STORED ENERGY

Learning objective:

- 32) The participants can **describe** the risks and hazards of stored energy in electrical systems (Knowledge, basic level)

The instructor shall:

- 3.4.1 Explain the risks related to:
 - a. The UPS system - e.g. risk of back feed
 - b. Capacitors - e.g. risk of stored energy and arc flash
 - c. Batteries - e.g. risk of stored energy and arc flash
- 3.4.2 Ask the participants relevant questions that challenge the participants to describe the risks and hazards, and how these risks and hazards can be mitigated

The participants shall:



- 3.4.3 Describe in their own words the risks and hazards of static electricity, and how these risks and hazards can be mitigated

ELEMENT 3.5 - STATIC ELECTRICITY

Learning objective:

- 33) The participants can **describe** the risks and hazards of static electricity (Knowledge, basic level)

The instructor shall:

- 3.5.1 Present the risks and hazards of static electricity in connection with the blade
- 3.5.2 Ask relevant questions to the participants that challenge the participants to describe the risks and hazards, and how these risks and hazards can be mitigated

The participants shall:

- 3.5.3 Describe in their own words the risks and hazards of static electricity, and how these risks and hazards can be mitigated

ELEMENT 3.6 - SAFETY SIGNS

Learning objective:

- 34) The participants can **describe** different safety signs and their meanings (Knowledge, basic level)

The instructor shall:

- 3.6.1 Explain how to identify the sign for “Danger Electricity”
- 3.6.2 Show examples of safety signs on different locations in the WTG
- 3.6.3 Facilitate discussions about the meaning of different safety signs

The participants shall:

- 3.6.4 Engage in discussions about different safety signs and their meanings

ELEMENT 3.7 - TYPES OF PPE

Learning objective:

- 35) The participants can **use** the required PPE for working with electricity (Skills, intermediate level)

The instructor shall:

- 3.7.1 Explain and demonstrate examples of usage and the inspection of PPE suitable for electrical work

The participants shall:



3.7.2 Practice the usage of the required PPE for working with electricity

The instructor shall:

- 3.7.3 Give constructive feedback on the participants' practice of the usage of the required PPE for working with electricity

ELEMENT 3.8 - THE IMPORTANCE OF APPROPRIATE ISOLATION

Learning objectives:

- 36) The participants can **describe** why it is important to prevent unexpected start-up when working with electricity (Knowledge, basic level)
- 37) The participants can **discuss** the importance of proper isolation when working with electricity (Knowledge, intermediate level)
- 38) The participants can **recognise** typical wind turbine reactions when an emergency stop button is pressed, and that an emergency stop button is not normally considered as an isolation (Knowledge, basic level)

The instructor shall:

- 3.8.1 Facilitate group discussions about the importance of appropriate isolation when working with electricity
- 3.8.2 Show the importance of emergency stop buttons in the wind turbine
- 3.8.3 Describe typical wind turbine reactions when an emergency stop button is pressed
- 3.8.4 Explain that an emergency stop button is not normally considered as an isolation
- 3.8.5 Facilitate discussions about why it is important to prevent unexpected start-up when working with electricity

The participants shall:

- 3.8.6 Engage in a group discussion about the importance of appropriate isolation when working with electricity
- 3.8.7 Engage in discussions about why it is important to prevent unexpected start-up when working with electricity

The instructor shall:

- 3.8.8 Give constructive feedback on the participants' group discussion about the importance of appropriate isolation when working with electricity

Lesson 4 - ELECTRICAL COMPONENTS



100 min.

The aim of this lesson is to give the participants basic knowledge and understanding of electrical components.

ELEMENT 4.1 - RESISTORS

Learning objectives:

- 39) The participants can **describe** the function of resistors (Knowledge, basic level)
- 40) The participants can **recognise** resistors on a diagram (Knowledge, basic level)

The instructor shall:

- 4.1.1 Explain the function of resistors
- 4.1.2 Show examples of and explain the symbol for resistors
- 4.1.3 Show examples of and explain the position of resistors in a circuit
- 4.1.4 Ask the participants relevant questions about the function of resistors

The participants shall:

- 4.1.5 Describe in their own words and share understandings about the function of resistors

ELEMENT 4.2 - BATTERIES

Learning objectives:

- 41) The participants can **describe** the function of batteries (Knowledge, basic level)
- 42) The participants can **recognise** batteries on a diagram (Knowledge, basic level)
- 43) The participants can **describe** the risk and hazards associated with stored energy (Knowledge, basic level)

The instructor shall:

- 4.2.1 Explain the function of batteries
- 4.2.2 Show examples of and explain the symbols for batteries
- 4.2.3 Explain the position of batteries in a circuit
- 4.2.4 Explain the risks and hazards associated with stored energy
- 4.2.5 Ask the participants relevant questions about the function of batteries and the risk and hazards associated with stored energy

The participants shall:

- 4.2.6 Describe in their own words and share understandings about the function of batteries, and the risk and hazards of the stored energy



ELEMENT 4.3 - SWITCHES

Learning objectives:

- 44) The participants can **describe** the function of switches (Knowledge, basic level)
- 45) The participants can **recognise** switches on a diagram (Knowledge, basic level)

The instructor shall:

- 4.3.1 Explain the function of switches
- 4.3.2 Show examples of and explain the operation of switches (manual, part of a relay, part of a contactor...)
- 4.3.3 Show examples of and explain the symbols for different switches (NO, NC)
- 4.3.4 Explain the position of switches in a circuit
- 4.3.5 Ask the participants relevant questions about the function of switches

The participants shall:

- 4.3.6 Describe in their own words and share understandings about the function of switches

ELEMENT 4.4 - CONTACTORS

Learning objectives:

- 46) The participants can **describe** the function of contactors (Knowledge, basic level)
- 47) The participants can **recognise** contactors on a diagram (Knowledge, basic level)

The instructor shall:

- 4.4.1 Explain the function of contactors
- 4.4.2 Explain the operation of contactors
- 4.4.3 Show examples of and explain the symbol for contactors
- 4.4.4 Explain the position of contactors in a circuit
- 4.4.5 Ask the participants relevant questions about the function of contactors

The participants shall:

- 4.4.6 Describe in their own words and share understandings about the function of contractors

ELEMENT 4.5 - RELAYS

Learning objectives:

- 48) The participants can **describe** the function of relays (Knowledge, basic level)



49) The participants can **recognise** relays on a diagram (Knowledge, basic level)

The instructor shall:

- 4.5.1 Explain the function of relays
- 4.5.2 Explain the operation of relays
- 4.5.3 Show examples of and explain the symbol for relays
- 4.5.4 Explain the position of relays in a circuit
- 4.5.5 Ask the participants relevant questions about the function of relays

The participants shall:

- 4.5.6 Describe in their own words and share understandings about the function of relays

ELEMENT 4.6 - DIODES

Learning objectives:

- 50) The participants can **describe** the function of diodes (Knowledge, basic level)
- 51) The participants can **recognise** a diode on a diagram (Knowledge, basic level)

The instructor shall:

- 4.6.1 Explain the function of diodes
- 4.6.2 Show examples of and explain the symbol for diodes
- 4.6.3 Explain the position of diodes in a circuit
- 4.6.4 Explain how to check a diode with the multimeter
- 4.6.5 Ask the participants relevant questions about the function of diodes

The participants shall:

- 4.6.6 Describe in their own words and share understandings about the function of diodes

ELEMENT 4.7 - BRIDGE RECTIFIERS

Learning objectives:

- 52) The participants can **describe** the function of bridge rectifiers (Knowledge, basic level)
- 53) The participants can **recognise** bridge rectifiers on a diagram (Knowledge, basic level)

The instructor shall:

- 4.7.1 Explain the function of bridge rectifiers



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- 4.7.2 Explain the operation of bridge rectifiers
- 4.7.3 Show examples of and explain the symbol for bridge rectifiers
- 4.7.4 Explain the position of bridge rectifiers in a circuit
- 4.7.5 Ask the participants relevant questions about the function of bridge rectifiers

The participants shall:

- 4.7.6 Describe in their own words and share understandings about the function of bridge rectifiers

ELEMENT 4.8 - CAPACITORS

Learning objectives:

- 54) The participants can **describe** the function of capacitors (Knowledge, basic level)
- 55) The participants can **recognise** capacitors on a diagram (Knowledge, basic level)
- 56) The participants can **describe** the risk and hazards of the stored energy (Knowledge, basic level)

The instructor shall:

- 4.8.1 Explain the function of capacitors
- 4.8.2 Show examples of and explain the symbol for a capacitor
- 4.8.3 Define the unit for capacitance (farads) and its divisions
- 4.8.4 Explain the position of capacitors in a circuit
- 4.8.5 Explain the risks and hazards associated with stored energy
- 4.8.6 Ask the participants relevant questions about the function of capacitors and the risk and hazards of stored energy

The participants shall:

- 4.8.7 Describe in their own words and share understandings about the function of capacitors and the risk and hazards of stored energy

ELEMENT 4.9 - TRANSFORMERS

Learning objectives:

- 57) The participants can **describe** the function of transformers (Knowledge, basic level)
- 58) The participants can **recognise** transformers on a diagram (Knowledge, basic level)

The instructor shall:

- 4.9.1 Explain the function of transformers
- 4.9.2 Show examples of and explain the symbol for transformers



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- 4.9.3 Explain the position of transformers in a circuit
- 4.9.4 Ask the participants relevant questions about the function of transformers

The participants shall:

- 4.9.5 Describe in their own words and share understandings about the function of transformers

ELEMENT 4.10 - GENERATORS AND MOTORS

Learning objectives:

- 59) The participants can **describe** the function of generators and motors (Knowledge, basic level)
- 60) The participants can **recognise** generators and motors on a diagram (Knowledge, basic level)

The instructor shall:

- 4.10.1 Explain the basic function of generators and motors
- 4.10.2 Show examples of and explain the symbols for generators and motors
- 4.10.3 Explain the position of generators and motors in a circuit
- 4.10.4 Ask the participants relevant questions about the basic function of generators and motors

The participants shall:

- 4.10.5 Describe in their own words and share understandings about the function of generators and motors

ELEMENT 4.11 - FUSES AND CIRCUIT BREAKERS

Learning objectives:

- 61) The participants can **describe** the function of fuses and circuit breakers (Knowledge, basic level)
- 62) The participants can **recognise** fuses and circuit breakers on a diagram (Knowledge, basic level)

The instructor shall:

- 4.11.1 Explain the function of fuses
- 4.11.2 Explain the function of circuit breakers
- 4.11.3 Show examples of and explain the symbol for fuses
- 4.11.4 Show examples of and explain the symbol for circuit breakers
- 4.11.5 Explain the position of fuses and circuit breakers in a circuit
- 4.11.6 Ask the participants relevant questions about the function of fuses and circuit breakers

The participants shall:



4.11.7 Describe in their own words and share understandings about the function of fuses and circuit breakers

ELEMENT 4.12 - PROCESSOR CONTROL SYSTEMS

Learning objective:

63) The participants can **recognise** the function of the processor control system and its position in the diagram (Knowledge, basic level)

The instructor shall:

4.12.1 Explain the function of a Wind Turbine Processor Control System

4.12.2 Explain the position of the Wind Turbine Processor Control System in the circuit

Lesson 5 - SENSORS

90 min.

The aim of this lesson is to give the participants basic knowledge of the different sensors in an electric circuit.

ELEMENT 5.1 - INTRODUCTION TO SENSORS

Learning objective:

64) The participants can **explain** the function of sensors (Knowledge, intermediate level)

The instructor shall:

5.1.1 Explain the function of sensors

5.1.2 Explain the difference between analogue & digital signals

5.1.3 Ask the participants relevant questions about the function of sensors

The participants shall:

5.1.4 Explain in their own words and share understandings about the function of sensors

The instructor shall:

5.1.5 Give constructive feedback on the participants' explanations about the functions of sensors

ELEMENT 5.2 - WIND SENSORS

Learning objective:

65) The participants can **describe** the function of the wind sensors (Knowledge, basic level)



- 66) The participants can **recognise** how to identify the wind sensors on a diagram (Knowledge, basic level)

The instructor shall:

- 5.2.1 Explain the function of wind sensors
- 5.2.2 Show examples of and explain the symbols for wind sensors
- 5.2.3 Explain the position of wind sensors in a circuit
- 5.2.4 Ask the participants relevant questions about the function of wind sensors

The participants shall:

- 5.2.5 Describe in their own words and share understandings about the function of wind sensors

ELEMENT 5.3 - TEMPERATURE SENSORS

Learning objectives:

- 67) The participants can **describe** the function of a temperature sensor (Knowledge, basic level)
- 68) The participants can **recognise** a temperature sensor on a diagram (Knowledge, basic level)

The instructor shall:

- 5.3.1 Explain the function of temperature sensors
- 5.3.2 Explain the operation of temperature sensors (PT100 and thermistor)
- 5.3.3 Show examples of and explain the symbols for temperature sensors (PT100 and thermistor)
- 5.3.4 Explain the position of temperature sensors in a circuit (PT100 and thermistor)
- 5.3.5 Ask the participants relevant questions about the functions of temperature sensors and what is distinctive about the function of temperature sensors compared to wind sensors as previously covered in the lesson

The participants shall:

- 5.3.6 Describe in their own words and share understandings about the function of temperature sensors (PT 100 and thermistor) and what is distinctive about the function of temperature sensors compared to wind sensors

ELEMENT 5.4 - POSITION SENSORS

Learning objective:

- 69) The participants can **describe** the function of position sensors (Knowledge, basic level)

The instructor shall:



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- 5.4.1 Explain the function of position sensors
- 5.4.2 Explain the position of sensors in a circuit (yaw, nacelle, blades...)
- 5.4.3 Ask the participants relevant questions about the function of position sensors compared to temperature sensors and wind sensors as previously covered in the lesson

The participants shall:

- 5.4.4 Describe in their own words and share understandings about the function of position sensors and what is distinctive about the function of position sensors compared to temperature sensors covered in the lesson

ELEMENT 5.5 - OTHER SENSORS

Learning objective:

- 70) The participants can **describe** other types of sensors that can be on a turbine (Knowledge, basic level)

The instructor shall:

- 5.5.1 Facilitate discussions about other types of sensors that can be on turbines

The participants shall:

- 5.5.2 Engage in discussions about other types of sensors that can be on turbines

Lesson 6 - ELECTRICAL CIRCUITS

120 min.

The aim of this lesson is to give the participants basic knowledge of how to read and interpret a simple electrical diagram and how to assemble it on a circuit

ELEMENT 6.1 - SYMBOLS AND DIAGRAMS

Learning objective:

- 71) The participants can **explain** electrical components and how to interpret basic electrical diagrams (Knowledge, intermediate level)

The instructor shall:

- 6.1.1 Show an example of an electrical diagram covering the components mentioned in the equipment list for the BTT Electrical Module
- 6.1.2 Explain how to interpret the electrical diagram



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- 6.1.3 Create a short learning activity, where the participants have to identify different components in the diagram
- 6.1.4 Ask the participants relevant questions about electrical components and how to interpret basic electrical diagrams

The participants shall:

- 6.1.5 Identify different components in the diagram
- 6.1.6 Explain in their own words and share understandings about electrical components and how to interpret basic electrical diagrams

The instructor shall:

- 6.1.7 Give constructive feedback on the participants' explanations about the electrical components and how to interpret basic electrical diagrams

ELEMENT 6.2 - ASSEMBLY OF AN ELECTRICAL CIRCUIT

Learning objective:

- 72) The participants can **perform** the assembly of a simple electric circuit (Skills, intermediate level)

The instructor shall:

- 6.2.1 Facilitate practice to improve the participants' ability to assemble an electrical circuit following a basic electrical diagram including the components mentioned in the equipment list for the BTT Electrical Module
- 6.2.2 Facilitate practice in the correct operation of the circuit

The participants shall:

- 6.2.3 Practice the ability to assemble an electrical circuit following a basic electrical diagram including the components mentioned in the equipment list for the BTT Electrical Module
- 6.2.4 Practice the correct operation of the circuit

The instructor shall:

- 6.2.5 Give constructive feedback on the above practice

Lesson 7 - ELECTRICAL MEASURING INSTRUMENTS

70 min.

The aim of this lesson is to give the participants the basic knowledge about the correct and safe way to measure current, voltage, resistance, continuity, diodes and capacitance.



ELEMENT 7.1 - SYMBOLS AND SETTINGS ON ELECTRICAL MEASURING INSTRUMENTS

Learning objectives:

- 73) The participants can **recognise** the symbols and settings used for current, voltage and resistance in the measuring instruments (Knowledge, basic level)
- 74) The participants can **describe** how to identify the validity of tools (Knowledge, basic level)

The instructor shall:

- 7.1.1 Explain and demonstrate settings on the Electrical Measuring Instruments including:
 - a. VAC and VDC
 - b. A and mA
 - c. Ohms/continuity
- 7.1.2 Explain and demonstrate the visual inspection of test instruments and leads
- 7.1.3 Facilitate discussions with the participants about how to identify the validity of tools

The participants shall:

- 7.1.4 Engage in discussions about how to identify the validity of tools

ELEMENT 7.2 - HOW TO MEASURE WITH ELECTRICAL MEASURING INSTRUMENTS

Learning objective:

- 75) The participants can **perform** the measurement of current, voltage, resistance, PT100, continuity, diodes, bridge rectifiers and capacitance (Skills, intermediate level)

The instructor shall:

- 7.2.1 Explain and demonstrate the measurement of, and facilitate practice for the participants in:
 - a. VAC and VDC
 - b. A and mA
 - c. Ohms / continuity
 - d. Diode and bridge rectifier
 - e. Capacitor
 - f. PT100

The participants shall:

- 7.2.2 Practice the ability to measure voltage, current and resistance
- 7.2.3 Practice the ability to measure continuity



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- 7.2.4 Practice the ability to measure a diode and a bridge rectifier
- 7.2.5 Practice the ability to measure a capacitor
- 7.2.6 Practice the ability to measure a PT100

The instructor shall:

- 7.2.7 Give constructive feedback on the participants above practice

ELEMENT 7.3 - MEASURING POINTS

Learning objective:

- 76) The participants can **describe** measuring points in a physical circuit (Knowledge, basic level)
- 77) The participants can **describe** how to identify measuring points on a diagram (Knowledge, basic level)

The instructor shall:

- 7.3.1 Facilitate discussions with the participants about the measuring points in a physical circuit
- 7.3.2 Facilitate discussions with the participants about identifying measuring points in a diagram

The participants shall:

- 7.3.3 Engage in discussions about the measuring points in a physical circuit
- 7.3.4 Engage in discussions about identifying measuring points in a diagram

Lesson 8 - SUMMARY AND THEORETICAL TEST

30 min.

The aim of this lesson is to summarize the BTT module and to conduct a theoretical test with the participants.

ELEMENT 8.1 - SUMMARY

Learning objective:

- 78) The participants can **recall** the objectives that have been covered within this module.

The instructor shall:

- 8.1.1 Summarise the BTT module referring to the objectives.

ELEMENT 8.2 - THEORETICAL TEST

After having successfully completed this BTT Electrical module, participants will be able to:



- Pass the final test

The instructor shall:

- 8.2.1 Introduce the test to the participants, explaining the rules to be followed during the test
- 8.2.2 Conduct the test with the participants

The participants shall:

- 8.2.3 Conduct the test

The instructor shall:

- 8.2.4 Check the test results and give feedback on the participants about the test results
- 8.2.5 In the event that a participant fails the test, conduct an interview with the participant according to “Participants Performance Assessment” section.

Lesson 9 - TRAINING REVIEW

15 min.

The aim of this lesson is to enable the participants to reflect on and process their learning outcome and key takeaways from the module, aiming to achieve a high learning transfer from the module to his/her way of working.

ELEMENT 9.1 - TRAINING REVIEW

The instructor shall:

- 9.1.1 Re-present the overall aims and learning objectives of the module for the participants’ comparison of their learning outcomes and the achievement of their previously stated expectations for the module

The participants shall:

- 9.1.2 Reflect on their learning outcome and key takeaways from BTT Electrical Module, aiming to achieve a high learning transfer from the module to his/her way of working by means of e.g.:
 - a. Group discussions or walk & talk
 - b. Questions & answers in class, or where suitable

Note: The instructor may additionally conduct a local evaluation of the training.

ELEMENT 9.2 - FEEDBACK SESSION

The instructor shall:



- 9.2.1 Give an overall feedback and feed forward on the participants' learning outcome inspired by the training as well as from the training-review-session.
- 9.2.2 Encourage the participants to examine and grow awareness of which specific elements in their own WTG type/WTG environment differ from the training scenario environment (to visualize and enhance learning transfer) and to discuss with colleagues about how the BTT content, methods and techniques are similar or different to the local specific conditions identified after the module completion.



GLOBAL WIND
ORGANISATION

Hydraulic Module (BTTH)



11 Module 3 - The BTT Hydraulic Module

11.1 Aims and objectives of the BTT Hydraulic Module

The aim of the BTT Hydraulic Module is to give the participants the knowledge and skills to carry out basic hydraulic tasks (supervised by an experienced technician), using safe working procedures and the correct PPE.

After having successfully completed the BTT Hydraulic Module, participants will be able to:

- 1) **Explain** the basics of hydraulics (Knowledge, intermediate level)
- 2) **Explain** risks and hazards associated with hydraulic work (Knowledge, intermediate level)
- 3) **Describe** the function of different types of pumps (Knowledge, basic level)
- 4) **Perform** check of start/stop pressure of a pump (Skills, intermediate level)
- 5) **Describe** the function of different types of actuators (Knowledge, basic level)
- 6) **Explain** the function of different types of valves (Knowledge, intermediate level)
- 7) **Describe** the function of accumulators (Knowledge, basic level)
- 8) **Perform** check and precharge of accumulators (Skills, intermediate level)
- 9) **Describe** the function of different types of sensors (Knowledge, basic level)
- 10) **Recognise** the components that transfer the oil (Knowledge, basic level)
- 11) **Describe** the handling of oil procedures (Knowledge, basic level)
- 12) **Recognise** and find different components on a hydraulic diagram (Knowledge, basic level)
- 13) **Perform** the accurate measurement of the hydraulic pressure (Skills, intermediate level)

11.2 Duration of the BTT Hydraulic Module

The total contact time for completing this BTT hydraulic module is estimated to be 8.92 hours. This is based on the time estimate given in the module timetable.

The training provider must not exceed the times per day given in table 11-2 below.

The training provider must ensure that sufficient time is allowed for participants with prior experience to share their experiences related to the module in a way that is constructive for the entire class.

	Maximum duration per day
Contact time	8 hours
Total training day	10 hours

Table 11-2 - Maximum duration for training days



Note: Contact time includes completion of course lesson content, practical exercises, and activities directly related to these.

The total training day includes contact time, meals and breaks and travel between training sites (where applicable)

11.3 Equipment

The equipment required for training as listed in Annex 3 must be available and must fulfil national legal requirements of the country where the training is taking place.

11.4 BTT Hydraulic Module Timetable

Within the module timetables, the approximate duration of each of the lessons is given. The training provider may choose to deliver elements of the training according to other timetables, as long as the total duration is not reduced and practical elements are not reduced in length. Theoretical elements may be delivered during the practical exercises, when feasible.

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

Lesson		Element		Approx. duration
1	Introduction	1.1	Safety instructions and emergency procedures	
		1.2	Facilities	
		1.3	Introduction	
		1.4	Aim and objectives	
		1.5	On-going assessment	
		1.6	Motivation	
		1.7	Human factor	
		TOTAL		
2	Hydraulic introduction	2.1	The hydraulic system	
		2.2	Pascal's Law	
		TOTAL		
3	Hydraulic safety	3.1	Why hydraulic safety?	
		3.2	High pressure systems	
		3.3	Stored energy	
		3.4	Safety signs	
		3.5	Chemicals	
		3.6	Types of PPE	
		3.7	The importance of appropriate isolation	
TOTAL				60 min.



4	Pumps	4.1	Introduction to pumps	
		4.2	Pumps exercise	
TOTAL				30 min.
5	Actuators	5.1	Introduction to actuators	
		TOTAL		
6	Valves	6.1	Introduction to valves	
		6.2	Directional control valves	
		6.3	Pressure relief valves	
		6.4	Pressure reduction valves	
		6.5	Needle valves	
		6.6	Non return valves	
		6.7	Throttle valves	
		6.8	Restrictor valves	
TOTAL				105 min.
7	Accumulators	7.1	Introduction to accumulators	
		7.2	Pre-charge pressure	
TOTAL				80 min.
8	Sensors	8.1	Introduction to sensors	
		8.2	Pressure sensors	
TOTAL				15 min.
9	Pipes, hoses and connections	9.1	Oil transfer	
		9.2	Hydraulic connections	
TOTAL				20 min.
10	Oil and filters	10.1	Handling oil procedures/cleanliness	
		10.2	Collecting an oil sample	
		10.3	Check oil level	
		10.4	Filters	
TOTAL				45 min.
11	Hydraulic diagrams	11.1	Main symbols and components	
		11.2	Identifying measuring points	
TOTAL				45 min.
12	Pressure measuring tools	12.1	Pressure gauge/manometer characteristics	
		12.2	Pressure measuring	
TOTAL				20 min.
13	Summary and Theoretical test	13.1	Summary	
		13.2	Theoretical test	
TOTAL				30 min.
14	Training review	14.1	Training review	



TOTAL	15 min.
GRAND TOTAL	535 min.
(If done after other BTT module)	510 min.

Table 11-4 - BTT Hydraulic module timetable

11.5 Learning outcomes of the BTT Hydraulic Module

The learning outcomes specified for the BTT Hydraulic Module are:

Lesson 1 - INTRODUCTION

30 min. (5 min. if done after other BTT module)

The aim of this lesson is to enable the participants on the GWO BTT Hydraulic Module training to engage in the training safely and with motivation, while recognising what is expected of them during the training

NOTE: If this module is delivered combined with other BTT modules to the same participants, the redundant introductory elements shall not be repeated.

After successfully completing this lesson of the BTT Hydraulic Module, participants will be able to:

- 1) **Describe** the module content and the facilities involved to ensure a clear understanding of what is expected during the module (Knowledge, basic level)
- 2) **Name** and **point out** local emergency procedures and facilities (Knowledge, basic level)
- 3) **Describe** the relevant human factors and the implications thereof (Knowledge, basic level)

ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Learning objectives:

- 4) The participants can **recognise** the safety instructions, rules and emergency procedures (Knowledge, basic level)
- 5) The participants **show an interest or curiosity** in the safety and emergency procedures (Ability, basic level)

The instructor shall:

1.1.1 Explain and ask involving questions concerning:

- a. safety instructions according to internal procedures
- b. emergency procedures and emergency exits in the areas where the participants can be expected to be located during the module



The participants shall:

- 1.1.2 Engage in answering the above questions

ELEMENT 1.2 - FACILITIES

Learning objective:

- 6) The participants can **recognise** the facilities at the training location (Knowledge, basic level)

The instructor shall:

- 1.2.1 Give a general description of the facilities at the location (administration, dining area, restrooms and toilets, etc.)

The participants shall:

- 1.2.2 Note relevant facilities, and ask questions when in doubt about facilities

ELEMENT 1.3 - INTRODUCTION

Learning objective:

- 7) The participants **show an interest** in fellow participants and the programme of the BTT Hydraulic Module (Ability, basic level)

The instructor shall:

- 1.3.1 Explain and ask involving questions about the programme of the BTT Hydraulic Module, including breaks and meal times
- 1.3.2 Give a short introduction of themselves, including their background as an instructor
- 1.3.3 Ask for participants' expectations of the training and of their learning outcome

The participants shall:

- 1.3.4 Give a short introduction of themselves, including their job function, and share their expectations of the training and learning outcome expectation for the training

ELEMENT 1.4 - AIM AND OBJECTIVES

Learning objective:

- 8) The participants can **recognise** the scope and main objectives of the BTT Hydraulic Module (Knowledge, basic level)

The instructor shall:



- 1.4.1 Explain the scope and main objectives of the BTT Hydraulic Module
- 1.4.2 Involve participants by means of questions about the participants' understandings and individual experiences relevant to the BTT Hydraulic Module

The participants shall:

- 1.4.3 Engage in answering questions, and share experiences relevant to the BTT Hydraulic Module

ELEMENT 1.5 - ONGOING ASSESSMENTS

Learning objective:

- 9) The participants can **recognise** the reasons for the ongoing assessment and **recognise** how the GWO participant assessment form will be used throughout the module (Knowledge, basic level)

The instructor shall:

- 1.5.1 Explain the reasons for the on-going assessment
- 1.5.2 Explain the GWO participant assessment form and how it will be used
- 1.5.3 Ask for the participants thoughts on the assessment procedure presented

The participants shall:

- 1.5.4 Engage in discussions on the assessment procedure

ELEMENT 1.6 - MOTIVATION

Learning objective:

- 10) The participants **show a willingness** to be personally involved in the learning activities throughout the BTT Hydraulic Module (Ability, basic level)

The instructor shall:

- 1.6.1 Explain and facilitate discussions on:
 - a. the importance of personal involvement in the module
 - b. the need for the BTT Hydraulic Module when working in the wind industry

The participants shall:

- 1.6.2 Engage themselves in discussions about the importance of personal involvement in the module, and the need for the BTT Hydraulic Module when working in the wind industry

ELEMENT 1.7 - HUMAN FACTORS



Learning objectives:

- 11) The participants can **describe** the relevant human factors and the implications thereof (Knowledge, basic level)
- 12) The participants **show an interest** and **willingness** to focus on human factors during the following practical exercises (Ability, basic level)

The Instructor shall:

- 1.7.1 Present how human factors have an influence on accidents in the wind industry
- 1.7.2 Lead a discussion about the role of the individual in improving human performance, and how this improvement can benefit safety when working in the wind industry, by considering factors like:
 - a. Attention and perception
 - b. Group behaviour and peer pressure
 - c. Fitness and health
 - d. Domestic and work-related stress
 - e. Workload (both overload and underload)
 - f. Fatigue
 - g. Time pressure and deadlines
 - h. Alcohol, medication and substance abuse

The participants shall:

- 1.7.3 Engage in discussions and share understandings about the influence of human factors on accidents when working in the wind industry

Lesson 2 - HYDRAULIC INTRODUCTION

30 min.

The aim of this lesson is to give the participants basic knowledge of hydraulic systems.

ELEMENT 2.1 - THE HYDRAULIC SYSTEM

Learning objective:

- 13) The participants can **explain** the function and principles of a basic hydraulic system (Knowledge, intermediate level)

The instructor shall:



- 2.1.1 Explain the purpose of hydraulics
- 2.1.2 Explain the relationship between hydraulics, electrics and mechanical movement in a wind turbine
- 2.1.3 Define and explain pressure and flow (units)
- 2.1.4 Ask the participants relevant questions about the function and principles of a basic hydraulic system

The participants shall:

- 2.1.5 Explain in their own words and share understandings about the function and principles of a basic hydraulic system

The instructor shall:

- 2.1.6 Give constructive feedback on the participants' explanations about the function and principles of a basic hydraulic system

ELEMENT 2.2 - PASCAL'S LAW

Learning objective:

- 14) The participants can **explain** hydraulic power transmission / Pascal's Law (Knowledge, intermediate level)

The instructor shall:

- 2.2.1 Explain the basic concept of Pascal's Law
- 2.2.2 Explain about the incompressibility of oil
- 2.2.3 Show and explain practical examples of Pascal's Law
- 2.2.4 Create a learning activity, such as distributing simple practical examples to the participants will help the participants to apply and discuss Pascal's Law

The participants shall:

- 2.2.5 Analyse and discuss Pascal's Law

The instructor shall:

- 2.2.6 Give constructive feedback on the participants' application and discussion of the hydraulic power transmission / Pascal's Law

Lesson 3 - HYDRAULIC SAFETY

60 min.



The aim of this lesson is to enable the participants to handle hydraulic hazards in a wind turbine.

ELEMENT 3.1 - WHY HYDRAULIC SAFETY

Learning objectives:

- 15) The participants can **discuss** the importance of hydraulic safety (Knowledge, intermediate level)
- 16) The participants can **discuss** the hydraulic risks and hazards (Knowledge, intermediate level)

The instructor shall:

- 3.1.1 Explain the hazards caused by exposure to high pressure oil (e.g. cuts, oil injections, contamination) and nitrogen (e.g. nitrogen in the lungs, high pressure stored)
- 3.1.2 Show the importance of working according to approved work practices (e.g. through storytelling or scenarios)
- 3.1.3 Facilitate group discussions with the participants about the consequences of hydraulic incidents (pressure, nitrogen...)
- 3.1.4 Facilitate group discussions with the participants about hydraulic risks and hazards, and similarities and differences between these risks and hazards compared to other hazardous energies such as mechanics and electricity

The participants shall:

- 3.1.5 Engage in a group discussion about the consequences of hydraulic incidents (pressure, nitrogen...)
- 3.1.6 Engage in a group discussion about hydraulic risks and hazards, and the differences and similarities with these risks and hazards compared to other hazardous energies, such as mechanics and electricity

The instructor shall:

- 3.1.7 Give constructive feedback on the participants' group discussions about the consequences of hydraulic incidents and hydraulic risks and hazards

ELEMENT 3.2 - HIGH PRESSURE SYSTEMS

Learning objectives:

- 17) The participants can **recognise** what a pressure system is (Knowledge, basic level)
- 18) The participants can **describe** the importance of checking and relieving system pressure, including accumulators, before working on the system (Knowledge, basic level)
- 19) The participants can **describe** the risks and hazards of high pressure in hydraulic systems (Knowledge, basic level)

The instructor shall:



- 3.2.1 Explain what a pressure system is
- 3.2.2 Lead a discussion about the importance of checking and relieving system pressure, including accumulators before working on the system (e.g. test points, manometers and needle valves)
- 3.2.3 Show the importance of the emergency stop button in a wind turbine
- 3.2.4 Describe typical reactions of the hydraulic systems in a wind turbine when an emergency stop button is pressed
- 3.2.5 Lead a discussion about the danger due to actuators movement

The participants shall:

- 3.2.6 Engage in a discussion about the importance of checking and relieving system pressure including accumulators before working on the system (e.g. test points, manometers and needle valves)
- 3.2.7 Engage in a discussion about the danger due to in actuator's movement

ELEMENT 3.3 - STORED ENERGY

Learning objective:

- 20) The participants can **describe** the risks and hazards of stored energy in hydraulic systems (Knowledge, basic level)

The instructor shall:

- 3.3.1 Explain where there is stored energy in a hydraulic system
- 3.3.2 Explain the risks associated with a charged accumulator
- 3.3.3 Explain the risks associated with trapped pressure in other components (i.e. actuators)
- 3.3.4 Ask the participants relevant questions about the risks and hazards of stored energy in hydraulic systems

The participants shall:

- 3.3.5 Describe in their own words and share understandings about the risks and hazards of stored energy in hydraulic systems

ELEMENT 3.4 - SAFETY SIGNS

Learning objective:

- 21) The participants can **describe** different safety signs and their meanings (Knowledge, basic level)

The instructor shall:



- 3.4.1 Show an example of and explain how to identify the sign for “Danger Hydraulic Pressure”
- 3.4.2 Show examples of safety signs
- 3.4.3 Facilitate discussions about different safety signs and their meanings

The participants shall:

- 3.4.4 Engage in discussions about different safety signs and their meanings

ELEMENT 3.5 - CHEMICALS

Learning objectives:

- 22) The participants can **discuss** the risks and hazards of oil in hydraulic systems (Knowledge, intermediate level)
- 23) The participants can **describe** the need of SDS (Knowledge, basic level)
- 24) The participants can **describe** the environmental safety involved when handling oil (Knowledge, basic level)

The instructor shall:

- 3.5.1 Facilitate group discussions about the hazards caused by exposure to hydraulic oil and nitrogen
- 3.5.2 Lead a discussion about the need of Safety Data Sheets (SDS)
- 3.5.3 Lead a discussion about the environmental safety implications when handling oil

The participants shall:

- 3.5.4 Engage in a group discussion about the hazards caused by exposure to hydraulic oil and nitrogen
- 3.5.5 Engage in a discussion about the need for Safety Data Sheets (SDS)
- 3.5.6 Engage in a discussion about the environmental safety involved when handling oil

The instructor shall:

- 3.5.7 Give constructive feedback on the participants’ group discussion about the hazards caused by exposure to hydraulic oil and nitrogen

ELEMENT 3.6 - TYPES OF PPE

Learning objective:

- 25) The participants can **inspect** and **use** the required PPE for working with hydraulics (Skills, intermediate level)

The instructor shall:



- 3.6.1 Show examples of and explain gloves that are suitable for hydraulic work
- 3.6.2 Explain that not all gloves are suitable for hydraulic work
- 3.6.3 Show examples of and explain goggles can be used for hydraulic work and the importance of wearing them
- 3.6.4 Show the consequence of not wearing the right PPE (through e.g. storytelling or examples)
- 3.6.5 Demonstrate how to test if the gloves are fit for use:
 - a. Check the gloves for holes
 - b. Check that the gloves are suitable for hydraulic oil
- 3.6.6 Facilitate practice for the participants' in selecting the right PPE to wear for hydraulic work, and how to inspect and use hydraulic PPE

The participants shall:

- 3.6.7 Practice selecting the right PPE to wear for hydraulic work
- 3.6.8 Practice how to inspect and use hydraulic PPE

The instructor shall:

- 3.6.9 Give constructive feedback on the participants' selection of the right PPE to wear for hydraulic work, and inspection and use of hydraulic PPE

ELEMENT 3.7 - THE IMPORTANCE OF APPROPRIATE ISOLATION

Learning objective:

- 26) The participants can **discuss** the importance of proper isolation when working with hydraulics (Knowledge, intermediate level)

The instructor shall:

- 3.7.1 Facilitate group discussions about the importance of using appropriate isolation when working with hydraulics and to prevent unexpected start-up when working with hydraulics

The participants shall:

- 3.7.2 Engage in a group discussion about why it is important to use appropriate isolation and to prevent unexpected start-up when working with hydraulics

The instructor shall:

- 3.7.3 Give constructive feedback on the participants' group discussions about the importance of using appropriate isolation and to prevention unexpected start-up when working with hydraulics



Lesson 4 - PUMPS

30 min.

The aim of this lesson is to enable the participants to be able to explain the main type of pumps of hydraulic circuits, and to perform checks of the start and stop pressure on pumps.

ELEMENT 4.1 - INTRODUCTION TO PUMPS

Learning objectives:

- 27) The participants can **describe** the function of pumps (Knowledge, basic level)
- 28) The participants can **recognise** pumps on a diagram (Knowledge, basic level)
- 29) The participants can **describe** examples of how they can be operated (Knowledge, basic level)

The instructor shall:

- 4.1.1 Explain the function of pumps
- 4.1.2 Explain the operation of a pump by an electrical motor
- 4.1.3 Explain the operation of a pump manually
- 4.1.4 Show examples of and explain the symbols for pumps
- 4.1.5 Explain the position of pumps in a circuit
- 4.1.6 Ask the participants relevant questions about the function of pumps and provide examples of how pumps can be operated
- 4.1.7 Create a short learning activity where the participants have to identify pumps on a diagram

Participants shall:

- 4.1.8 Describe in their own words and share understandings about the function of pumps and provide examples of how pumps can be operated
- 4.1.9 Identify pumps on a diagram

ELEMENT 4.2 - PUMPS EXERCISE

Learning objective:

- 30) The participants can **perform** checks of the start and stop pressure of a pump following the instructions (Skills, intermediate level)

The instructor shall:

- 4.2.1 Explain and demonstrate the process to check the start and stop pressure on a pump



- 4.2.2 Facilitate practice to improve the participants' ability to check the start and stop pressure on a pump following the instructions from the instructor

The participants shall:

- 4.2.3 Practice checking the start and stop pressure on a pump following the instructions from the instructor

The instructor shall:

- 4.2.4 Give constructive feedback on the participants' practice in how to check the start and stop pressure on a pump following the instructions from the instructor

Lesson 5 - ACTUATORS

15 min.

The aim of this lesson is to enable the participants to be able to describe the main type of actuators (e.g. cylinders)

ELEMENT 5.1 - INTRODUCTION TO ACTUATORS

Learning objectives:

- 31) The participants can **describe** function of actuators (Knowledge, basic level)
- 32) The participants can **recognise** actuators on a diagram (Knowledge, basic level)

The instructor shall:

- 5.1.1 Explain the function of actuators
- 5.1.2 Explain different types of actuators (e.g. cylinders and callipers) and their operation
- 5.1.3 Show examples of and explain the symbols for actuators
- 5.1.4 Explain the position of actuators in a circuit
- 5.1.5 Ask the participants relevant questions about the function of actuators
- 5.1.6 Create a short learning activity where the participants have to identify actuators on a diagram

Participants shall:

- 5.1.7 Describe in their own words and share understandings about the function of actuators
- 5.1.8 Identify actuators on a diagram

Lesson 6 - VALVES



105 min.

The aim of this lesson is to enable the participants to be able to explain the function of valves.

ELEMENT 6.1 - INTRODUCTION TO VALVES

Learning objective:

33) The participants can **explain** the function of valves (Knowledge, intermediate level)

The instructor shall:

- 6.1.1 Explain the function of valves (controlling flow, oil direction, pressure...)
- 6.1.2 Ask the participants relevant questions about the function of valves (controlling flow, oil direction, pressure...)

The participants shall:

- 6.1.3 Explain in their own words and share understandings about the function of valves

The instructor shall:

- 6.1.4 Give constructive feedback on the participants' explanations about the function of valves

ELEMENT 6.2 - DIRECTIONAL CONTROL VALVES

Learning objectives:

- 34) The participants can **recognise** the function of different types of directional control valves (Knowledge, basic level)
- 35) The participants can **describe** the operation of different types of directional control valves (Knowledge, basic level)
- 36) The participants can **recognise** different types of directional valves on a diagram (Knowledge, basic level)

The instructor shall:

- 6.2.1 Explain the function of directional valves
- 6.2.2 Explain about the ports and positions (e.g. 2/3, 3/4)
- 6.2.3 Explain the principle of operation of directional valves and how they change position (electrically, hydraulically, manually...)
- 6.2.4 Show examples of and explain the symbols for electrically operated valves and hydraulic pilot operated valves



- 6.2.5 Explain the position of directional control valves in a circuit
- 6.2.6 Explain that valves are shown de-energised in the diagram
- 6.2.7 Explain the function of proportional valves in a hydraulic circuit
- 6.2.8 Explain the principle of operation of the proportional valves
- 6.2.9 Show examples of and explain the symbol for a proportional valve
- 6.2.10 Facilitate discussions about the operation of directional valves and the operation of a proportional valve in a circuit

The participants shall:

- 6.2.11 Engage in discussions about the operation of directional valves
- 6.2.12 Engage in discussions about the operation of a proportional valve in a circuit

ELEMENT 6.3 - PRESSURE RELIEF VALVES

Learning objectives:

- 37) The participants can **describe** the function and operation of the pressure relief valve (Knowledge, basic level)
- 38) The participants can **recognise** the pressure relief valve on a diagram (Knowledge, basic level)
- 39) The participants can **perform** the adjustment of a pressure relief valve (Skills, intermediate level)

The instructor shall:

- 6.3.1 Explain the function of the pressure relief valve
- 6.3.2 Explain the operation of the pressure relief valve
- 6.3.3 Ask the participants relevant questions about the function and operation of the pressure relief valve
- 6.3.4 Demonstrate how to check and adjust the pressure relief valve
- 6.3.5 Show examples of and explain the symbol for a pressure relief valve
- 6.3.6 Explain the position of pressure relief valves in a circuit
- 6.3.7 Facilitate practice for the participants in checking and adjusting the pressure relief valve in a circuit

The participants shall:

- 6.3.8 Describe in their own words and share understandings about the function and operation of the pressure relief valve
- 6.3.9 Practice checking and adjusting the pressure relief valve in a circuit

The instructor shall:



- 6.3.10 Give constructive feedback on the participants' practice of checking and adjusting the pressure relief valve in a circuit

ELEMENT 6.4 - PRESSURE REDUCTION VALVES

Learning objectives:

- 40) The participants can **describe** the function and operation of the pressure reduction valve (Knowledge, basic level)
- 41) The participants can **recognise** the pressure reduction valve on a diagram (Knowledge, basic level)

The instructor shall:

- 6.4.1 Explain the function of the pressure reduction valve
- 6.4.2 Explain the operation of the pressure reduction valve
- 6.4.3 Ask the participants relevant questions about the function and operation of the pressure reduction valve
- 6.4.4 Show examples of and explain the symbol for a pressure reduction valve
- 6.4.5 Explain the position of pressure reduction valves in a circuit

The participants shall:

- 6.4.6 Describe in their own words and share understandings about the function and operation of the pressure reduction valve

ELEMENT 6.5 - NEEDLE VALVES

Learning objectives:

- 42) The participants can **describe** the function and operation of the needle valve (Knowledge, basic level)
- 43) The participants can **recognise** a needle valve on a diagram (Knowledge, basic level)
- 44) The participants can **perform** the depressurizing of a system using a needle valve (Skills, intermediate level)

The instructor shall:

- 6.5.1 Explain the function of the needle valve in a circuit
- 6.5.2 Explain the operation of the needle valve
- 6.5.3 Ask the participants relevant questions about the function and operation of the needle valve
- 6.5.4 Show examples of and explain the symbol for a needle valve



- 6.5.5 Explain the position of a needle valve in a circuit
- 6.5.6 Facilitate practice for the participants in the operation of the needle valve in a circuit and the ability to use a needle valve to depressurize the hydraulic system

The participants shall:

- 6.5.7 Describe in their own words and share understandings about the function and operation of the needle valve
- 6.5.8 Practice the operation of the needle valve in a circuit
- 6.5.9 Practice the ability to use a needle valve to depressurize the hydraulic system

The instructor shall:

- 6.5.10 Give constructive feedback on the participants' practice in the operation of the needle valve in a circuit and the ability to use a needle valve to depressurize the hydraulic system

ELEMENT 6.6 - NON-RETURN VALVES

Learning objectives:

- 45) The participants can **describe** the function and operation of different types of non-return valves (Knowledge, basic level)
- 46) The participants can **recognise** the different types of non-return valve on a diagram (Knowledge, basic level)

The instructor shall:

- 6.6.1 Explain the function of a non-return valve
- 6.6.2 Explain the operation of a non-return valve
- 6.6.3 Explain the function of a pilot operated non-return valve
- 6.6.4 Explain the operation of a pilot operated non-return valve
- 6.6.5 Ask the participants relevant questions about the function and operation of different types of non-return valves
- 6.6.6 Show examples of and explain the symbol for a non-return valve
- 6.6.7 Show examples of and explain the symbol for a pilot operated non-return valve
- 6.6.8 Explain the position of a non-return valve in a circuit

The participants shall:

- 6.6.9 Describe in their own words and share understandings about the function and operation of different types of non-return valves



ELEMENT 6.7 - THROTTLE VALVES

Learning objectives:

- 47) The participants can **describe** the function of the throttle valve (Knowledge, basic level)
- 48) The participants can **recognise** a throttle valve on a diagram (Knowledge, basic level)

The instructor shall:

- 6.7.1 Explain the function of a throttle valve
- 6.7.2 Explain the operation of a throttle valve
- 6.7.3 Ask the participants relevant questions about the function and operation of a throttle valve
- 6.7.4 Show examples of and explain the symbol for a throttle valve
- 6.7.5 Explain the position of a throttle valve in a circuit

The participants shall:

- 6.7.6 Describe in their own words and share understandings about the function and operation of a throttle valve

ELEMENT 6.8 - RESTRICTOR VALVES

Learning objective:

- 49) The participants can **describe** the function and operation of the restrictor valve (Knowledge, basic level)
- 50) The participants can **recognise** a restrictor valve on a diagram (Knowledge, basic level)

The instructor shall:

- 6.8.1 Explain the function of a restrictor valve
- 6.8.2 Explain the operation of a restrictor valve
- 6.8.3 Ask the participants about the function and operation of a restrictor valve
- 6.8.4 Show examples of and explain the symbol for a restrictor valve
- 6.8.5 Explain the position of a restrictor valve in a circuit

The participants shall:

- 6.8.6 Describe in their own words and share understandings about the function and operation of a restrictor valve



Lesson 7 - ACCUMULATORS

80 min.

The aim of this lesson is to enable the participants to be able to describe the function of accumulators and how to do the pre-charge of Nitrogen under safe conditions.

ELEMENT 7.1 - INTRODUCTION TO ACCUMULATORS

Learning objectives:

- 51) The participants can **describe** the function of the different accumulators (Knowledge, basic level)
- 52) The participants can **recognise** accumulators on a diagram (Knowledge, basic level)

The instructor shall:

- 7.1.1 Explain the function of the accumulators
- 7.1.2 Explain the operation of the accumulators
- 7.1.3 Explain the different types of accumulators (bladder, piston and diaphragm)
- 7.1.4 Show examples of and explain the symbols for accumulators
- 7.1.5 Explain the position of accumulators in a circuit
- 7.1.6 Ask the participants relevant questions about the function of the different accumulators
- 7.1.7 Create a short learning activity where the participants have to identify accumulators on a diagram

The participants shall:

- 7.1.8 Describe in their own words and share understandings about the function of the different accumulators
- 7.1.9 Identify accumulators on a diagram

ELEMENT 7.2 - PRE-CHARGE PRESSURE

Learning objective:

- 53) The participants can **perform** check of the pre-charge pressure and refill the accumulator (Skills, intermediate level)

The instructor shall:

- 7.2.1 Explain nitrogen bottles storage and handling requirements
- 7.2.2 Explain the importance of discharging the accumulators prior to working on the system
- 7.2.3 Demonstrate how to check the pre-charge pressure of an accumulator



- 7.2.4 Explain the temperature correction chart
- 7.2.5 Demonstrate how to refill the accumulator
- 7.2.6 Facilitate practice to improve the participants' abilities to check the pre-charge pressure of an accumulator and to refill the accumulator

The participants shall:

- 7.2.7 Practice the ability to check the pre-charge pressure of an accumulator
- 7.2.8 Practice the ability to refill the accumulator

The instructor shall:

- 7.2.9 Give constructive feedback on the participants' abilities to check the pre-charge pressure of an accumulator and to refill the accumulator

Lesson 8 - SENSORS

15 min.

The aim of this lesson is to enable the participants to be able to describe the function of different sensors.

ELEMENT 8.1 - INTRODUCTION TO SENSORS

Learning objective:

- 54) The participants can **describe** the function of sensors (Knowledge, basic level)

The instructor shall:

- 8.1.1 Explain the function of sensors
- 8.1.2 Facilitate discussions about the function of sensors and the different types of hydraulic sensors

The participants shall:

- 8.1.3 Engage in discussions about the function of sensors and the different types of hydraulic sensors

ELEMENT 8.2 - PRESSURE SENSORS

Learning objectives:

- 55) The participants can **describe** the function of a pressure sensor (Knowledge, basic level)
- 56) The participants can **recognise** pressure sensors on a diagram (Knowledge, basic level)



The instructor shall:

- 8.2.1 Explain the function of the pressure transducer (transmitter) and pressure switch
- 8.2.2 Show examples of and explain the symbol for a pressure transducer (transmitter) and pressure switch
- 8.2.3 Explain the position of pressure sensors (transducer and switch) in a circuit
- 8.2.4 Ask the participants relevant questions about the function of pressure sensors
- 8.2.5 Create a short learning activity where the participants have to identify pressure sensors on a diagram

The participants shall:

- 8.2.6 Describe in their own words and share understandings about the function of pressure sensors
- 8.2.7 Identify pressure sensors on a diagram

Lesson 9 - PIPES, HOSES AND CONNECTIONS

20 min.

The aim of this lesson is to enable the participants to be able to recognise the components that transfer the oil in the hydraulic system.

ELEMENT 9.1 - OIL TRANSFER

Learning objectives:

- 57) The participants can **describe** the function and inspection of the components that transfer the oil (Knowledge, basic level)
- 58) The participants can **recognise** the components that transfer the oil on a diagram (Knowledge, basic level)

The instructor shall:

- 9.1.1 Explain the function of hydraulic pipes and hoses
- 9.1.2 Explain the different types of pipes, hoses and fittings used in hydraulic systems
- 9.1.3 Show examples of and explain the symbol for a hose and pipes
- 9.1.4 Explain the position of hoses and pipes in a circuit
- 9.1.5 Explain how to visually inspect for leaks in the oil transfer system
- 9.1.6 Ask the participants relevant questions about the function and inspection of the components that transfer the oil
- 9.1.7 Create a short learning activity where the participants have to identify components that transfer the oil on a diagram



The participants shall:

- 9.1.8 Describe in their own words and share understandings about the function and inspection of the components that transfer the oil
- 9.1.9 Identify components that transfer the oil on a diagram

ELEMENT 9.2 - HYDRAULIC CONNECTIONS

Learning objectives:

- 59) The participants can **describe** how to use different fittings to make a hydraulic connection (Knowledge, basic level)
- 60) The participants can **recognise** a quick release coupling on a diagram (Knowledge, basic level)

The instructor shall:

- 9.2.1 Describe how to make a connection with different fittings (threaded, quick release, by hand...)
- 9.2.2 Explain the function of quick release couplings
- 9.2.3 Explain the operation of quick release couplings
- 9.2.4 Explain how to use quick release couplings
- 9.2.5 Show examples of and explain the symbol for a quick release coupling
- 9.2.6 Explain the position of a quick release coupling in a circuit
- 9.2.7 Ask the participants relevant questions about how to use different fittings to make a hydraulic connection
- 9.2.8 Create a short learning activity where the participants have to identify a quick release coupling on a diagram

The participants shall:

- 9.2.9 Describe in their own words and share understandings about how to use different fittings to make a hydraulic connection
- 9.2.10 Identify a quick release coupling on a diagram

Lesson 10 - OIL AND FILTERS

40 min.

The aim of this lesson is to enable the participants to be able to describe procedures for the handling of oil.

ELEMENT 10.1 - PROCEDURES FOR THE HANDLING OF OIL



Learning objectives:

- 61) The participants can **describe** basic procedures for the handling of oil (Knowledge, basic level)
- 62) The participants can **recognise** the importance of cleanliness (Knowledge, basic level)

The instructor shall:

- 10.1.1 Describe that there are different types of oils with different properties and uses
- 10.1.2 Emphasize the importance of using the right one and not mixing different oils by e.g. highlighting the consequences that can happen if different oils are mixed
- 10.1.3 Emphasize the importance of cleanliness
- 10.1.4 Ask the participants relevant questions about the basic procedures for the handling of oil

The participants shall:

- 10.1.5 Describe in their own words and share understandings about the basic procedures for the handling of oil

ELEMENT 10.2 - COLLECTING AN OIL SAMPLE

Learning objective:

- 63) The participants can **describe** the purpose and importance of a proper oil sample (Knowledge, basic level)

The instructor shall:

- 10.2.1 Explain the purpose of taking an oil sample
- 10.2.2 Emphasize the importance of properly collecting an oil sample according to given instructions
- 10.2.3 Ask the participants relevant questions about the purpose and importance of a proper oil sample

The participants shall:

- 10.2.4 Describe in their own words and share understandings about the purpose and importance of a proper oil sample

ELEMENT 10.3 - CHECKING OIL LEVELS

Learning objective:

- 64) The participants can **perform** checks of oil levels (Skills, intermediate level)

The instructor shall:



- 10.3.1 Explain the function of the tank
- 10.3.2 Explain oil level checking with a dip stick, sight glass and filling hole
- 10.3.3 Facilitate practice for the participants in the procedures for checking oil levels (e.g. with a dip stick, sight glass and filling hole)

The participants shall:

- 10.3.4 Practice the procedures for checking oil levels (e.g. with a dip stick, sight glass and filling hole)

The instructor shall:

- 10.3.5 Give constructive feedback on the participants' practice of the procedures for checking oil levels

ELEMENT 10.4 - FILTERS

Learning objectives:

- 65) The participants can **describe** the function of filters (Knowledge, basic level)
- 66) The participants can **describe** the maintenance of filters (Knowledge, basic level)
- 67) The participants can **recognise** filters on a diagram (Knowledge, basic level)

The instructor shall:

- 10.4.1 Explain the function of the filters
- 10.4.2 Facilitate discussions on the importance of replacing filters
- 10.4.3 Explain the different types of filters (depending of the position and particle sizes)
- 10.4.4 Show examples of and explain the symbol for filters
- 10.4.5 Explain the position of filters in a circuit
- 10.4.6 Ask the participants relevant questions about the function of filters
- 10.4.7 Create a learning activity where the participants shall identify filters on a diagram

The participants shall:

- 10.4.8 Engage in discussions about the importance of replacing filters
- 10.4.9 Describe in their own words and share understandings about the function of filters
- 10.4.10 Identify filters on a diagram

Lesson 11 - HYDRAULIC DIAGRAMS

45 min.



The aim of this lesson is to enable the participants to be able to identify and find different components on a hydraulic diagram.

ELEMENT 11.1 - SYMBOLS AND DIAGRAMS

Learning objectives:

- 68) The participants can **account for** the main symbols and components in a hydraulic system diagram (e.g., pump, tank, hoses, valves) (Knowledge, intermediate level)
- 69) The participants can **explain** how to interpret the hydraulic diagram (Knowledge, intermediate level)

The instructor shall:

- 11.1.1 Show and explain an example of a hydraulic diagram covering the components mentioned in the previous lessons.
- 11.1.2 Explain that valves are shown de-energised in the diagram
- 11.1.3 Explain how to interpret the hydraulic diagram
- 11.1.4 Ask the participants relevant questions about the different components in the diagram and how to interpret the hydraulic diagram

The participants shall:

- 11.1.5 Describe in their own words and share understandings about the different components in the diagram
- 11.1.6 Describe in their own words and share understandings about how to interpret the hydraulic diagram

The instructor shall:

- 11.1.7 Give constructive feedback on the participants' explanations about the different components in the diagram and how to interpret the hydraulic diagram

ELEMENT 11.2 - IDENTIFYING MEASURING POINTS

Learning objectives:

- 70) The participants can **recognise** the function of measuring points (Knowledge, basic level)
- 71) The participants can **describe** how to identify accurate measuring points using a diagram (Knowledge, basic level)

The instructor shall:

- 11.2.1 Explain the function of measuring points in a circuit
- 11.2.2 Show examples of and explain the symbol of measuring points



11.2.3 Explain the position of measuring points in a circuit

11.2.4 Facilitate discussions about identifying measuring points using a diagram

The participants shall:

11.2.5 Engage in discussions about identifying accurate measuring points using a diagram

Lesson 12 - PRESSURE MEASURING TOOLS

20 min.

The aim of this lesson is to enable the participants to be able to measure the hydraulic pressure accurately.

ELEMENT 12.1 - PRESSURE GAUGE/MANOMETER

Learning objectives:

72) The participants can **recognise** the function and symbol of pressure gauges/manometers (Knowledge, basic level)

73) The participants can **describe** the use of pressure gauges/manometers (Knowledge, basic level)

74) The participants can **describe** the importance of calibration (Knowledge, basic level)

The instructor shall:

12.1.1 Explain the function of pressure gauges/manometers

12.1.2 Explain different types of pressure gauges/manometers (e.g. maximum pressure, accuracy, digital vs dial indicator...)

12.1.3 Show examples of and explain the symbol for a pressure gauge/manometer

12.1.4 Facilitate discussions about how to use a pressure gauge/manometer and the importance of calibration

The participants shall:

12.1.5 Engage in discussions about how to use a pressure gauge/manometer

12.1.6 Engage in discussions about the importance of calibration

ELEMENT 12.2 - PRESSURE MEASUREMENT

Learning objective:

75) The participants can **perform** the measurement of hydraulic pressure (Skills, intermediate level)

The instructor shall:



12.2.1 Explain and demonstrate how to take an accurate pressure measurement

12.2.2 Facilitate practice for the participants to improve the participants' ability to measure the hydraulic pressure accurately

The participants shall:

12.2.3 Practice the ability to measure the hydraulic pressure accurately

The instructor shall:

12.2.4 Give constructive feedback on the participants' ability to measure the hydraulic pressure accurately

Lesson 13 - SUMMARY AND THEORETICAL TEST

30 min.

The aim of this lesson is to summarize the BTT Module and to conduct a theoretical test with the participants.

ELEMENT 13.1 - SUMMARY

Learning objective:

76) The participants can **recall** the objectives that have been covered within this module.

The instructor shall:

13.1.1 Summarise the BTT Module referring to the objectives.

ELEMENT 13.2 - THEORETICAL TEST

After having successfully completed this BTT Hydraulic module, participants will be able to:

- Pass the final test

The instructor shall:

13.2.1 Introduce the test to the participants, explaining the rules to be followed during the test

13.2.2 Conduct the test with the participants

The participants shall:

13.2.3 Conduct the test

The instructor shall:



- 13.2.4 Check the test results, and give feedback to the participants about the test result
- 13.2.5 In the event that a participant fails the test, conduct an interview with the participant according to the 'Participant Performance Assessment' section.

Lesson 14 - TRAINING REVIEW

15 min.

The aim of this lesson is to enable the participants to reflect on and process their learning outcome and key takeaways from the module, aiming to achieve a high learning transfer from the module to his/her way of working.

ELEMENT 14.1 - TRAINING REVIEW

The instructor shall:

- 14.1.1 Re-present the overall aims and learning objectives of the module for the participants' comparison of their learning outcome and the achievement of their previously stated expectations for the module

The participants shall:

- 14.1.2 Reflect on their learning outcome and key takeaways from the BTT Hydraulic Module, aiming to achieve a high learning transfer from the module to his/her way of working by means of e.g.:
 - a. Group discussions or walk & talk
 - b. Questions & answers in class, or where suitable

Note: The instructor may additionally conduct a local evaluation of the training.

ELEMENT 14.2 - FEEDBACK SESSION

The instructor shall:

- 14.2.1 Give an overall feedback and feed forward on the participants' learning outcome inspired by the training as well as from the training-review-session.
- 14.2.2 Encourage the participants to examine and grow awareness of which specific elements in their own WTG type/WTG environment differ from the training scenario environment (to visualize and enhance learning transfer) and to discuss with colleagues about how the BTT content, methods and techniques are similar or different to the local specific conditions identified after the module completion.



GLOBAL WIND
ORGANISATION

Installation

Module

(BTTH)



12 Module 4 - The BTT Installation Module

12.1 Aims and objectives of the BTT Installation Module

The aim of this BTT Installation Module is to give the participants the knowledge and skills to carry out basic installation tasks (supervised by an experienced technician), using safe working procedures and the correct PPE.

After having successfully completed the BTT Installation Module, participants will be able to:

- 1) **Recognise** the main installation activities (Knowledge, basic level)
- 2) **Discuss** the overall risks and hazards associated with the installation environment (Knowledge, intermediate level)
- 3) **Discuss** the checklist system throughout the complete installation process (Knowledge, intermediate level)
- 4) **Describe** the characteristics of the installation environments (Knowledge, basic level)
- 5) **Recognise** the principles and standards for handling and storing goods and components onsite or within a storage area, before and after installation (Knowledge, basic level)
- 6) **Discuss** the basic principles of the lifting equipment (Knowledge, intermediate level)
- 7) **Describe** the basic preparation of main components before installation (Knowledge, basic level)
- 8) **Describe** the basic mechanical completion (Knowledge, basic level)
- 9) **Perform** the basic electrical completion including the principles and standards for handling and installing cables (Skills, intermediate level)
- 10) **Describe** the basic hydraulic completion (Knowledge, basic level)
- 11) **Recognise** the principles of operating external generators during installation (Knowledge, basic level)
- 12) **Recognise** the basis of how to do a handover to commissioning (Knowledge, basic level)

12.2 Duration of the BTT Installation Module

The total contact time for completing this BTT installation module is estimated to be 17.67 hours. This is based on the time estimate given in the module timetable.

The training provider must not exceed the time per day given in table 12-2 below.

The training provider must ensure that sufficient time is allowed for participants with prior experience to share their experiences related to the module in a way that is constructive for the entire class.



	Maximum duration per day
Contact time	8 hours
Total training day	10 hours

Table 12-2 - Maximum duration for training days

Note: Contact time includes completion of course lesson content, practical exercises, and activities directly related to these.

The total training day includes contact time, meals and breaks, and travel between training sites (where applicable)

12.3 Participant Prerequisites for the BTT Installation Module

In order to attend the BTT Installation module, participants must first be certified in the BTT Mechanical module.

12.4 Equipment

The equipment required for training as listed in Annex 3 must be available and must fulfil national legal requirements of the country where the training is taking place.

12.5 BTT Installation Module Timetable

Within the module timetables, the approximate duration of each of the lessons is given. The training provider may choose to deliver elements of the training according to other timetables, as long as the total duration is not reduced and practical elements are not reduced in length. Theoretical elements may be delivered during the practical exercises when feasible.

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

Lesson		Element		Approx. duration
1	Introduction	1.1	Safety instructions and emergency procedures	
		1.2	Facilities	
		1.3	Introduction	
		1.4	Aim and objectives	
		1.5	On-going assessment	
		1.6	Motivation	
		1.7	Human factor	
TOTAL				30 min.



(if done after other BTT module)				5 min.
2	Introduction to Installation	2.1	Installation overview	
		2.2	Why installation safety?	
		2.3	Safety signs	
		2.4	Types of PPE	
		2.5	The importance of appropriate isolation	
TOTAL			55 min.	
3	General procedures for working onsite with installation	3.1	Checklists, Work instructions, etc.	
		3.2	Housekeeping	
TOTAL			30 min.	
4	Installation environments	4.1	Installation environments	
TOTAL			45 min.	
5	Handling and storing	5.1	Risks and hazards associated with handling and storing	
		5.2	Reception / Inspection	
		5.3	Unloading and storage of blades, nacelle, tower sections & hub	
		5.4	Tools and equipment	
		5.5	Return of goods and components	
TOTAL			70 min.	
6	Lifting operations	6.1	Types of lifting	
		6.2	Risks and hazards associated with lifting operations	
		6.3	Roles and responsibilities	
TOTAL			100 min.	
7	Main component preparation, pre-assembly and assembly	7.1	Preparation, pre-assembly and assembly	
		7.2	Risks and hazards associated with main component preparation, pre-assembly and assembly	
		7.3	Challenges when assembling the main components	
TOTAL			50 min.	



8	Principles of mechanical Completion	8.1 8.2 8.3	Introduction to mechanical completion Examples of mechanical completion Risks and hazards associated with mechanical completion	
TOTAL				75 min.
9	Principles of electrical completion including cable work	9.1 9.2 9.3 9.4 9.5 9.6 9.7	Introduction to electrical completion Examples of electrical completion Risks and hazards associated with handling and working with cables Different types of cables Simple installation diagrams Cutting and crimping of cables Marking, routing and termination of all cable types	
TOTAL				420 min.
10	Principles of hydraulic completion	10.1 10.2 10.3	Introduction to hydraulic completion Examples of hydraulic completion Risks and hazards associated with hydraulic completion	
TOTAL				40 min.
11	Principles of operation with external generators	11.1 11.2 11.3 11.4 11.5	Principles of yaw, rotor and blade operation with external generator Risks and hazards associated with the operation of auxiliary systems with an external generator Preconditions for the operation of a lift with an external generator Preconditions for the operation of an internal crane with an external generator Use of external generators for other auxiliary uses	
TOTAL				50 min.
12	Introduction to handover to the commissioning	12.1 12.2	Handover to commissioning Risks and hazards associated with handing over to the commissioning	
TOTAL				30 min.
13	Summary and Theoretical test	13.1	Summary Theoretical test	
TOTAL				50 min.
14	Training review	14.1	Training review	



TOTAL	15 min.
GRAND TOTAL	1060 min.
(If done after other BTT modules)	1035 min.

Table 12-5 – GWO BTT Installation module timetable

12.6 Learning outcomes of the BTT Installation Module

The learning outcomes specified for the BTT Installation Modules are:

Lesson 1 - INTRODUCTION

30 min. (5 min. if done after other BTT module)

The aim of this lesson is to enable the participants on the GWO BTT Installation Module training to engage in the training safely and with motivation, while recognising what is expected of them during the training

NOTE: If this module is delivered combined with other BTT modules to the same participants, the redundant introductory elements shall not be repeated.

After successfully completing this lesson of the BTT Installation Module, participants will be able to:

- 1) **Describe** the module content and the facilities involved to ensure a clear understanding of what is expected during the module (Knowledge, basic level)
- 2) **Name** and **point out** local emergency procedures and facilities (Knowledge, basic level)
- 3) **Describe** the relevant human factors and the implications thereof (Knowledge, basic level)

ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Learning objectives:

- 4) The participants can **recognise** the safety instructions, rules and emergency procedures (Knowledge, basic level)
- 5) The participants **show an interest or curiosity** in the safety and emergency procedures (Ability, basic level)

The instructor shall:

1.1.1 Explain and ask involving questions concerning:

- a. safety instructions according to internal procedures
- b. emergency procedures and emergency exits in the areas where the participants can be expected to be located during the module



The participants shall:

- 1.1.2 Engage in answering the above questions

ELEMENT 1.2 - FACILITIES

Learning objective:

- 6) The participants can **recognise** the facilities at the training location (Knowledge, basic level)

The instructor shall:

- 1.2.1 Give a general description of the facilities at the location (administration, dining area, restrooms and toilets, etc.)

The participants shall:

- 1.2.2 Note relevant facilities and ask questions when in doubt about facilities

ELEMENT 1.3 - INTRODUCTION

Learning objective:

- 7) The participants **show an interest** in fellow participants and the programme of the BTT Installation Module (Ability, basic level)

The instructor shall:

- 1.3.1 Explain and ask involving questions about the programme of the BTT Installation module, including breaks and meal times
- 1.3.2 Give a short introduction about themselves, including their backgrounds as instructors
- 1.3.3 Ask for participants' expectations of the training and of their learning outcome

The participants shall:

- 1.3.4 Give a short introduction about themselves, including job function, and share their expectations of the training and learning outcome for the training

ELEMENT 1.4 - AIM AND OBJECTIVES

Learning objective:

- 8) The participants can **recognise** the scope and main objectives of the BTT Installation module (Knowledge, basic level)

The instructor shall:



- 1.4.1 Explain the scope and main objectives of the BTT Installation module
- 1.4.2 Involve participants through questions about the participants' understandings and individual experiences relevant to the BTT Installation module

The participants shall:

- 1.4.3 Engage in answering questions and share experiences relevant to the BTT Installation module

ELEMENT 1.5 - ONGOING ASSESSMENTS

Learning objective:

- 9) The participants can **recognise** the reasons for the ongoing assessment, and **recognise** how the GWO participant assessment form will be used throughout the module (Knowledge, basic level)

The instructor shall:

- 1.5.1 Explain the reasons for the ongoing assessment
- 1.5.2 Explain the GWO participant assessment form, and how it will be used
- 1.5.3 Ask for the participants thoughts on the assessment procedure presented

The participants shall:

- 1.5.4 Engage in discussions on the assessment procedure

ELEMENT 1.6 - MOTIVATION

Learning objective:

- 10) The participants **show a willingness** to be personally involved in the learning activities throughout the Installation module (Ability, basic level)

The instructor shall:

- 1.6.1 Explain and facilitate discussions on:
 - a. the importance of personal involvement in the module
 - b. the need for the BTT Installation module when working in the wind industry

The participants shall:

- 1.6.2 Engage themselves in discussions about the importance of personal involvement in the module and the need for the BTT Installation module when working in the wind industry

ELEMENT 1.7 - HUMAN FACTORS



Learning objectives:

- 11) The participants can **describe** the relevant human factors, and the implications thereof (Knowledge, basic level)
- 12) The participants **show an interest and willingness** to focus on human factors during the following practical exercises (Ability, basic level)

The instructor shall:

- 1.7.1 Present how the human factor has an influence on accidents in the wind industry
- 1.7.2 Lead a discussion about the role of the individual in improving human performance and how this improvement can benefit safety when working in the wind industry, by considering factors like:
 - a. Attention and perception
 - b. Group behaviour and peer pressure
 - c. Fitness and health
 - d. Domestic and work-related stress
 - e. Workload (both overload and underload)
 - f. Fatigue
 - g. Time pressure and deadlines
 - h. Alcohol, medication and substance abuse

The participants shall:

- 1.7.3 Engage in discussions and share understandings about the human factor influence on accidents when working in the wind industry

Lesson 2 - INTRODUCTION TO INSTALLATION

55 min.

The aim of this lesson is to give the participants an overview of the installation activities of a wind farm and enable the participants to handle installation hazards in an installation environment.

ELEMENT 2.1 - INSTALLATION OVERVIEW

Learning objective:

- 13) The participants can **describe** the main installation activities (Knowledge, basic level)

The instructor shall:



2.1.1 Present the main activities required for the installation of turbines. This will include:

- a. Incoming inspection of components
- b. Unloading
- c. Storage and preservation
- d. Repair
- e. Preparation
- f. Pre-assembly
- g. Lifting / assembly
- h. Tightening
- i. Cable work
- j. Finishing (Mechanical, Hydraulic and Electrical)

2.1.2 Ask the participants relevant questions about the main activities required for the installation of turbines

The participants shall:

2.1.3 Describe in their own words and share understandings about the main activities required for the installation of turbines

ELEMENT 2.2 - WHY INSTALLATION SAFETY?

Learning objectives:

- 14) The participants can **describe** how to identify known and suspected hazards involved in the installation of turbines (Knowledge, basic level)
- 15) The participants can **describe** the health risks associated with the hazardous situations (Knowledge, basic level)
- 16) The participants can **describe** the means to reduce the exposure to acceptable levels (Knowledge, basic level)
- 17) The participants can **discuss** the importance of installation safety (Knowledge, intermediate level)

The instructor shall:

2.2.1 Explain how to identify known and suspected hazards involved in the installation of turbines. This will include:

- a. All sources of hazardous situations, e.g. electricity, dropped objects, crushing damage, sharp items, toxic materials and/or substances used in the workplace
- b. Tools/equipment malfunctioning due to poor control and/or handling during installation.



- 2.2.2 Ask the participants relevant questions about how to identify known and suspected hazards involved in the installation of turbines

The participants shall:

- 2.2.3 Describe in their own words and share understandings about how to identify known and suspected hazards involved in the installation of turbines

The instructor shall:

- 2.2.4 Explain the health risks associated with the hazardous situations, e.g.:
 - a. Electrical shocks, arc flash, electrocution etc.
 - b. Exposure to solvent dropped objects may result in broken limbs and/or bruises
 - c. Mechanical tools malfunctioning may cause minor or major cuts and/or crushing damage
 - d. Entrapment
 - e. Human factors

- 2.2.5 Ask the participants relevant questions about the health risks associated with the hazardous situations

The participants shall:

- 2.2.6 Describe in their own words and share understandings about the health risks associated with the hazardous situations

The instructor shall:

- 2.2.7 Explain the means to reduce the exposure to acceptable levels, e.g.:
 - a. Do not work on electrical equipment until it has been put in a safe condition (not live) by a qualified electrician
 - b. The hierarchy of controls (Elimination, Substitution, Engineering Controls, Administrative Controls, PPE)
 - c. Safe work procedures
 - d. Using work equipment properly
 - e. What to do if something goes wrong.

- 2.2.8 Ask the participants relevant questions about the means to reduce the exposure to acceptable levels

The participants shall:

- 2.2.9 Describe in their own words and share understandings about the means to reduce the exposure to acceptable levels

The instructor shall:



- 2.2.10 Facilitate group discussions with the participants about the importance of safe working procedures, identifying the necessary PPE and the appropriate tools when working in an installation environment

The participants shall:

- 2.2.11 Engage in a group discussion about the importance of safe working procedures, identifying the necessary PPE and the appropriate tools when working in an installation environment.

The instructor shall:

- 2.2.12 Give constructive feedback on the participants' group discussion about the importance of installation safety when working in an installation environment

ELEMENT 2.3 - SAFETY SIGNS

Learning objectives:

- 18) The participants can **describe** different safety signs' and their meanings (Knowledge, basic level)
- 19) The participants **show an interest** in adhering to the meaning of different safety signs' (Ability, basic level)

The instructor shall:

- 2.3.1 Explain how to identify different signs in an installation environment
- 2.3.2 Show examples of and explain safety signs in different locations in an installation environment
- 2.3.3 Facilitate discussions about different safety signs' and their meanings.

The participants shall:

- 2.3.4 Engage in discussions about different safety signs' and their meanings.

ELEMENT 2.4 - TYPES OF PPE

Learning objective:

- 20) The participants can **discuss** the required PPE in an installation environment (Knowledge, intermediate level)

The instructor shall:

- 2.4.1 Show examples of and explain the usage and inspection of suitable PPE suitable in an installation environment.
- 2.4.2 Facilitate group discussions about the differences and similarities between the required PPE when working in an installation environment and the required PPE for working with mechanics



The participants shall:

- 2.4.3 Engage in a group discussion about the differences and similarities between the required PPE when working in an installation environment and the required PPE for working with mechanics

The instructor shall:

- 2.4.4 Give constructive feedback on the participants' group discussions about the differences and similarities between the required PPE when working in an installation environment and the required PPE for working with mechanics

ELEMENT 2.5 - THE IMPORTANCE OF APPROPRIATE ISOLATION

Learning objective:

- 21) The participants can **discuss** the importance of proper isolation when working in an installation environment (Knowledge, intermediate level)

The instructor shall:

- 2.5.1 Explain using e.g. stories or scenarios the importance of using appropriate isolations when in an installation environment.
- 2.5.2 Facilitate group discussions with the participants on the importance of proper isolation when in an installation environment

The participants shall:

- 2.5.3 Engage in a group discussion about the importance of proper isolation when in an installation environment (e.g. why it is important to respect isolation locks and tags in place)

The instructor shall:

- 2.5.4 Give constructive feedback on the participants' group discussion about the importance of proper isolation when in an installation environment

Lesson 3 - GENERAL PROCEDURES FOR WORKING ONSITE WITH INSTALLATION

30 min.

The aim of this lesson is to give participants an understanding of the checklist system through the complete installation process.

ELEMENT 3.1 - CHECKLISTS, WORK INSTRUCTIONS, ETC.

Learning objectives:



- 22) The participants can **recognise** the checklist system throughout the complete installation process (Knowledge, basic level)
- 23) The participants can **describe** the importance of working according to the approved working practices (Knowledge, basic level)
- 24) The participants can **describe** the importance of completing a task properly before starting the next (Knowledge, basic level)
- 25) The participants can **describe** the importance of performing toolbox talks every day (Knowledge, basic level)

The instructor shall:

- 3.1.1 Explain the purpose of checklist, work instructions, etc. (show an example of a checklist, work instructions, etc.)
- 3.1.2 Facilitate discussions with the participants about the importance of:
 - a. working according to the approved working practices (checklist, work instructions, etc.)
 - b. completing a task properly before starting the next
 - c. performing toolbox talks every day to discuss the specifics about the work to be performed during the day

The participants shall:

- 3.1.3 Engage in discussions about the importance of working according to the approved working practices (checklist, work instructions, etc.)
- 3.1.4 Engage in discussions about the importance of completing a task properly before starting the next
- 3.1.5 Engage in discussions about the importance of performing toolbox talks every day to discuss the specifics about the work to be performed during the day

ELEMENT 3.2 - HOUSEKEEPING

Learning objective:

- 26) The participants can **describe** the importance of good housekeeping and the consequences of poor housekeeping when working in an installation environment (Knowledge, basic level)

The instructor shall:

- 3.2.1 Facilitate discussions with the participants about:
 - a. the importance of having everything clean and tidy, and its impact on safety and quality
 - b. the consequences of poor housekeeping
 - c. the importance of personal commitment to good housekeeping



The participants shall:

- 3.2.2 Engage in discussions about the importance of having everything clean and tidy and its impact on safety and quality
- 3.2.3 Engage in discussions about the consequences of poor housekeeping
- 3.2.4 Engage in discussions about the importance of personal commitment to good house keeping

Lesson 4 - INSTALLATION ENVIRONMENTS

45 min.

The aim of this lesson is to give the participants an understanding of the characteristics of the installation environments.

ELEMENT 4.1 - INSTALLATION ENVIRONMENTS

Learning objectives:

- 27) The participant can **describe** the characteristics of installation environments, including site induction, various key working areas, safety behaviour and personnel roles (Knowledge, basic level)
- 28) The participants can **describe** the differences between on-shore and off-shore sites (Knowledge, basic level)

The instructor shall:

- 4.1.1 Explain key on-site working areas (i.e. administration, hardstand, storage, crane operation, preassembly, etc.)
- 4.1.2 Describe the layout of a typical hardstand
- 4.1.3 Explain safety behaviour and limitations in the different key areas (refer to Site induction, site specific safety rules)
- 4.1.4 Explain personnel roles (e.g. Site Manager, Site Supervisors, Team Leaders, installation crew, admin staff, crane operator, Health & Safety, third parties etc.)
- 4.1.5 Explain what is meant by site Induction, and relate it to the previous point
- 4.1.6 Explain the differences with an off-shore site (examples of areas, environment, safety rules...)
- 4.1.7 Facilitate discussions about onsite organization, and the differences between on-shore and off-shore sites

The participants shall:

- 4.1.8 Engage in discussions about onsite organization typical roles and responsibilities, communication, and the interaction between them



- 4.1.9 Engage in discussions about the differences between on-shore and off-shore sites.

Lesson 5 - HANDLING AND STORING

70 min.

The aim of this lesson is to give the participants knowledge about the principles and standards of handling and storing goods and components onsite or within a storage area, before and after installation.

ELEMENT 5.1 - RISKS AND HAZARDS ASSOCIATED WITH HANDLING AND STORING

Learning objective:

- 29) The participants can **discuss** the risks and hazards associated with handling and storing goods and components (Knowledge, intermediate level)

The instructor shall:

- 5.1.1 Facilitate group discussions on examples of the risks and hazards associated with handling and storing.

The participants shall:

- 5.1.2 Engage in a group discussion on examples of the risks and hazards associated with handling and storing.

The instructor shall:

- 5.1.3 Give constructive feedback on the participants' group discussion on examples of the risks and hazards associated with handling and storing.

ELEMENT 5.2 - RECEPTION / INSPECTION

Learning objectives:

- 30) The participants can **recognise** the importance of inspecting goods and components before being unloaded (Knowledge, basic level)
- 31) The participants can **recognise** the importance of notifying a supervisor about any damage found before unloading, and tag "out of service" (or "do not use" or similar) if something is broken while being used (Knowledge, basic level)
- 32) The participants can **perform** reception/inspection of goods and components (Skills, intermediate level)

The instructor shall:

- 5.2.1 Explain the importance of inspecting goods and components before being unloaded (responsibility):



- a. Inspection
- b. Nacelle
- c. Tower sections
- d. Blades
- e. Hubs
- f. Other goods, e.g. tower bolts...
- g. If any damage is found, the supervisor should be notified (a damage report could be completed by a supervisor to register the damages found)

- 5.2.2 Explain the importance of notifying a supervisor about any damage found before unloading
- 5.2.3 Emphasize the importance of notifying a supervisor and tag “out of service” (or “do not use” or similar) if something is broken while being used.
- 5.2.4 Demonstrate how to perform inspections in accordance with work instructions, checklists, etc.
- 5.2.5 Facilitate practice for the participants to perform an inspection and document it on a checklist

The participants shall:

- 5.2.6 Practice and perform an inspection and document it on a checklist (the focus is on the use of the checklist, not on the inspection itself)

The instructor shall:

- 5.2.7 Give constructive feedback on the participants’ inspection and documentation of this on a checklist

ELEMENT 5.3 - UNLOADING AND STORAGE OF BLADES, NACELLE, TOWER SECTIONS & HUB

Learning objectives:

- 33) The participants can **recognise** how to unload and store goods and components in a correct and safe manner (Knowledge, basic level)
- 34) The participants can **recognise** the importance of keeping blades in the correct sets, due to weight (Knowledge, basic level)
- 35) The participants can **recognise** the importance of securing dry conditions for tower bolts during storage (Knowledge, basic level)
- 36) The participants can **recognise** the need for maintenance during storage (Knowledge, basic level)
- 37) The participants can **recognise** the cost and consequence of the incorrect handling and storage of main components (Knowledge, basic level)
- 38) The participants can **describe** the importance of ownership by everyone on site (ownership culture) (Knowledge, basic level)



The instructor shall:

- 5.3.1 Describe how to unload the main components in a correct and safe manner
- 5.3.2 Describe how to store the main components correctly onsite
- 5.3.3 Describe the importance of keeping blades in the correct sets, due to weight
- 5.3.4 Describe the importance of securing dry conditions for tower bolts during storage
- 5.3.5 Describe the need for maintenance during storage, and give examples (dehumidifiers, rotation of gearboxes, hubs, pitch systems...)
- 5.3.6 Describe the cost and consequence of incorrect handling and storage of main components.
- 5.3.7 Facilitate discussions with the participants about the importance of ownership by everyone on site (ownership culture)

The participants shall:

- 5.3.8 Engage in discussions about the importance of ownership by everyone on site (ownership culture)

ELEMENT 5.4 - TOOLS AND EQUIPMENT

Learning objective:

- 39) The participants can **describe** how to maintain tools and equipment during installation (Knowledge, basic level)

The instructor shall:

- 5.4.1 Describe the importance of keeping the tools and the tool container clean and regularly maintained
- 5.4.2 Explain that an inventory list can usually be found in the tool container, and should be cross referenced to make sure that all tools delivered on site are returned
- 5.4.3 Ask the participants relevant questions about how to maintain tools and equipment during installation

The participants shall:

- 5.4.4 Describe in their own words and share understandings about how to maintain tools and equipment during installation

ELEMENT 5.5 - RETURNING GOODS AND COMPONENTS

Learning objectives:

- 40) The participants can **recognise** what needs to be returned, and how to prepare for returning goods and components (Knowledge, basic level)
- 41) The participants can **describe** how tools should be returned (Knowledge, basic level)



- 42) The participants can **distinguish** between the correct and incorrect way to fill in a return goods report (Skills, intermediate level)

The instructor shall:

5.5.1 Explain what needs to be returned:

- a. Transport frames
- b. Goods

5.5.2 Facilitate discussions with the participants on how to return tools:

- a. Ensure they are tidy and clean
- b. Ensure they are working properly
- c. Tools and equipment returned in the tool container must be correctly packed and stored
- d. Ensure defective tools are labelled

The participants shall:

5.5.3 Engage in discussions about how to return tools

The instructor shall:

5.5.4 Show examples of and describe the return goods report

5.5.5 Facilitate practice ants to improve the participants' ability to fill in a return goods report

The participants shall:

5.5.6 Practice the ability to fill in a return goods report

The instructor shall:

5.5.7 Give constructive feedback on the participants' ability to fill in a return goods report

Lesson 6 - LIFTING OPERATIONS

100 min.

The aim of this lesson is to give the participants basic knowledge about the principles of lifting equipment.

ELEMENT 6.1 - TYPES OF LIFTING

Learning objectives:

- 43) The participants can **name** different types of lifting (Knowledge, basic level)



- 44) The participants can **recognise** the lifting equipment for main components (Knowledge, basic level)
- 45) The participants can **recognise** the requirement for having lifting plans and the contents of a lifting plan (Knowledge, basic level)
- 46) The participants can **describe** and analyse examples of the three different types of lifting in relation to the components (Knowledge, basic level)
- 47) The participants can **describe** how to identify requirements for performing the lifting in accordance with local legislation and company policies (Knowledge, basic level)

The instructor shall:

6.1.1 Describe different types of lifting:

- a. Basic lift
- b. Standard lift
- c. Complex lift

6.1.2 Describe the lifting equipment for main components (blades, nacelle, tower sections, hub, drive train and generator)

6.1.3 Describe the principles of lifting for main components (blades, nacelle, tower sections, hub, drive train and generator)

6.1.4 Explain the requirement to comply with local legislation, company policies, etc.

6.1.5 Explain the requirement for training

6.1.6 Explain the requirement for having lifting plans

6.1.7 Describe the contents of a lifting plan

6.1.8 Explain the requirement of Permit to Lift (once everything is ready to perform the lift, the responsible person will evaluate if everything is in place and then sign the Permit to Lift, so the lifting operation can start)

6.1.9 Facilitate an activity where the participants can discuss and analyse examples of the three different types of lifting in relation to the components

6.1.10 Facilitate a discussion on how to identify requirements for performing the lifts in accordance with local legislation and company policies

The participants shall:

6.1.11 Engage in discussions about and analyse examples of the three different types of lifting in relation to the components (blades, nacelle, tower sections, hub, drive train and generator)

6.1.12 Engage in discussions about how to identify requirements for performing the lifts in accordance with local legislation and company policies (WKIs, local laws, lifting plan...)

ELEMENT 6.2 - RISKS AND HAZARDS ASSOCIATED WITH LIFTING OPERATIONS



Learning objectives:

- 48) The participants can **discuss** the risks and hazards associated with lifting operations (Knowledge, intermediate level)
- 49) The participants can **recognise** the importance of inspection of the lifting equipment (Knowledge, basic level)
- 50) The participants can **recognise** the importance of reporting and tagging (“do not use”) damaged lifting equipment (Knowledge, basic level)
- 51) The participants can **describe** typical procedural errors and their consequences in lifting operations and damage to the equipment (Knowledge, basic level)
- 52) The participants can **recognise** how to control movement of loads when lifting by means of tag lines (Knowledge, basic level)

The instructor shall:

- 6.2.1 Facilitate group discussions on the risks and hazards associated with lifting operations (wind speed limits, loads falling due to failures in lifting equipment etc.)
- 6.2.2 Explain the importance of selecting the correct lifting equipment, (also including Working Load Limit)
- 6.2.3 Explain the importance of inspection of the lifting equipment (including Working Load Limit, markings must be readable...)
 - a. Working Load Limit
 - b. Tag with inspection date (not outdated)
 - c. Visual inspection to confirm that it is in good condition
- 6.2.4 Explain the importance of reporting and tagging (“do not use”) damaged lifting equipment
- 6.2.5 Show examples of and explain typical procedural errors in lifting operations and damage to the equipment
- 6.2.6 Explain how to control movement of loads when lifting by means of tag lines
- 6.2.7 Facilitate a discussion about the consequences of procedural errors in lifting operations and damage to the equipment

The participants shall:

- 6.2.8 Engage in a group discussion on the risks and hazards associated with lifting operations (wind speed limits, loads falling due to failures in lifting equipment, etc.)
- 6.2.9 Engage in discussions about the consequences of procedural errors in lifting operations and damage to the equipment

The instructor shall:



- 6.2.10 Give constructive feedback on the participants' group discussion on the risks and hazards associated with lifting operations

ELEMENT 6.3 - ROLES AND RESPONSIBILITIES

Learning objectives:

- 53) The participants can **recognise** the roles and responsibilities when lifting (Knowledge, basic level)
- 54) The participants can **recognise** the importance of communication when lifting (Knowledge, basic level)
- 55) The participants can **describe** their own role in lifting operations (Knowledge, basic level)

The instructor shall:

- 6.3.1 Explain the different roles and responsibilities during lifting operations (refer to lift plan)
- 6.3.2 Explain the importance of communication (who, how, etc.)
- 6.3.3 Describe the different roles for various types of lifting operations (provide examples)
- 6.3.4 Facilitate a discussion about the participants' own roles in lifting operations

The participants shall:

- 6.3.5 Engage in discussions about their own role in lifting operations

Lesson 7 - MAIN COMPONENT PREPARATION, PRE-ASSEMBLY AND ASSEMBLY

50 min.

The aim of this lesson is to give participants basic knowledge of the preparation of main components before installation.

ELEMENT 7.1 - PREPARATION, PRE-ASSEMBLY AND ASSEMBLY

Learning objectives:

- 56) The participants can **describe** the preparation of the different types of main components, Tower-sections – Hub – Blades – Nacelle - Generator – Drive Train (Knowledge, basic level)
- 57) The participants can **recognise** the difference between preparation, pre-assembly and assembly (Knowledge, basic level)
- 58) The participants can **recognise** why preparation is performed before pre-installation and installation (Knowledge, basic level)



- 59) The participants can **recognise** the importance of cleaning the main components before they are installed (Knowledge, basic level)
- 60) The participants can **recognise** why it is important to repair damage to components before installation (Knowledge, basic level)
- 61) The participants can **recognise** what is meant by cleaning (Knowledge, basic level)
- 62) The participants can **describe** the difference between onshore and off-shore approaches to preparation and pre-installation of main components (Knowledge, basic level)

The instructor shall:

7.1.1 Give examples of and explain the difference between:

- a. Preparation – e.g. gathering tools, mounting stud bolts on blades, installing spinner shells on hub, removing transport frames or equipment, cleaning flanges, etc.
- b. Pre-assembly - assembly of components before being mounted in the turbine, e.g. mounting of cooler top on top of nacelle, mounting of hub in the nacelle, mounting of blades into the hub
- c. Assembly – e.g. assembly of main components into the turbine itself (tower sections, nacelle, hub, rotor, etc.)

7.1.2 Explain why preparation is performed before pre-installation and installation

7.1.3 Explain and show the importance of cleaning the main components before they are installed

7.1.4 Explain and show why it is important to repair damage to components before installation

7.1.5 Show examples of and explain cleaning.

7.1.6 Describe the difference between onshore and offshore approaches to preparation and pre-installation of main components

7.1.7 Facilitate discussions about different tasks for preparation, pre-installation and installation of WTG at on-shore and offshore sites.

The participants shall:

- 7.1.8 Engage in discussions about different tasks for preparation, pre-installation and installation of WTG at on-shore and off-shore sites.

ELEMENT 7.2 - RISKS AND HAZARDS ASSOCIATED WITH MAIN COMPONENT PREPARATION, PRE-ASSEMBLY AND ASSEMBLY

Learning objective:

- 63) The participants can **explain** the risks and hazards associated with main component preparation, pre-assembly and assembly (Knowledge, intermediate level)



The instructor shall:

- 7.2.1 Explain the risks and hazards associated with:
 - a. Main component preparation
 - b. Pre-assembly of components
 - c. Assembly of components
 - d. Cleaning.
- 7.2.2 Present examples from installation sites with relevant risks and hazards associated with main component preparation, pre-assembly and assembly (e.g. pictures, videos, a case or scenarios)
- 7.2.3 Divide the participants into small groups
- 7.2.4 Ask the participant groups to analyse the examples with the following aims:
 - a. Find the relevant risks and hazards
 - b. Explain in their own words and share understandings about how the risk and hazards can be mitigated

The participants shall:

- 7.2.5 Analyse the examples to find the relevant risks and hazards
- 7.2.6 Engage in discussions about how the risks in the above examples can be mitigated

The instructor shall:

- 7.2.7 Give constructive feedback on the participant groups to enable the participants to be able to explain the risks and hazards of main component preparation, pre-assembly and assembly

ELEMENT 7.3 - CHALLENGES WHEN ASSEMBLING MAIN COMPONENTS

Learning objectives:

- 64) The participants can **recognise** challenges when assembling the main components - i.e. tower-tower alignment, yaw alignment, etc. (Knowledge, basic level)
- 65) The participants can **describe** how the challenges of assembling the main components above can be mitigated and solved (Knowledge, basic level)

The instructor shall:

- 7.3.1 Give examples of and explain the challenges when assembling components:
 - a. Foundation alignment
 - b. Tower-Tower alignment
 - c. Yaw alignment.



7.3.2 Facilitate discussions about how the challenges mentioned above can be mitigated and solved.

The participants shall:

7.3.3 Engage in discussions about how the challenges mentioned above can be mitigated and solved.

Lesson 8 - PRINCIPLES OF MECHANICAL COMPLETION

75 min.

The aim of this lesson is to give participants basic knowledge of mechanical completion.

ELEMENT 8.1 - INTRODUCTION TO MECHANICAL COMPLETION

Learning objective:

66) The participants can **recognise** the principles and application of, and the reason for, mechanical completion (Knowledge, basic level)

The instructor shall:

8.1.1 Explain that there are mechanical tasks to be completed in the turbine after the main components have been installed.

ELEMENT 8.2 - EXAMPLES OF MECHANICAL COMPLETION

Learning objectives:

67) The participants can **apply** the required documentation on a checklist for the mechanical completion of partly complete WTG (Skills, intermediate level)

68) The participants can **describe** the requirement to take photographs if they see something wrong to help document the problem (Knowledge, basic level)

69) The participants can **recognise** examples of the mechanical tasks that need to be completed after the installation of the main components (Knowledge, basic level)

The instructor shall:

8.2.1 Describe examples of the mechanical tasks that need to be completed after the installation of the main components - i.e. alignment, cleaning, conservation, turbine walkdown.

8.2.2 Facilitate practice for the participants to document on a checklist the mechanical completion of a partly complete WTG

8.2.3 Ask the participants relevant questions about the requirement to take photographs if they see something wrong to help document the problem.



The participants shall:

- 8.2.4 Practice documenting on a checklist the mechanical completion of a partly complete WTG (aids to be used: images, video, 3D or VR)
- 8.2.5 Describe in their own words and share understandings about the requirement to take photographs if they see something wrong to help document the problem.

The instructor shall:

- 8.2.6 Give constructive feedback on the participants' documentation in a checklist of the mechanical completion of a partly complete WTG

ELEMENT 8.3 - RISKS AND HAZARDS ASSOCIATED WITH MECHANICAL COMPLETION

Learning objectives:

- 70) The participants can **discuss** risks and hazards associated with mechanical completion and possible ways to mitigate these risks and hazards (Knowledge, intermediate level)
- 71) The participants can **describe** the importance of appropriate isolation/locking techniques (Knowledge, basic level)
- 72) The participants can **describe** the correct PPE for mechanical completion (Knowledge, basic level)

The instructor shall:

- 8.3.1 Describe examples of different risks and hazards associated with mechanical completion (i.e. platforms not mounted yet)
- 8.3.2 Facilitate group discussions about the risks and hazards associated with mechanical completion, and how these risks and hazards can be mitigated
- 8.3.3 Facilitate discussions about the importance of appropriate isolation/locking techniques and the correct PPE

The participants shall:

- 8.3.4 Engage in a group discussion about the hazards associated with mechanical completion
- 8.3.5 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 8.3.6 Engage in discussions about the correct PPE.

The instructor shall:

- 8.3.7 Give constructive feedback on the participants' group discussion about the hazards associated with mechanical completion



Lesson 9 - PRINCIPLES OF ELECTRICAL COMPLETION, INCLUDING CABLE WORK

420 min.

The aim of this lesson is to give participants basic knowledge and practical skills for electrical completion, including the principles and standards for handling and installing cables.

ELEMENT 9.1 - INTRODUCTION TO ELECTRICAL COMPLETION

Learning objective:

73) The participants can **recognise** electrical completion principles and application (Knowledge, basic level)

The instructor shall:

9.1.1 Explain the electrical tasks to be completed in the turbine after the main components have been installed.

ELEMENT 9.2 - EXAMPLES OF ELECTRICAL COMPLETION

Learning objective:

74) The participants can **describe** examples of tasks related to electrical completion (Knowledge, basic level)

The instructor shall:

9.2.1 Give examples of and describe electrical tasks that need to be completed after the installation of the main components:

- a. Preparing lights
- b. Installing ventilators
- c. Installing safety systems (aviation lights)
- d. Installing tower section cables
- e. Routing of cables
- f. Termination of cables.

9.2.2 Ask the participants relevant questions about examples of tasks related to electrical completion

The participants shall:

9.2.3 Describe in their own words and share understandings about examples of tasks related to electrical completion



ELEMENT 9.3 - RISKS AND HAZARDS ASSOCIATED WITH HANDLING AND WORKING WITH CABLES

Learning objectives:

- 75) The participants can **discuss** the risks and hazards associated with electrical completion (Knowledge, intermediate level)
- 76) The participants can **discuss** the risks and hazards associated with cable work inside the tower (Knowledge, intermediate level)
- 77) The participants can **recognise** that the incorrect use of cutting and crimping tools could cause personal injury (Knowledge, basic level)
- 78) The participants can **recognise** that the incorrect use of cutting and crimping tools could lead to damage to the insulation or a poor connection, resulting in serious damage such as fire (Knowledge, basic level)
- 79) The participants can **describe** the importance of appropriate isolation/locking techniques (Knowledge, basic level)
- 80) The participants can **describe** the correct PPE for electrical completion (Knowledge, basic level)

The instructor shall:

- 9.3.1 Facilitate group discussions on the risks and hazards associated with electrical completion
- 9.3.2 Explain that the incorrect use of cutting and crimping tools could cause personal injury
- 9.3.3 Facilitate group discussions on the risks associated with the installation of cables inside tower and the hoisting/lowering of cables
- 9.3.4 Explain that the incorrect use of cutting and crimping tools could lead to damage to the insulation or a poor connection, resulting in serious damage such as fire.
- 9.3.5 Facilitate discussions about the importance of appropriate isolation/locking techniques and the correct PPE

The participants shall:

- 9.3.6 Engage in a group discussion about the hazards associated with the electrical completion - i.e. the use of the correct tools in a safe manner to avoid injury or damage
- 9.3.7 Engage in a group discussion about the risks and hazards associated with cable work inside the tower
- 9.3.8 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 9.3.9 Engage in discussions about the correct PPE.

The instructor shall:

- 9.3.10 Give constructive feedback on the participants' group discussions about the hazards associated with electrical completion, and the risks and hazards associated with cable work inside the tower



ELEMENT 9.4 - DIFFERENT TYPES OF CABLES

Learning objective:

- 81) The participants can **identify** and **explain** the purpose and application of different types of cables - i.e. small signal, main power (LV&HV) and fibre optic cables (Knowledge, intermediate level)

The instructor shall:

- 9.4.1 Show examples of and explain different types and purposes of cables:
- Small signal cables: shielded and unshielded, rubber, PVC, cable glands
 - Main power (HV&LV) cables: copper, aluminium, rubber and PVC insulation types
 - Fibre optic cables: glass core, plastic core.
- 9.4.2 Ask the participants relevant questions about the purposes and application of the different cable types in the WTG.

The participants shall:

- 9.4.3 Explain in their own words and share understandings about the purposes and application of the different cable types in the WTG.

The instructor shall:

- 9.4.4 Give constructive feedback on the participants' explanations of the purposes and application of the different cable types in the WTG.

ELEMENT 9.5 - SIMPLE INSTALLATION DIAGRAMS

Learning objective:

- 82) The participants can **perform** the installation of cables by following simple installation diagrams (Skills, intermediate level)

The instructor shall:

- 9.5.1 Explain and demonstrate how to use simple electrical diagrams to mount cables (i.e. installation of lights) by identifying:
- Colour and numbering codes (explain that there should be a reference to applicable local standards: i.e. ISO or ANSII and also company-specific Work Instructions)
 - Cable list (explain that there should be a reference to applicable local standards: i.e. ISO or ANSII and also company-specific Work Instructions)
 - Cable core list.



- 9.5.2 Facilitate practice for the participants in reading a simple electrical diagram, cable list and cable core list in order to complete installation of simple components (i.e. light sources or fans)

The participants shall:

- 9.5.3 Practice reading a simple electrical diagram, cable list and cable core list in order to complete installation of simple components (i.e. light sources or fans)

The instructor shall:

- 9.5.4 Give constructive feedback on the participants' reading of a simple electrical diagram, cable list and cable core list in order to complete installation of simple components

ELEMENT 9.6 - CUTTING AND CRIMPING OF CABLES

Learning objective:

- 83) The participants can **perform** the cutting and crimping of small signal and main power LV cables (Skills, intermediate level)

The instructor shall:

- 9.6.1 Explain the different types and purposes of tools used for cutting and crimping cables:
- Knives and special cutting tools
 - Stripping tools to remove cable insulation
 - Crimping tools for signal cables and main cables: manual and hydraulic tools.
- 9.6.2 Explain and demonstrate how to cut and crimp small signal cables
- Shielded and unshielded
 - Rubber and PVC insulation types
- 9.6.3 Explain and demonstrate how to cut and crimp main power (LV) cables
- Copper and aluminium (special attention to correct cable die-set)
 - Rubber and PVC insulation types
 - Install heat/cold shrink tube on top of cable and cable lug after cable lug has been crimped.
- 9.6.4 Facilitate practice for the participants in cutting and crimping small signal cables and main power (LV) cables

The participants shall:

- 9.6.5 Practice cutting and crimping small signal cables:
- Shielded and unshielded



- b. Rubber and PVC insulation types
- c. Install heat/cold shrink tube on top of cable and cable lug after cable lug has been crimped.

9.6.6 Practice cutting and crimping main power (LV) cables:

- a. Copper and aluminium (special attention to the correct cable die-set)
- b. Rubber and PVC insulation types.

The instructor shall:

- 9.6.7 Give constructive feedback on the participants' cutting and crimping of small signal and main power LV cables

ELEMENT 9.7 - MARKING, ROUTING AND TERMINATION OF ALL CABLE TYPES

Learning objectives:

- 84) The participants can **describe** typical faults during termination, and ways to mitigate these typical faults (Knowledge, basic level)
- 85) The participants can **perform** the marking, routing and termination of all cable types (Skills, intermediate level)

The instructor shall:

- 9.7.1 Show examples of and explain different types of marking and their purposes for all cable types:
 - a. Cable and conductor
 - b. Cabinet (diagram)
- 9.7.2 Show examples of and explain important factors when routing all cable types (inform participants to refer to work instructions for the specifics):
 - a. Bending radius (why a minimum is important)
 - b. Not twisted
 - c. Distance between cables types and groups
 - d. Fastening of cables: fixed vs flexible
 - e. Cable protection tubes or edge protection
 - f. Cable glands.
- 9.7.3 Show examples of and explain important factors when handling fibre optic cables:
 - a. Handle with care due to fragility (lower it individually, do not combine with other cables when handling)
 - b. Excess cable should not be cut out, but coiled



- c. How to bend (coil bending radius) in accordance with work instructions
- d. End protection caps are only to be removed just before the cable is connected to the individual processor.

9.7.4 Demonstrate how to perform termination on signal cables

- a. Mounting of ferrules
- b. Mounting in clamp and screw terminals
- c. Shield termination types.

9.7.5 Demonstrate how to perform termination on main power cables (copper/aluminium)

- a. Mounting of cable lugs on busbar (correct torque)
- b. Mounting of cable to connectors (correct torque)

9.7.6 Facilitate discussions about typical faults during termination

9.7.7 Facilitate practice for the participants to mark, route and terminate all cable types

The participants shall:

9.7.8 Engage in discussions about typical faults during termination:

- a. Insulation in terminal & loose cores
- b. In correct torque – generates heat
- c. Poor crimping – all kinds of scenarios.

9.7.9 Practice mounting markings in accordance with an electrical diagram:

- a. Cable and conductor
- b. Cabinet (diagram)

9.7.10 Practice routing all cable types applying these factors:

- a. Bending radius
- b. Distance between cables types and groups
- c. Fastening of cables: fixed vs flexible
- d. Cable protection tubes or edge protection
- e. Cable glands.

9.7.11 Practice routing fibre optic cables

9.7.12 Practice correctly terminating signal cables:

- a. Mounting of ferrules
- b. Mounting in clamp and screw terminals
- c. Shield termination types.



9.7.13 Practice correctly terminating main power cables (copper/aluminium):

- a. Mounting of cable lugs on busbar (correct torque)
- b. Mounting of cable to connectors (correct torque)

The instructor shall:

9.7.14 Give constructive feedback on the participants' marking, routing and termination of all cable types

Lesson 10 - PRINCIPLES OF HYDRAULIC COMPLETION

40 min.

The aim of this lesson is to give participants basic knowledge of hydraulic completion.

ELEMENT 10.1 - INTRODUCTION TO HYDRAULIC COMPLETION

Learning objective:

- 86) The participants can **recognise** the principles and application of hydraulic completion (Knowledge, basic level)

The instructor shall:

10.1.1 Explain that there are hydraulic tasks to be completed in the turbine after the main components have been installed.

ELEMENT 10.2 - EXAMPLES OF HYDRAULIC COMPLETION

Learning objectives:

- 87) The participants can **describe** examples of topics during pre-assembly and installation while performing hydraulic completion (Knowledge, basic level)
- 88) The participants can **describe** the importance of following the work instructions (Knowledge, basic level)
- 89) The participants can **describe** the importance of cleanliness (Knowledge, basic level)

The instructor shall:

- 10.2.1 Show examples of and describe hydraulic tasks that need to be completed after the installation of the main components:
- a. Mounting of the hydraulics at the hub
 - b. Connecting the hydraulic rotating union



c. Mounting the hydraulic yaw brake (if present)

- 10.2.2 Ask the participants relevant questions about examples of topics during pre-assembly and installation while performing hydraulic completion
- 10.2.3 Explain the importance of following the work instructions (avoid leaks and breakdowns)
- 10.2.4 Explain the importance of cleanliness (most breakdowns are due to contamination)
- 10.2.5 Facilitate discussions about the importance of following the work instructions and cleanliness

The participants shall:

- 10.2.6 Describe in their own words and share understandings about examples of topics during pre-assembly and installation while performing hydraulic completion
- 10.2.7 Engage in discussions about the importance of following the work instructions (avoid leaks and breakdowns)
- 10.2.8 Engage in discussions about the importance of cleanliness (most breakdowns are due to contamination)

ELEMENT 10.3 - RISKS AND HAZARDS ASSOCIATED WITH HYDRAULIC COMPLETION

Learning objectives:

- 90) The participants can **discuss** the risks and hazards associated with hydraulic completion (Knowledge, intermediate level)
- 91) The participants can **recognise** how to react in case of hydraulic incident (hydraulic injures)
- 92) The participants can the **recognise** the importance of reporting and cleaning any oil spillage
- 93) The participants can **describe** the importance of appropriate isolation/locking techniques (Knowledge, basic level)
- 94) The participants can **describe** the correct PPE for hydraulic completion (Knowledge, basic level)

The instructor shall:

- 10.3.1 Show examples of and describe different risks and hazards associated with hydraulic completion (including possibility of pressure in accumulators)
- 10.3.2 Facilitate group discussions on the risks and hazards associated with hydraulic completion, and how these risks and hazards should be handled by the participants
- 10.3.3 Explain how to react in case of hydraulic incident (hydraulic injures)
- 10.3.4 Explain the importance of reporting and cleaning any oil spillage.
- 10.3.5 Facilitate discussions about the importance of appropriate isolation/locking techniques and the correct PPE

The participants shall:



- 10.3.6 Engage in a group discussion about the hazards associated with hydraulic completion
- 10.3.7 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 10.3.8 Engage in discussions about the correct PPE.

The instructor shall:

- 10.3.9 Give constructive feedback about the participants' group discussions about the risks and hazards associated with hydraulic completion, and how these risks and hazards should be handled by the participants

Lesson 11 - PRINCIPLES OF OPERATION WITH EXTERNAL GENERATORS

50 min.

The aim of this lesson is to give the participants an understanding of the principles of operating external generators during installation.

ELEMENT 11.1 - PRINCIPLES OF YAW, ROTOR AND BLADES OPERATION WITHOUT GRID-POWER

Learning objectives:

- 95) The participants can **recognise** why the operation of the auxiliary systems is needed (Knowledge, basic level)
- 96) The participants can **recognise** how to operate the auxiliary systems (Knowledge, basic level)
- 97) The participants can **supply** an electrical installation using auxiliary power instead of the main power supply (Skills, intermediate level)

The instructor shall:

- 11.1.1 Explain why the operation of the auxiliary systems is needed (Yaw systems, pitch, etc.)
- 11.1.2 Show examples of and describe how to operate the auxiliary systems (yaw, pitch, etc.)
- 11.1.3 Facilitate practice connecting the auxiliary power to an electrical system while ensuring the main power is disconnected

The participants shall:

- 11.1.4 Based on a work instruction, practice connecting the auxiliary power to an electrical system while ensuring the main power is disconnected (this is to simulate supplying a turbine with an external generator while the switchgear is disconnected)

The instructor shall:



- 11.1.5 Give constructive feedback on the participants' practice for connecting the auxiliary power to an electrical system while ensuring the main power is disconnected

ELEMENT 11.2 - RISKS AND HAZARDS ASSOCIATED WITH THE OPERATION OF AUXILIARY SYSTEMS WITH EXTERNAL GENERATORS

Learning objectives:

- 98) The participants can **discuss** the risks and hazards associated with the operation of auxiliary systems with an external generator and how these risks and hazards can be mitigated (Knowledge, intermediate level)
- 99) The participants can **describe** the importance of appropriate isolation/locking techniques (Knowledge, basic level)
- 100) The participants can **describe** the correct PPE (Knowledge, basic level)

The instructor shall:

- 11.2.1 Show examples of and describe the different risks and hazards associated with the operation of auxiliary systems without grid-power.
- 11.2.2 Facilitate group discussions on the risks and hazards associated with the operation of auxiliary systems without grid power, and how these risks and hazards can be mitigated.

The participants shall:

- 11.2.3 Engage in a group discussion about the risks and hazards associated with the operation of auxiliary systems without grid power, and how these risks and hazards can be mitigated
- 11.2.4 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 11.2.5 Engage in discussions about the correct PPE.

The instructor shall:

- 11.2.6 Give constructive feedback on the participants' group discussion about the risks and hazards associated with operation of auxiliary systems with an external generator, and how these risks and hazards can be mitigated

ELEMENT 11.3 - PRECONDITIONS FOR THE OPERATION OF LIFTS WITH AN EXTERNAL GENERATOR

Learning objectives:

- 101) The participants can **recognise** preconditions for the operation of a lift with an external generator (Knowledge, basic level)



- 102) The participants can **describe** the risks and hazards associated with operating the lift or being in the vicinity zone of the lift (Knowledge, basic level)
- 103) The participants can **describe** how to identify the requirements for operating, installing and certifying the lifts in accordance with the local legislation and company policies (Knowledge, basic level)

The instructor shall:

- 11.3.1 Explain the preconditions for the operation of a lift without grid-power, e.g.:
- The lift must be inspected and certified
 - Operators must be trained when applicable
- 11.3.2 Explain the risks and hazards associated with operating the lift or being in the vicinity zone of the lift.
- 11.3.3 Ask the participants relevant questions about the risks and hazards associated with operating the lift or being in the vicinity zone of the lift
- 11.3.4 Facilitate discussions about how to identify the requirements for operating, installing and certifying the lifts in accordance with the local legislation and company policies

The participants shall:

- 11.3.5 Describe in their own words and share understandings about the risks and hazards associated with operating the lift or being in the vicinity zone of the lift
- 11.3.6 Engage in discussions about how to identify the requirements for operating, installing and certifying the lifts in accordance with the local legislation and company policies.

ELEMENT 11.4 - PRECONDITIONS FOR THE OPERATION OF INTERNAL CRANES WITH AN EXTERNAL GENERATOR

Learning objectives:

- 104) The participants can **recognise** the intended use of the nacelle crane (Knowledge, basic level)
- 105) The participants can **recognise** examples of internal crane locations in the nacelle (Knowledge, basic level)
- 106) The participants can **recognise** the different main components of the nacelle crane (Knowledge, basic level)
- 107) The participants can **recognise** preconditions for the operation of an internal crane with an external generator (Knowledge, basic level)
- 108) The participants can **describe** the risks and hazards associated with operating the cranes or being within the lifting area (Knowledge, basic level)
- 109) The participants can **describe** the requirements for operating, installing and certifying the cranes in accordance with the local legislation and company policies (Knowledge, basic level)



The instructor shall:

- 11.4.1 Explain the intended use of the nacelle crane
- 11.4.2 Show examples of internal crane locations in the nacelle
- 11.4.3 Show examples of and explain the different main components of a nacelle crane
- 11.4.4 Explain the preconditions for the operation of a crane without grid power, e.g.:
 - a. The internal and transition piece crane must be inspected and certified
 - b. Operators must be trained when applicable
- 11.4.5 Explain the risks and hazards associated with operating the cranes or being within the lifting area.
- 11.4.6 Ask the participants relevant questions about the risks and hazards associated with operating the cranes or being within the lifting area
- 11.4.7 Facilitate discussions about how to identify the requirements for operating, installing and certifying the cranes in accordance with the local legislation and company policies

The participants shall:

- 11.4.8 Describe in their own words and share understandings about the risks and hazards associated with operating the cranes or being within the lifting area
- 11.4.9 Engage in discussions about how to identify requirements for operating, installing and certifying the cranes in accordance with the local legislation and company policies.

ELEMENT 11.5 - USE OF EXTERNAL GENERATORS FOR OTHER AUXILIARY USES

Learning objectives:

- 110) The participants can **describe** the basic principles of using external generators for auxiliary systems (Knowledge, basic level)
- 111) The participants can **describe** the importance of ground connections and GFCIs/RCDs (Knowledge, basic level)
- 112) The participants can **describe** the need for a qualified person/s to put the external generator into operation (Knowledge, basic level)

The instructor shall:

- 11.5.1 Show examples of and explain uses for external generators to supply auxiliary equipment:
 - a. Tower lights and sockets
 - b. Containers
 - c. Tools



- 11.5.2 Ask relevant questions to the participants about the basic principles of using external generators for auxiliary systems
- 11.5.3 Facilitate a discussion on the importance of ground connections and GFCIs/RCDs
- 11.5.4 Facilitate a discussion on the need for a qualified person/s to put the external generator into operation

The participants shall:

- 11.5.5 Describe in their own words and share understandings about the basic principles of using external generators for auxiliary systems
- 11.5.6 Engage in discussions about the importance of ground connections and GFCIs/RCDs and the need for a qualified person/s to put the external generator into operation

Lesson 12 - INTRODUCTION TO HANDOVER TO COMMISSIONING

30 min.

The aim of this lesson is to give the participants basic knowledge of the handover to commissioning.

ELEMENT 12.1 - HANDOVER TO COMMISSIONING

Learning objectives:

- 113) The participants can **recognise** the term commissioning (Knowledge, basic level)
- 114) The participants can **recognise** handover/completion of the checklist (Knowledge, basic level)

The instructor shall:

- 12.1.1 Define the term commissioning
- 12.1.2 Explain the handover of a checklist to commissioning personnel

ELEMENT 12.2 - RISKS AND HAZARDS ASSOCIATED WITH HANDING OVER TO COMMISSIONING

Learning objective:

- 115) The participants can **discuss** the possible risks, hazards and consequences of the handing over to commissioning (Knowledge, intermediate level)

The instructor shall:

- 12.2.1 Explain the risks associated with handover to commissioning in terms of cost, project timeline and potential damage to components.



- 12.2.2 Show examples of and describe the risks and hazards that may lead to injury to personnel (e.g. incorrectly applied isolation procedures or forgotten tools)
- 12.2.3 Show examples of and describe the risks associated with the handover to commissioning in terms of cost, project timeline and potential damage to components if tasks are completed partially, incorrectly or their status incorrectly reported.
- 12.2.4 Facilitate group discussions on the risks and hazards associated with the handover to commissioning

The participants shall:

- 12.2.5 Engage in a group discussion about the risks and hazards to personnel involved in handover to commissioning as a consequence of tasks having been completed partially, incorrectly or their status incorrectly reported
- 12.2.6 Engage in a group discussion about the consequences for commissioning in terms of cost, project timeline and potential damage to components if tasks are completed partially, incorrectly or their status incorrectly reported.

The instructor shall:

- 12.2.7 Give constructive feedback on the participants' group discussions about the possible risks, hazards and consequences of the handover to commissioning

Lesson 13 - SUMMARY AND THEORETICAL TEST

50 min.

The aim of this lesson is to summarize the BTT Installation Module and to conduct a theoretical test with the participants.

ELEMENT 13.1 - SUMMARY

Learning objective:

- 116) The participants can **recall** the objectives that have been covered within this module

The instructor shall:

- 13.1.1 Summarise the BTT Installation Module referring to the objectives

ELEMENT 13.2 - THEORETICAL TEST

After having successfully completed this BTT Installation module, participants will be able to:

- Pass the final test



The instructor shall:

- 13.2.1 Introduce the test to the participants, explaining the rules to be followed during the test
- 13.2.2 Conduct the test with the participants

The participants shall:

- 13.2.3 Conduct the test (20 questions / 30 min)

The instructor shall:

- 13.2.4 Check the test results and give feedback to the participants about the test results
- 13.2.5 In the event that a participant fails the test, conduct an interview with the participant according to the 'Participant Performance Assessment' section.

Lesson 14 - TRAINING REVIEW

15 min.

The aim of this lesson is to enable the participants to reflect on and process their learning outcome and key takeaways from the module, aiming to achieve a high learning transfer from the module to his/her way of working.

ELEMENT 14.1 - TRAINING REVIEW

The instructor shall:

- 14.1.1 Re-present the overall aims and learning objectives of the module for the participants' comparison of their learning outcomes and the achievement of their previously stated expectations for the module

The participants shall:

- 14.1.2 Reflect on their learning outcome and key takeaways from the BTT Installation Module, aiming to achieve a high learning transfer from the module to his/her way of working, by means of e.g.:
 - a. Group discussions or walk & talk
 - b. Questions & answers in class, or where suitable

Note: The instructor may additionally conduct a local evaluation of the training.



ELEMENT 14.2 - FEEDBACK SESSION

The instructor shall:

- 14.2.1 Give overall feedback and feed forward on the participants' learning outcome inspired by the training as well as from the training-review-session.
- 14.2.2 Encourage the participants to examine and grow awareness of which specific elements in their own WTG type/WTG environment differ from the training scenario environment (to visualise and enhance learning transfer), and to discuss with colleagues about how the BTT content, methods and techniques are similar or different to the local specific conditions identified after the module completion.



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Annexes



ANNEX 1 - EQUIPMENT LIST

The equipment required for training must be available and must fulfil national legal requirements where applicable. The tools, materials and equipment are needed for the execution of the modules are listed in the following pages.

Any equipment used during the GWO training modules shall meet or exceed the minimum requirements of the national standards listed in table A3-1 to A3-4. When working in a country where there is no applicable national standard then the equipment shall meet or exceed the minimum requirements of the European standards.

Each participant shall have access to a tool kit which contains sufficient tools for them to be able to complete the exercises as detailed in the module.

Each participant shall be provided with PPE appropriate to the task they are performing.

Note: All equipment shall be maintained and where appropriate, inspected and tested in accordance with current national Standards/legislation and manufacturers' recommendations.

Note: There is no need to calibrate the tools as long as this is not compromising safety and the tools are maintained. In this case the tools must be tagged "NO CALIBRATION. ONLY FOR TRAINING" or similar, so that the user knows that the tools are only allowed to be used for training purposes.



1. BTT MECHANICAL MODULE

The following equipment is required during the entire duration of this BTT Mechanical Training to meet the needs of the BTT Mechanical Module:

- PPE suitable for mechanical work (mechanical gloves, safety goggles, safety shoes or boots and working clothing)
- Spanners (1 per two participants)
- Torque wrenches (at least two different ranges)
- Sockets
- Screwdrivers
- Hexagon (Allen) keys
- Feeler gauges (1 per two participants)
- Dial gauge (1 per two participants)
- Vernier Calliper (1 per two participants)
- Dial Test Indicators
- Brake disc
- Brake pad
- Mock up for bolt torque including various sets of bolts allowing torque and tension
- A simple cooling circuit (or part of it)
- A simple lubrication system (or part of it)
- Hydraulic tools for torque and tension with electrical pumps
- An impact gun

Any equipment used during this GWO training module shall meet or exceed the minimum requirements of the national standards in the country where the training is taking place. When working in a country where there is no applicable national standard then the equipment shall meet or exceed the minimum requirements of the European standards.



2. BTT ELECTRICAL MODULE

The following equipment is required during the entire duration of this BTT Electrical Training to meet the needs of the BTT Electrical Module.

- PPE suitable for electrical work (Insulating gloves (at least one pair per two participants), goggles, safety shoes or boots and suitable clothing)
- LOTO equipment

Measuring devices:

- Multimeter (at least 1 per two participants)
- Two Pole voltage detector (at least 1 per 6 participants)

There must be a panel with standard DIN rail for mounting an electrical circuit (1 per two participants) and the following components:

- Power supply or transformer and a bridge rectifier
- Electrical protection
- Appropriate electrical wires
- Different value resistances
- Lamps
- Switches
- Capacitors
- Diodes
- Terminals for rail
- Push buttons (NO and NC)
- Contactors
- Relays
- Emergency stop button
- PT 100 sensor

Any equipment used during this GWO training module shall meet or exceed the minimum requirements of the national standards in the country where the training is taking place. When working in a country where there is no applicable national standard then the equipment shall meet or exceed the minimum requirements of the European standards.



3. BTT HYDRAULIC MODULE

The following equipment is required during the entire duration of this BTT Hydraulics Training to meet the need of the BTT Hydraulics Module:

- PPE suitable for hydraulic work (Gloves, safety goggles, safety shoes or boots and suitable clothing or overalls)
- LOTO equipment
- Filling kit for nitrogen
- Nitrogen bottle
- Pressure gauge/manometer

There must be a rig with pre-built electrical control of a hydraulic circuit that contains the following components:

- Tank with level indicator
- Pump with electrical motor
- Directional valve
- Needle valve
- Pressure relief valve
- Non-return valve
- Pressure switch
- Actuator
- Accumulator
- Test points
- Oil
- Filters

Any equipment used during this GWO training module shall meet or exceed the minimum requirements of the national standards in the country where the training is taking place. When working in a country where there is no applicable national standard then the equipment shall meet or exceed the minimum requirements of the European standards.



4. BTT INSTALLATION MODULE

The following equipment is required during the entire duration of this training to meet the needs of the BTT Installation Module:

- PPE suitable for installation work (gloves, safety goggles, safety coverall goggles that can be worn on top of prescription glasses), safety shoes or working boots and protective work clothing)
- Spanners
- Torque wrenches
- Sockets
- Screwdrivers
- Cable ties
- Heat shrinks / cold shrinks
- Hexagon (Allen) keys
- Tool set for cutting, stripping and crimping small cables (smaller than 6mm²) – 1 set for 2 participants
- Tool set for cutting and stripping main cables (massive & core conductors, bigger than 35mm²) – 1 set for 2 participants
- Tool set for crimping wires bigger than 35mm² (electric or electro-hydraulic) – 1 set for 4 participants
- Log Out Tag Out kit (this kit should not be required if not needed considering the setup available for the practices)
- Mock-up for cable work including:
 - a. Electrical cabinets with standard DIN rails for mounting terminals (clamp, screw type)
 - b. Clamp, screw type terminals
 - c. Cable glands
 - d. Cable trays
 - e. Bus bars (copper) with holes to connect cables with cable lugs

Any equipment used during this GWO training module shall meet or exceed the minimum requirements of the national standards in the country where the training is taking place. When working in a country where there is no applicable national standard then the equipment shall meet or exceed the minimum requirements of the European standards.



ANNEX 2 - VERSION HISTORY

Amendment Date	Oct. 2020	Approved by & date	
Version	5.1	Description of changes	
<ul style="list-style-type: none"> - GWO Standard updated to match the Corporate Visual identity of GWO (CVI) - Each module now contains a cover page and the module name listed in the header as reference. - New ISO Code added to standard - All previous versions of the Change log have now been moved to Annex XX. The current change log remains at the start of the standard. - Duplicate information removed from Section 4. Scope <p>The following sections have been removed due to this information now included in the new Requirements for Training Providers and Requirements for Certification Bodies (released May 2020)</p> <p>Section 5</p> <ul style="list-style-type: none"> - 5.4 Conformity with other training – section removed - 5.5 Legal Requirements – Section Removed <p>Section 6</p> <ul style="list-style-type: none"> - 6.1 Instructors – section removed - 6.3 Facilities and Equipment – section removed - 6.5 Theoretical training facilities – section removed <p>Section 8</p> <ul style="list-style-type: none"> - 8.1 Administrative arrangements – section removed - 8.4 Requirement to upload training record in WINDA – section removed (course Codes have now been moved to section 5.6) - 8.4 Training Providers own Records and Certificates issue – section removed <p>Annex 1</p> <ul style="list-style-type: none"> - Participant Performance Assessment Form – Section removed <p>Annex 2</p> <ul style="list-style-type: none"> - Medical Assessment Form – Section removed <p>All section reference numbers have now been updated</p>			



Amendment Date	October 2019	Approved by & date	
Version	5	Description of changes	
<ul style="list-style-type: none"> - Formatting changes throughout including numbering of all sections. - Equipment list for modules moved to Annex 3. - No content changes to lessons. 			

Amendment Date	March 2019	Approved by & date	
Version	5	Description of changes	
<p>Taxonomy alignment throughout</p> <p>Content changes</p> <ul style="list-style-type: none"> - Participant performance assessment updated with 'each module' to allow participants to pass the individual modules & time allowed for each question increased to 1.5 minutes. <p>Mechanical Module</p> <ul style="list-style-type: none"> - Element 3.4.2 inserted 'Explain the importance ...' - Element 3.4.4 inserted 'describe typical examples ...' - Element 5.2.1 inserted 'explain types of tools ...' - Element 5.2.1 & 5.2.2 inserted importance of pre-use check - Element 5.3.1 & 5.3.2 swapped to make chronological sense - Element 5.4.1 changed to 'function of feeler gauges' - Element 5.5.1 changed to 'function of callipers' - Element 5.6.1 changes to 'function of dial gauges' - Element 6.1.2 & 6.1.4 inserted 'how to inspect hydraulic ...' <p>Electrical Module time changes (not affecting overall module duration)</p> <ul style="list-style-type: none"> - Introduction to electricity reduced from 90 to 70 min. - Electric circuits increased from 80 to 120 min. - Electric components reduced from 120 to 100 min. <p>Electrical module content change</p> <ul style="list-style-type: none"> - Element 3.1.2 inserted 'the importance of working to ...' - Element 3.2.3 inserted megohmmeter as a source of HV danger - Element 3.2.4 inserted 'the requirement for HV training' - Element 3.3.3 inserted 'not all circuits protected by RCD' - Lesson 4 LO's removed demonstrate to lesson 6 - Element 4.6.5, 4.7.5 & 4.8.6 moved to lesson 6 - Lesson 7 LO 2 added PT100 and Bridge rectifier (moved from lesson 4) - Element 7.2.2 wording change - Element 3.8.1 Inserted 'explain ... emergency stop' - Element 3.8.2 Inserted 'describe typical ...' - Element 3.8.3 Inserted 'explain that emergency...' <p>Hydraulic module time changes (Not affecting overall module duration)</p> <ul style="list-style-type: none"> - Lesson 2 increased from 25 to 30 minutes - Lesson 10 reduced from 45 to 40 minutes 			



Hydraulic module content changes

- Element 2.1.2 Inserted 'explain the relationship...'
- Element 3.1.2 Inserted 'according to approved WI'
- Element 3.2.3, 3.2.4 Inserted 'emergency stop buttons'

Element 3.3.3 Inserted 'the risks associated with trapped pressure.'

Amendment Date	2018	Approved by & date	
Version	4	Description of changes	
New module 'Installation' developed and inserted.			

Amendment Date	2017	Approved by & date	
Version	3	Description of changes	
<p>Content changes</p> <ul style="list-style-type: none"> - New name: Basic Technical Training (replaces Basic Maintenance Training) to reflect a wider target group for the standard - New intro "Scope" replaces "Foreword and Editorial" - General: new section on "Understanding GWO Learning Objectives" incl. Taxonomy Table - General: new section on "Conformity with other training" section added - Entire course duration shorter (at least 31 hrs and 20 min contact time.) due to elimination of various redundant content and rearrangement of multiple objectives, lessons and elements - BTT now organised as three separate modules, and requires upload of 1 record per module to allow for greater flexibility - Module timetables are specified as approximations, as long as the total duration is not reduced, and practical elements are not reduced in length - If all three modules are delivered as a single training, introductory elements and evaluation elements may be combined - New lesson for Hydraulic tightening tools - Control Measure Form modified - Handout requirement included - Requirements for the test - Duplicated sensors removed - List of Definitions to avoid different interpretations by training providers <p>Major editing and layout changes: All redundant generic requirements placed in general sections of standard, and deleted from each of the module descriptions, including:</p> <ul style="list-style-type: none"> - Table of content - List of abbreviations - Target group - Legal requirements 			



- Overview

Amendment Date	October 2016	Approved by & date	
Version	2	Description of changes	
<ul style="list-style-type: none"> - Participant prerequisites - Added prerequisite for Participants to possess a personal WINDA ID and provide it to the Training Provider prior to completing the course. - Changed certification requirement from issuing a certificate to instead upload a record of training to WINDA. <p>Changed requirement from handing out certificates to Participants to instead ensure that Participants have provided their WINDA ID.</p>			