



Basic Technical Training (BTT)

V9

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CONTENTS

1.	LIST OF ABBREVIATIONS.....	5
2.	TERMS AND DEFINITIONS.....	6
3.	CHANGE LOG.....	8
4.	SCOPE.....	10
5.	GENERAL REQUIREMENTS FOR THE BASIC TECHNICAL TRAINING	10
5.1	Overview	10
5.2	Target Group	11
5.3	Aims and Objectives	11
5.4	Duration of the Basic Technical Training Standard Modules	11
5.5	Validity Period	12
5.6	Course Codes	13
5.7	Participant Prerequisites	13
5.8	Instructor Qualification Prerequisites	13
6.	GENERAL RESOURCES REQUIRED TO DELIVER THE BTT MODULES	13
6.1	Practical Training Facilities	14
6.2	Handouts	14
7.	USING THIS STANDARD TO DEVELOP TRAINING	14
8.	ADMINISTRATION AND CERTIFICATION OF MODULES	14
8.1	Participant Performance Assessment	14
9.	THE BTT MECHANICAL MODULE	18
9.1	Aims and Objectives for the BTT Mechanical Module	18
9.2	Duration of the BTT Mechanical Module	18
9.3	BTT Mechanical Module Participant Ratio	19
9.4	Equipment for the BTT Mechanical Module	19
9.5	BTT Mechanical Module Timetable	19
9.6	Detailed Description of the BTT Mechanical Module	21
	Lesson 1 - Introduction	21
	Lesson 2 - Mechanical Introduction	25
	Lesson 3 - Mechanical Safety.....	28
	Lesson 4 - The Principles of Bolted and Welded Connections.....	31
	Lesson 5 - Use of Manual Tightening and Measuring Tools	34
	Lesson 6 - Gearbox.....	38



Lesson 7 - Braking Systems	40
Lesson 8 - Yaw System.....	42
Lesson 9 - Cooling System	43
Lesson 10 - Lubrication System	45
Lesson 11 - Summary and Theoretical Test	48
Lesson 12 - Training Review	49
10. THE BTT ELECTRICAL MODULE	51
10.1 Aims and Objectives of the BTT Electrical Module	51
10.2 Duration of the BTT Electrical Module	51
10.3 BTT Electrical Module Participant Ratio	52
10.4 Equipment for the BTT Electrical Module	52
10.5 BTT Electrical Module Timetable	52
10.6 Detailed Description of the BTT Electrical Module	54
Lesson 1 - Introduction	54
Lesson 2 - Introduction to Electricity	58
Lesson 3 - Electrical Safety	61
Lesson 4 - Electrical Components	67
Lesson 5 - Sensors	75
Lesson 6 - Electrical Circuits	77
Lesson 7 - Electrical Measuring Instruments.....	79
Lesson 8 - Summary and Theoretical Test	81
Lesson 9 - Training Review	82
11. THE BTT HYDRAULIC MODULE.....	85
11.1 Aims and Objectives of the BTT Hydraulic Module	85
11.2 Duration of the BTT Hydraulic Module	85
11.3 BTT Hydraulic Module Participant Ratio	86
11.4 Equipment	86
11.5 BTT Hydraulic Module Timetable	86
11.6 Detailed description of the BTT Hydraulic Module	88
Lesson 1 - Introduction	88
Lesson 2 - Hydraulic Introduction	93
Lesson 3 - Hydraulic Safety.....	94
Lesson 4 - Pumps.....	99
Lesson 5 - Actuators	101
Lesson 6 - Valves	102
Lesson 7 - Accumulators.....	108
Lesson 8 - Sensors	109
Lesson 9 - Pipes, Hoses and Connections	111
Lesson 10 - Oil and Filters	112
Lesson 11 - Hydraulic Diagrams	115



	Lesson 12 - Pressure Measuring Tools.....	117
	Lesson 13 - Summary and Theoretical Test.....	118
	Lesson 14 - Training Review	119
12.	THE BTT BOLT TIGHTENING MODULE.....	122
12.1	Aims and Objectives of the BTT Bolt Tightening Module	122
12.2	Duration of the Bolt Tightening Module	122
12.3	BTT Bolt Tightening Participant Ratio	122
12.4	Participant Prerequisites for the BTT Bolt Tightening Module	123
12.5	Developing Training Scenarios for this Module	123
12.6	Equipment	126
12.7	BTT Bolt Tightening Module Timetable	127
12.8	Detailed Description of the BTT Bolt Tightening Module	129
	Lesson 1 - Introduction	129
	Lesson 2 - Bolt Tightening in the Wind Industry.....	133
	Lesson 3 - Framing the Scenario: Bolt Torquing Using Energy Powered Tools.....	138
	Lesson 4 - Pre-Task Phase: Planning and Preparation	141
	Lesson 5 - The Task Phase: Safely and Correctly Torquing Bolts Using Electrical and Hydraulic Tools.....	147
	Lesson 6 - Post-task Phase: Pack Up and Review	152
	Lesson 7 - Framing the Scenario: Bolt Tensioning Using Energy Powered Tools.....	154
	Lesson 8 - Pre-Task Phase: Planning and Preparation	157
	Lesson 9 - The Task Phase: Safe and Correct Tensioning of Bolts Using Hydraulic Tools.....	162
	Lesson 10 - Post-Task Phase: Pack Up and Review.....	167
	Lesson 11 - Using Mechanical Handling Aids to Assist with Bolt Tightening Tasks.....	169
	Lesson 12 - Training Review	174
13.	THE BTT INSTALLATION MODULE.....	177
13.1	Aims and Objectives of the BTT Installation Module	177
13.2	Duration of the BTT Installation Module	177
13.3	BTT Installation Participant Ratio	178
13.4	Participant Prerequisites for the BTT Installation Module	178
13.5	Equipment	178
13.6	BTT Installation Module Timetable	178
13.7	Detailed Description of the BTT Installation Module	181
	Lesson 1 - Introduction	181
	Lesson 2 - Introduction to Installation	185
	Lesson 3 - General Procedures for Working Onsite with Installation	190
	Lesson 4 - Installation Environments.....	192
	Lesson 5 - Handling and Storing	193
	Lesson 6 - Lifting Operations.....	197
	Lesson 7 - Main Component Preparation, Pre-assembly and Assembly.....	200
	Lesson 8 - Principles of Mechanical Completion	203



Lesson 9 - Principle of Electrical Completion	206
Lesson 10 - Principles of Hydraulic Completion	213
Lesson 11 - Principles of Operation with External Generators	215
Lesson 12 - Introduction to Handover to Commissioning	220
Lesson 13 - Summary and Theoretical Test	221
Lesson 14 - Training Review	222
 ANNEX 1 - EQUIPMENT LIST	 225
ANNEX 2 - SCENARIO DOCUMENTS: BOLT TORQUING	232
ANNEX 3 - SCENARIO DOCUMENTS: BOLT TENSIONING	247
ANNEX 4 - VERSION HISTORY	261

1. LIST OF ABBREVIATIONS

BTT	Basic Technical Training
CO ₂	Carbone Dioxide
GWO	Global Wind Organisation
JSA	Job Safety Analysis
LOTO	Lock Out Tag Out
OEM	Original Equipment Manufacturer
PDR	Plan-Do-Review
PPE	Personal Protective Equipment
SWA	Safe Work Approach
TRA	Task Risk Assessment
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.

Term	Definition
Bolt Tightening	Refers to the practice of tightening a bolt and includes both torquing and tensioning.
Engage in discussions	Instructor has to create discussions involving the participants.
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.
Function	Purpose. What is it doing? What can it be used for?
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.
Hazard	A hazard is any source of potential damage, harm or adverse health effect on something or someone.
HV Bolt	The 'HV' mark comes from the German term 'Hochfest Vorgespannt' meaning high strength preloaded.
Installation	• Preparation • Pre-assembly • Assembly
Must	For clarity where the word 'must' is used in this standard it shall have the same meaning as 'shall'.
Operation	How does it work?
Plan-Do-Review	Refers to a job safety and quality management process and may have other names including, but not limited to, Job Safety Analysis, Safe Work Approach, Task Risk Assessment, Task Plan, etc.
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.



Scenario	Refers to a training method that uses fictive simulations to align learning performance with real world job performance.
Shall	Verbal form used to indicate requirements strictly to be followed in order to conform to this training standard and from which no deviation is permitted.
Should	Verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required.
Use	How to operate it? How to make it work?



3. CHANGE LOG

Amendment date	Version	Approved by & date	Description of changes
June 2024	9	GWO TC April 2024	

Changes Throughout

- Corrected total calculated time in table 5.4.1 and 11.5.1
- Spelling and grammar corrections
- Added title to table 5.4.4

BTT Mechanical Module:

Element 2.1 – Main components of the structure

- Added text to 2.1.1, point e: "and lightning protection".
- Added text to 2.1.2, point e: "and lightning protection".

Element 2.1 – Main mechanical systems

- Added text to 2.2.1, point f: "/converter.

Element 2.3 – How a turbine works:

- Added text to 2.3.1: "using all the components from 2.2.1"

BTT Electrical Module

Element 3.5 Static Electricity

- Added text to 3.5.1: "grounding of components and lightning protection systems."

Element 4.12 – Processor Control Systems

- Added text to learning objective 69: "and communication between components".
- Added text to 4.12.1: "and how the controls system communicates with components via copper signal cable, optical cable, or data cable."

Bolt Tightening Module:

Element 4.3 PLANNING FOR SAFETY

SS4.3.1 New letter bullet "I" added to both lists "Safety handles as prerequisite to perform operation"

Element 5.1 SETTING UP EQUIPMENT FOR USE



-
- SS5.1.1 New letter bullet "c" inserted (all subsequent bullets progress one) "Ensure safety handles are mounted for use"

Annex 1 BTT-B equipment list.

- Safety handles added to hydraulic torque tools bullet points x2
- Bolt Tensioning Scenario. Extra parentheses removed and misspelling corrected
- Bolt Tensioning Scenario. Bullet amended to "Mock up for bolt tensioning..."

Annex 2 GWO Manual for Bolt Torquing (For Training Purposed Only)

- Introduction. Safety. Sentence added "If no safety handle is present do not perform operation."

BTT Hydraulic Module

Element 10.2

- Changed element name to: "Element 10.2 - Collecting Oil and Grease sample".
 - Added text to 10.2.1: "or grease sample".
 - Added text to 10.2.2: "or grease sample".
 - Added text to 10.2.3: "or grease sample".
 - Added point 10.2.4: "Facilitate discussions about oil and grease cleanliness".
 - Added text to 10.2.5: "or grease sample".
-



4. SCOPE

Global Wind Organisation is a non-profit body founded by the wind turbine manufacturers and owners. Our members strive for an injury free work environment in the wind turbine industry, setting common international standards for safety training and emergency procedures.

This standard describes the requirements for Basic Technical Training modules that are recommended and endorsed by the members of GWO. The Standard comprises of five modules:

1. Mechanical
2. Electrical
3. Hydraulic
4. Bolt Tightening
5. Installation

This standard has been developed in response to the demand for recognisable 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 from G+ and the wind industry.

GWO members agree that everyone working on one of their properties (wind turbine generators, sub stations, etc.) shall complete Basic Technical Training courses and subsequent company specific training relevant for their assignments. All work shall be done in teams of at least two competent persons. Exemptions from the above can be made based on internal company rules.

General feedback on this document can be sent to info@globalwindsafety.org. See globalwindsafety.org on how to raise a complaint about a training provider or report a safety incident occurring during training.

5. GENERAL REQUIREMENTS FOR THE BASIC TECHNICAL 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 when working with energy powered bolt tightening 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 bolt tightening and installation modules are 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 5 modules:



- Module 1: Mechanical
- Module 2: Electrical
- Module 3: Hydraulic
- Module 4: Bolt Tightening
- Module 5: 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, or working with energy powered bolt tightening, 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 prepares participants for further company specific training by providing them with the necessary training to perform basic hydraulic, mechanical, electrical, bolt tightening and installation tasks.

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

5.4 Duration of the Basic Technical Training Standard Modules

The total contact time for completing the Basic Technical Training Standard is between *35 and 36 hours*. This is based on the times given in the module timetables and summarised in tables 5.4.1, 5.4.2 and 5.4.3 below.

The training provider must not exceed the time per day given in table 5.4.4 below.

Modules	Duration
Mechanical	8 hours 40 minutes
Electrical	9 hours 55 minutes
Hydraulic	8 hours 55 minutes
Bolt tightening	8 hours 0 minutes
TOTAL	35 hours 30 minutes

Table 5.4.1 - Duration of GWO Mechanical and Installation Modules

Modules	Duration
Mechanical	8 hours 40 minutes
Bolt tightening	8 hours 0 minutes



TOTAL	16 hours 40 minutes
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Table 5.4.2 – Duration of GWO Mechanical and Bolt Tightening Modules

Modules	Duration
Mechanical	8 hours 40 minutes
Installation	17 hours 40 minutes
TOTAL	26 hours 20 minutes

Table 5.4.3 – Duration of the CWO Mechanical and Installation Modules

	Maximum Duration Per Day
Contact time	8 hours
Total training day	10 hours

Table 5.4.4 - Maximum duration 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).

If a participant fails to meet the demands of a Basic Technical Training Module, they shall attend a new training in that module.

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 expectation 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, Bolt Tightening and Installation modules does not apply. This is based on the expectation 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 Bolt Tightening	BTTB
BTT Installation	BTTI

Table 5.6.1 – GWO BTT module course codes

5.7 Participant Prerequisites

All personnel participating must meet the participant prerequisites described in the GWO Requirements for Training.

There are additional prerequisites for both the Bolt Tightening and Installation modules:

- a. Before attending the BTT Bolt Tightening Module participants must first complete the BBT Mechanical Module.
- b. Before attending the BTT Installation Module participants must first complete both the BTT Mechanical and BTT Bolt Tightening modules.

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 Instructor Qualification Prerequisites

A competent GWO BTT instructor must adhere to the instructor requirements for GWO training.

6. GENERAL RESOURCES REQUIRED TO DELIVER THE BTT MODULES

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



6.1 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.

6.2 Handouts

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

- a. Electrical symbols mentioned in the BTT Standard
- b. Hydraulic symbols mentioned in the BTT Standard
- c. 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.

For the Bolt Tightening Module handouts (work instructions, manuals, PDAs and checklists) are found in Annexes 2 and 3. In circumstances where the training is being held on behalf of an OEM or owner operator, equivalent company specific documents may be used instead.

7. USING THIS STANDARD TO DEVELOP TRAINING

The training in this standard is designed around the GWO taxonomy described in the GWO Requirements for Training. Theoretical and practical activities must be delivered according to the defined taxonomic level in order to reach the described learning objectives.

When teaching about equipment, a generic approach to shall be applied aiming to avoid additional potential product specific formal training after completion of this training. However, national or regional legislation, company gap analysis and location specific risk assessments may require additional product specific familiarisation which is the responsibility of the duty holder.

In addition to this, all training based on this standard including all related resources shall, as a minimum, meet the requirements described in the GWO Requirements for Training.

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 the Hydraulic, Mechanical, Electrical and Installation modules according to the learning objectives (summative evaluation). The Bolt Tightening module does not require a written test, assessment of participant performance is conducted during practical exercises.



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
 - d. Participants may not use:
 - e. Mobile phones (except for calculator)
 - f. Wearables (e.g. google glasses)
 - g. Tablets
 - h. Internet browsers
 - i. Any other devices similar to those listed above

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.

Throughout each of the BTT modules, the instructor will use the participant performance assessment form (see annex 1 of the Requirements for Training) 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 outcome



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BTT Mechanical Module

(BTTM)



9. THE BTT MECHANICAL MODULE

9.1 Aims and Objectives for 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 complete this BTT Mechanical module, the participants will have the ability 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) **Recognise** the principles of a gearbox (Knowledge, basic level)
- 6) **Recognise** the function of the brake systems (Knowledge, basic level)
- 7) **Perform** inspection of brake systems (Skills, intermediate level)
- 8) **Recognise** the function of the yaw system and how to inspect it (Knowledge, basic level)
- 9) **Recognise** the function of the cooling system (Knowledge, basic level)
- 10) **Perform** inspection of the cooling system (Skills, intermediate level)
- 11) **Recognise** the function of the lubrication system (Knowledge, basic level)
- 12) **Perform** inspection of the lubrication system (Skills, intermediate level)

9.2 Duration of the BTT Mechanical Module

The total contact time for completing the BTT Mechanical module is 8 hours and 40 minutes.

The training provider must not exceed the time per day given in the table 9.2.1 below.

Maximum Duration Per Day	
Contact time	8 hours



Total training day	10 hours
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Table 9.2.1 – Maximum duration 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).

9.3 BTT Mechanical Module Participant Ratio

The ratio shown for theory sessions indicates the maximum number of participants per instructor attending the course.

Practical ratios indicate the maximum number of participants to be supervised by an instructor during each activity.

Module	Session	Instructor to Participant Ratio
BTT Mechanical	Theory	1:12
	Practical	1:8

Table 9.3.1 - Instructor to participant ratio

9.4 Equipment for the BTT Mechanical Module

The equipment required for training as listed in Annex 1 must be available and must fulfil national legal requirements.

9.5 BTT Mechanical Module Timetable

The order in which elements of this Module training are delivered may vary according to the didactical choices of the delivering training provider.

The delivery of this module must comply with the requirements described in the GWO Requirements for Training.

Lesson	Element		Duration
1. Introduction	1.1	Safety and emergency procedures	
	1.2	Facilities	
	1.3	Introduction	
	1.4	Aims and objectives	
	1.5	Ongoing assessment	



	1.6	Motivation	
	1.7	Human factors	
		TOTAL	30 min.
2. Mechanical introduction	2.1	Main components of the structure	
	2.2	Main mechanical systems	
	2.3	How a turbine works	
		TOTAL	60 min.
3. Mechanical safety	3.1	Why mechanical safety?	
	3.2	Safety signs	
	3.3	Types of PPE	
	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. Gearbox	6.1	The function and operating principles	
	6.2	Inspection of the gearbox	
		TOTAL	30 min.
7. Braking system	7.1	The function of the mechanical and aerodynamic brake	
	7.2	Inspection of the mechanical brake system	
		TOTAL	40 min.
8. Yaw system	8.1	The function of the yaw system	
	8.2	Inspection of the yaw system	



		TOTAL	30 min.
9. Cooling system	9.1	Components requiring cooling and why	
	9.2	Inspection of the cooling systems	
		TOTAL	30 min.
10. Lubrication system	10.1	Components requiring lubrication and why	
	10.2	Inspection of the lubrication systems	
		TOTAL	75 min.
11. Summary and theoretical test	11.1	Summary	
	11.2	Theoretical test	
		TOTAL	30 mins.
12. Training review	12.1	Training review	
		TOTAL	15 min.
		GRAND TOTAL	520 min.

Table 9.5.1 – BTT Mechanical module timetable

9.6 Detailed Description of the BTT Mechanical Module

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 having successfully completed this lesson, the participants can:

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



ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Learning objectives:

- 16) The participants can **recognise** the safety instructions, rules and emergency procedures (Knowledge, basic level)
- 17) 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:

- 18) 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:

- 19) 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 mealtimes
- 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 - AIMS AND OBJECTIVES

Learning objective:

- 20) 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:

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



ELEMENT 1.5 - ONGOING ASSESSMENTS

Learning objective:

- 21) 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:

- 22) 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 objective:

- 23) The participants can describe the relevant human factors and the implications thereof (Knowledge, basic level)
- 24) 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 - 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:

- 25) 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, blades and lightning protection
- 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, blades and lightning protection
- 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:

- 26) 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/converter
- 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.
- 2.2.3 Give constructive feedback on the participant groups' discussions



The participants shall:

- 2.2.4 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

ELEMENT 2.3 - HOW A TURBINE WORKS

Learning objective:

- 27) 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 using all components from 2.2.1
- 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.

Note Participants who have a valid CoHE certificate may omit this lesson

ELEMENT 3.1 - WHY MECHANICAL SAFETY

Learning objectives:

- 28) The participants can **discuss** the safety risks and hazards in mechanical systems (Knowledge, intermediate level)
- 29) 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)
- 3.1.5 Ask the participants relevant questions about safe working procedures, identifying the necessary PPE and appropriate tools when working with mechanics
- 3.1.6 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



The participants shall:

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

ELEMENT 3.2 - SAFETY SIGNS

Learning objectives:

- 30) The participants can **describe** different safety signs and their meanings (Knowledge, basic level)
- 31) 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:

- 32) 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



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:

- 33) The participants can **discuss** the importance of proper isolation when working with mechanics (Knowledge, intermediate level)
- 34) 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
- 3.4.4 Give constructive feedback on the participants' group discussion



The participants shall:

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

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 BOLTED CONNECTIONS

Learning objective:

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



The instructor shall:

- 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
 - e. Explain how bolt strength is proportional to the size of the bolt and dependent on material and quality
- 4.1.2 Explain the function of and types of washers
- 4.1.3 Explain the importance of bolt thread lubrication



- 4.1.4 Explain the importance of the same temperature for all set components
- 4.1.5 Define and explain torque and tension
- 4.1.6 Explain the principles of angular tightening
- 4.1.7 Show the importance of correct tightening (e.g. collapsing towers, electrical fires)
- 4.1.8 Facilitate group discussions on:
 - a. Bolts, threads, lubricants, strengths of materials and temperature influences
 - b. Force and torque
- 4.1.9 Give constructive feedback on the participant groups' discussions about bolted connections



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

ELEMENT 4.2 - THE LOCATIONS OF IMPORTANT BOLTED AND WELDED CONNECTIONS

Learning objective:

- 36) 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
- 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:

- 37) 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:

- 38) 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



- 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:

- 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

70 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:

- 39) 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



The participants shall:

- 5.1.2 Describe in their own words and share understandings about the metric system

ELEMENT 5.2 - SELECTING AND USING THE CORRECT MANUAL TIGHTENING TOOLS

Learning objectives:

- 40) The participants can **select** and apply the correct manual tightening tools (Skills, intermediate level)
- 41) 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)
- 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
- 5.2.7 Give constructive feedback on the participants' discussions about pre-use check on tools and the participants' selection and use of manual tightening tools



The participants shall:

- 5.2.8 Engage in a group discussion about the importance and performance of a pre-use check on tools
- 5.2.9 Practice selecting and using manual tightening tools

ELEMENT 5.3 - CORRECTLY SETTING AND USING A TORQUE WRENCH

Learning objectives:



- 42) The participants can **apply** a torque wrench correctly (Skills, intermediate level)
- 43) 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
- 5.3.5 Give constructive feedback on the participants' setting and use of torque wrenches



The participants shall:

- 5.3.6 Practice setting and using torque wrenches

ELEMENT 5.4 - FEELER GAUGES

Learning objectives:

- 44) The participants can **apply** feeler gauges (Skills, intermediate level)
- 45) The participants can **recognise** the importance of pre-use checks in terms of safety and quality (Knowledge, basic level)



The instructor shall:

- 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

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



The participants shall:

5.4.7 Practice the correct use and care of feeler gauges

ELEMENT 5.5 - CALLIPERS

Learning objectives:

46) The participants can **apply** a calliper (Skills, intermediate level)

47) 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)

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



The participants shall:

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

ELEMENT 5.6 - DIAL GAUGES

Learning objectives:

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



- 49) 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
- 5.6.6 Give constructive feedback on the participants use and care of a dial gauge



The participants shall:

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

LESSON 6 - GEARBOX

30 min.

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

ELEMENT 6.1 - FUNCTION AND OPERATING PRINCIPLES

Learning objectives:

- 50) The participants can **recognise** the function and operating principles of the gearbox (Knowledge, basic level)
- 51) The participants can **describe** the hazards associated with the gearbox (Knowledge, basic level)
- 52) The participants can **describe** the importance of appropriate isolation/locking techniques (Knowledge, basic level)
- 53) The participants can **describe** the correct PPE (Knowledge, basic level)



The instructor shall:

- 6.1.1 Explain the main function of the gearbox
- 6.1.2 Explain the operation of the gearbox
- 6.1.3 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:

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

ELEMENT 6.2 - INSPECTION OF THE GEARBOX

Learning objectives:

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



The instructor shall:

- 6.2.1 Explain the checking of hoses, and what to look for
- 6.2.2 Explain the checking of seals, and what to look for



- 6.2.3 Facilitate discussions on the importance of the right oil level and listening for abnormal noise from the gearbox



The participants shall:

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

LESSON 7 - BRAKING SYSTEMS

40 min.

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

ELEMENT 7.1 - THE FUNCTION OF THE MECHANICAL AND THE AERODYNAMIC BRAKES

Learning objectives:

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



The instructor shall:

- 7.1.1 Explain the function of the mechanical brake
- 7.1.2 Explain the function of the aerodynamic brake
- 7.1.3 Explain the consequences of them not functioning
- 7.1.4 Explain the operating principle of the mechanical brake
- 7.1.5 Explain the operating principle of the aerodynamic brake (e.g. stall, pitch etc.)



7.1.6 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:

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

7.1.8 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. risk of moving parts, pressurized systems)

7.1.9 Engage in discussions about the correct PPE

ELEMENT 7.2 - INSPECTION OF THE MECHANICAL BRAKE SYSTEM

Learning objective:

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



The instructor shall:

7.2.1 Explain how to check the disc surface for wear and scuffing due to excess friction

7.2.2 Explain how to check the disc brake pads for wear

7.2.3 Facilitate practice for the participants in checking the thickness of the brake pads and measuring the thickness of the brake disc

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



The participants shall:

7.2.5 Practice checking the thickness of the brake pads

7.2.6 Practice measuring the thickness of the brake disc



LESSON 8 - YAW SYSTEM

30 min.

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

ELEMENT 8.1 - THE FUNCTION OF THE YAW SYSTEM

Learning objectives:

- 62) The participants can **recognise** the function and operation of the yaw system (Knowledge, basic level)
- 63) The participants can **describe** the hazards associated with the yaw system (Knowledge, basic level)
- 64) The participants can **describe** the importance of appropriate isolation/locking techniques (Knowledge, basic level)
- 65) The participants can **describe** the correct PPE (Knowledge, basic level)



The instructor shall:

- 8.1.1 Explain the function of the yaw system
- 8.1.2 Explain the operation of the components in the yaw system (yaw motors, yaw gears, wind sensor, twist sensor and yaw bearing)
- 8.1.3 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:

- 8.1.4 Engage in discussions about the hazards associated with the yaw system



8.1.5 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)

8.1.6 Engage in discussions about the correct PPE

ELEMENT 8.2 - INSPECTION OF THE YAW SYSTEM

Learning objective:

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



The instructor shall:

8.2.1 Describe typical inspections tasks in the yaw system:

- a. Lubrication
- b. Torque
- c. Noise
- d. Brake pad and disc inspection

8.2.2 Ask the participants relevant questions about typical inspections tasks in the yaw system



The participants shall:

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

LESSON 9 - COOLING SYSTEM

30 min.

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

ELEMENT 9.1 - THE FUNCTION OF THE COOLING SYSTEM

Learning objectives:



- 67) The participants can **recognise** which components in a WTG have to be cooled and why (Knowledge, basic level)
- 68) The participants can **describe** the consequences of inadequate cooling (Knowledge, basic level)
- 69) The participants can **describe** the hazards associated with the cooling system (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:

- 9.1.1 Explain how heat is produced in the different systems and components (e.g. gearbox, generator, hydraulic system...)
- 9.1.2 Explain that heat can be transferred from component to component
- 9.1.3 Explain overheating problems
- 9.1.4 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:

- 9.1.5 Engage in discussions about the consequences of inadequate cooling
- 9.1.6 Engage in discussions about the hazards associated with the cooling systems
- 9.1.7 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 9.1.8 Engage in discussions about the correct PPE



ELEMENT 9.2 - INSPECTION OF THE COOLING SYSTEM

Learning objectives:

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



The instructor shall:

- 9.2.1 Explain how to perform a visual inspection of cooling systems (e.g. pin holes, cracks, cuts, friction marks, leaks)
- 9.2.2 Show the importance of checking the cooling liquid
- 9.2.3 Explain how to check the cleanliness of the heat exchanger
- 9.2.4 Show the importance of documenting any damage found
- 9.2.5 Facilitate practice for the participants in the visual inspection of cooling systems, and documenting the findings and the correct use of PPE
- 9.2.6 Give constructive feedback on the participants' visual inspection of cooling systems and documentation of the findings and correct use of PPE



The participants shall:

- 9.2.7 Practice the visual inspection of cooling systems and documenting the findings
- 9.2.8 Practice the correct use of PPE

LESSON 10 - LUBRICATION SYSTEM

75 min.



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

ELEMENT 10.1 - COMPONENTS REQUIRING LUBRICATION, AND WHY

Learning objectives:

- 76) The participants can **recognise** which components in a WTG must be lubricated and why (Knowledge, basic level)
- 77) The participants can **describe** the consequences of inadequate lubrication (Knowledge, basic level)
- 78) The participants can **describe** the hazards associated with lubrication systems (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 (Knowledge, basic level)



The instructor shall:

- 10.1.1 Explain why components need lubrication (e.g. gearbox, bearings...)
- 10.1.2 Explain how oil and grease reduce friction and lower the production of heat
- 10.1.3 Explain that oil and grease pumps can be used to keep the bearings, teeth, gears, etc. lubricated to reduce friction and corrosion
- 10.1.4 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:

- 10.1.5 Engage in discussions about the consequences of inadequate lubrication



- 10.1.6 Engage in discussions about the hazards associated with the lubricating 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 LUBRICATION SYSTEMS

Learning objectives:

- 81) The participants can **perform** the visual inspection of the lubrication system (Skills, intermediate level)
- 82) The participants can **recognise** the importance of ensuring the right amount and type of lubricant (Knowledge, basic level)
- 83) The participants can **recognise** the importance of documenting any damage found (Knowledge, basic level)
- 84) The participants can **use** the correct PPE for the inspection of the lubrication system (Skills, intermediate level)



The instructor shall:

- 10.2.1 Explain how to perform a visual inspection of lubrication systems (e.g. pin holes, cracks, cuts, friction marks, leaks)
- 10.2.2 Explain the importance of ensuring the right amount and type of lubricant (lubricant samples)
- 10.2.3 Show the importance of documenting any damage found
- 10.2.4 Facilitate discussions about the oil cleanliness rating and its impact on component performance
- 10.2.5 Facilitate practice for the participant in the visual inspection of lubricating systems, the documentation of the findings, and the correct use of PPE
- 10.2.6 Give constructive feedback on the participants' visual inspection of lubrication systems and documentation of the findings and correct use of PPE:



The participants shall:

- 10.2.7 Engage in discussions about the oil cleanliness rating and its impact on component performance



10.2.8 Practice visual inspection of lubricating systems, and document the findings

10.2.9 Practice the correct use of PPE

LESSON 11 - 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 11.1 - SUMMARY

Learning objective:

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



The instructor shall:

11.1.1 Summarise the BTT module, referring to the objectives.

ELEMENT 11.2 - THEORETICAL TEST

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

a. Pass the final test



The instructor shall:

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

11.2.3 Conduct the test with the participants

11.2.4 Check and give feedback about the participants' test result

11.2.5 In the event that a participant fails the test, conduct an interview with the participant according to "Participants Performance Assessment" section.



The participants shall:

11.2.6 Complete the test



LESSON 12 - 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 12.1 - TRAINING REVIEW



The instructor shall:

- 12.1.1 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:

- 12.1.2 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.:
- 12.1.3 Group discussions or walk & talk
- 12.1.4 Questions & answers in class, or where suitable

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

ELEMENT 12.2 - FEEDBACK SESSION



The instructor shall:

- 12.2.1 Give an overall feedback and feed forward on the participants' learning outcome inspired by the training as well as from the training-review-session.
- 12.2.2 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
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BTT Electrical Module

(BTTE)



10. 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 the BTT Electrical module is 9 hours and 55 minutes.

The training provider must not exceed the time per day given in the table 10.2.1 below.

	Maximum Duration Per Day
Contact time	8 hours
Total training day	10 hours

Table 10.2.1 - Maximum duration 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).



10.3 BTT Electrical Module Participant Ratio

The ratio shown for theory sessions indicates the maximum number of participants per instructor attending the course.

Practical ratios indicate the maximum number of participants to be supervised by an instructor during each activity.

Module	Session	Instructor to Participant Ratio
BTT Electrical	Theory	1:12
	Practical	1:8

Table 10.3.1 - Instructor to participant ratio

10.4 Equipment for the BTT Electrical Module

The equipment required for training as listed in Annex 1 must be available and must fulfil national legal requirements.

10.5 BTT Electrical Module Timetable

The order in which elements of this Module training are delivered may vary according to the didactical choices of the delivering training provider.

The delivery of this module must comply with the requirements described in the GWO Requirements for Training.

Lesson	Element	Duration
1. Introduction	1.1 Safety and emergency procedures	
	1.2 Facilities	
	1.3 Introduction	
	1.4 Aims and objectives	
	1.5 Ongoing assessment	
	1.6 Motivation	
	1.7 Human factors	
	TOTAL	30 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	70 min.



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			70 min.
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	Processors and control systems	
TOTAL			100 min.
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 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 mins.
9. Training review	9.1	Training review	
		TOTAL	15 min.
		GRAND TOTAL	595 min.

Table 10.5.1 – BTT Electrical module timetable

10.6 Detailed Description of the BTT Electrical Module

LESSON 1 - INTRODUCTION

30 min.

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:

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

ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Learning objectives:

- 10) The participants can **recognise** the safety instructions, rules and emergency procedures (Knowledge, basic level)



- 11) 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:
- 1.1.2 safety instructions according to internal procedures
- 1.1.3 emergency procedures and emergency exits in the areas where the participants can be expected to be located during the module



The participants shall:

- 1.1.4 Engage in answering the above questions

ELEMENT 1.2 - FACILITIES

Learning objective:

- 12) 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:

- 13) 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 mealtimes
- 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 - AIMS AND OBJECTIVES

Learning objective:

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



The instructor shall:

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



The participants shall:

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

ELEMENT 1.5 - ONGOING ASSESSMENTS

Learning objective:



- 15) 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:

- 16) 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:

- 17) The participants can **describe** the relevant human factors and the implications thereof (Knowledge, basic level)
- 18) 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:

- 19) 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
- 2.1.6 Give constructive feedback on the participants' explanations about what direct current is



The participants shall:

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

ELEMENT 2.2 - OHM'S LAW

Learning objectives:

- 20) The participants can **describe** the relationship between current, voltage and resistance (Knowledge, basic level)
- 21) 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
- 2.2.4 Give constructive feedback on the participants' use of Ohm's Law



The participants shall:

- 2.2.5 Engage in discussions on the relationship between current, voltage and resistance
- 2.2.6 Practice the use of Ohm's Law

ELEMENT 2.3 - ALTERNATING CURRENT

Learning objective:

- 22) 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
- 2.3.4 Give constructive feedback on the participants' explanations about what alternating current is



The participants shall:

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

ELEMENT 2.4 - ALTERNATING CURRENT/DIRECT CURRENT

Learning objective:

- 23) 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.
- 2.4.2 Give constructive feedback on the participants' group discussion about the difference between direct and alternating current



The participants shall:

- 2.4.3 Engage in a 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.

Note Participants who have a valid CoHE certificate may omit this lesson.

ELEMENT 3.1 - WHY ELECTRICAL SAFETY?

Learning objectives:

- 24) The participants can **explain** the dangers of electricity and the effects of electricity on the human body (Knowledge, intermediate level)
- 25) The participants can **recognise** the importance of Electrical Safety (Knowledge, basic level)
- 26) 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
- 3.1.6 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



The participants shall:

- 3.1.7 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
- 3.1.8 Engage in discussions about the relationship between current and contact time

ELEMENT 3.2 - LOW/HIGH VOLTAGE

Learning objectives:

- 27) The participants can **recognise** the definitions of low and high voltage (Knowledge, basic level)
- 28) The participants can **describe** the risks and hazards of low and high voltage (Knowledge, basic level)
- 29) The participants can **recognise** HV safety signs and HV restricted areas (Knowledge, basic level)
- 30) 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, megohmmeters, 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:

- 31) The participants can **explain** the function, importance and symbol of GFCI/RCD and PE (Knowledge, intermediate level)
- 32) The participants can **recognise** how to identify double isolated tools and that they do not require grounding (Knowledge, basic level)
- 33) 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)
- 34) The participants can **recognise** examples of and explain the symbol of GFCI/RCD and PE (Knowledge, basic level)
- 35) The participants can **recognise** that not all circuits on a wind turbine are protected by GFCI/RCD's (Knowledge, basic level)
- 36) The participants can **recognise** the relationship between current and contact time (Knowledge, basic level)
- 37) 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)
- 3.3.9 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



The participants shall:

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

ELEMENT 3.4 - STORED ENERGY

Learning objective:

- 38) 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:

- 39) 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, grounding of components and lightning protection systems
- 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:

- 40) 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:

- 41) 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
- 3.7.2 Give constructive feedback on the participants' practice of the usage of the required PPE for working with electricity



The participants shall:

- 3.7.3 Practice the usage of the required PPE for working with electricity

ELEMENT 3.8 - THE IMPORTANCE OF APPROPRIATE ISOLATION

Learning objectives:

- 42) The participants can **describe** why it is important to prevent unexpected start-up when working with electricity (Knowledge, basic level)
- 43) The participants can **discuss** the importance of proper isolation when working with electricity (Knowledge, intermediate level)
- 44) 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
- 3.8.6 Give constructive feedback on the participants' group discussion about the importance of appropriate isolation when working with electricity



The participants shall:

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

- 45) The participants can **describe** the function of resistors (Knowledge, basic level)
- 46) 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:

- 47) The participants can **describe** the function of batteries (Knowledge, basic level)
- 48) The participants can **recognise** batteries on a diagram (Knowledge, basic level)
- 49) 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:

- 50) The participants can **describe** the function of switches (Knowledge, basic level)



51) 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:

- 52) The participants can **describe** the function of contactors (Knowledge, basic level)
- 53) 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:

- 54) The participants can **describe** the function of relays (Knowledge, basic level)
- 55) 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:

- 56) The participants can **describe** the function of diodes (Knowledge, basic level)
- 57) 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:

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



The instructor shall:

- 4.7.1 Explain the function of bridge rectifiers
- 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:



- 60) The participants can **describe** the function of capacitors (Knowledge, basic level)
- 61) The participants can **recognise** capacitors on a diagram (Knowledge, basic level)
- 62) 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:

- 63) The participants can **describe** the function of transformers (Knowledge, basic level)
- 64) 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



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:

65) The participants can **describe** the function of generators and motors (Knowledge, basic level)

66) 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:

67) The participants can **describe** the function of fuses and circuit breakers (Knowledge, basic level)

68) 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:

- 69) The participants can **recognise** the function of the processor control system and its position in the diagram and communication between components (Knowledge, basic level)



The instructor shall:

- 4.12.1 Explain the function of a Wind Turbine Processor Control System and how the controls system communicates with components via copper signal cable, optical cable or data cable
- 4.12.2 Explain the position of the Wind Turbine Processor Control System in the circuit



The participants shall:

- 4.12.3 Describe in their own words and share understandings about the function of processor control systems



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:

70) 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
- 5.1.4 Give constructive feedback on the participants' explanations about the functions of sensors



The participants shall:

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

ELEMENT 5.2 - WIND SENSORS

Learning objectives:

- 71) The participants can **describe** the function of the wind sensors (Knowledge, basic level)
- 72) 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:

73) The participants can **describe** the function of a temperature sensor (Knowledge, basic level)

74) 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:

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



The instructor shall:

- 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:

- 76) 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:

- 77) 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
- 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
- 6.1.5 Give constructive feedback on the participants' explanations about the electrical components and how to interpret basic electrical diagrams



The participants shall:

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

ELEMENT 6.2 - ASSEMBLY OF AN ELECTRICAL CIRCUIT

Learning objective:

- 78) 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
- 6.2.3 Give constructive feedback on the above practice



The participants shall:

- 6.2.4 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
- 6.2.5 Practice the correct operation of the circuit

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:

- 79) The participants can **recognise** the symbols and settings used for current, voltage and resistance in the measuring instruments (Knowledge, basic level)
- 80) 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:

- 81) 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

7.2.2 Give constructive feedback on the participants above practice



The participants shall:

7.2.3 Practice the ability to measure voltage, current and resistance

7.2.4 Practice the ability to measure continuity

7.2.5 Practice the ability to measure a diode and a bridge rectifier

7.2.6 Practice the ability to measure a capacitor

7.2.7 Practice the ability to measure a PT100



ELEMENT 7.3 - MEASURING POINTS

Learning objectives:

- 82) The participants can **describe** measuring points in a physical circuit (Knowledge, basic level)
- 83) 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:

- 84) 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:

- a. Pass the final test



The instructor shall:

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



The participants shall:

- 8.2.6 Complete the test

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.:
- 9.1.3 Group discussions or walk & talk



9.1.4 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.



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11. 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 pre-charge 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 the BTT Hydraulic module is 8 hours and 55 minutes.

The training provider must not exceed the time per day given in the table 11.2.1 below.

Maximum Duration Per Day	
Contact time	8 hours



Total training day	10 hours
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Table 11.2.1 - Maximum duration 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).

11.3 BTT Hydraulic Module Participant Ratio

The ratio shown for theory sessions indicates the maximum number of participants per instructor attending the course.

Practical ratios indicate the maximum number of participants to be supervised by an instructor during each activity.

Module	Session	Instructor to Participant Ratio
BTT Hydraulic	Theory	1:12
	Practical	1:8

Table 11.3.1 - Instructor to participant ratio

11.4 Equipment

The equipment required for training as listed in Annex 1 must be available and must fulfil national legal requirements.

11.5 BTT Hydraulic Module Timetable

The order in which elements of this Module training are delivered may vary according to the didactical choices of the delivering training provider.

The delivery of this module must comply with the requirements described in the GWO Requirements for Training.

Lesson	Element		Duration
1. Introduction	1.1	Safety and emergency procedures	
	1.2	Facilities	
	1.3	Introduction	
	1.4	Aims and objectives	



	1.5	Ongoing assessment	
	1.6	Motivation	
	1.7	Human factors	
	TOTAL		30 min.
2. Hydraulic introduction	2.1	The hydraulic system	
	2.2	Pascal's law	
	TOTAL		30 min.
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	Pump exercise	
	TOTAL		30 min.
5. Actuators	5.1	Introduction to actuators	
	TOTAL		30 min.
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	Symbols and diagrams
	11.2	Identifying measuring points
TOTAL		45 min.
12. Pressure measuring tools	12.1	Pressure gauge/manometer
	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		555min.

Table 11.5.1 – BTT Hydraulic module timetable

11.6 Detailed description of the BTT Hydraulic Module

LESSON 1 - INTRODUCTION

30 min.

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:

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

ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Learning objectives:

- 17) The participants can **recognise** the safety instructions, rules and emergency procedures (Knowledge, basic level)
- 18) 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:

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:

- 19) 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 - AIMS AND OBJECTIVES

Learning objective:

- 20) 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:

- 21) 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:

- 22) 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:
- 1.6.2 the importance of personal involvement in the module
- 1.6.3 the need for the BTT Hydraulic Module when working in the wind industry



The participants shall:

- 1.6.4 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:

- 23) The participants can **describe** the relevant human factors and the implications thereof (Knowledge, basic level)
- 24) 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:

- 25) 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
- 2.1.5 Give constructive feedback on the participants' explanations about the function and principles of a basic hydraulic system



The participants shall:

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



ELEMENT 2.2 - PASCAL'S LAW

Learning objective:

- 26) 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
- 2.2.5 Give constructive feedback on the participants' application and discussion of the hydraulic power transmission / Pascal's Law



The participants shall:

- 2.2.6 Analyse and discuss 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.

Note Participants who have a valid CoHE certificate may omit this lesson.

ELEMENT 3.1 - WHY HYDRAULIC SAFETY

Learning objectives:

- 27) The participants can **discuss** the importance of hydraulic safety (Knowledge, intermediate level)



28) 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
- 3.1.5 Give constructive feedback on the participants' group discussions about the consequences of hydraulic incidents and hydraulic risks and hazards



The participants shall:

- 3.1.6 Engage in a group discussion about the consequences of hydraulic incidents (pressure, nitrogen...)
- 3.1.7 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

ELEMENT 3.2 - HIGH PRESSURE SYSTEMS

Learning objectives:

- 29) The participants can **recognise** what a pressure system is (Knowledge, basic level)
- 30) The participants can **describe** the importance of checking and relieving system pressure, including accumulators, before working on the system (Knowledge, basic level)
- 31) 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:

- 32) 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:

- 33) 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:

- 34) The participants can **discuss** the risks and hazards of oil in hydraulic systems (Knowledge, intermediate level)
- 35) The participants can **describe** the need of SDS (Knowledge, basic level)
- 36) 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



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



The participants shall:

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

ELEMENT 3.6 - TYPES OF PPE

Learning objective:

- 37) 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:
- Check the gloves for holes
 - 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
- 3.6.7 Give constructive feedback on the participants' selection of the right PPE to wear for hydraulic work, and inspection and use of hydraulic PPE



The participants shall:



3.6.8 Practice selecting the right PPE to wear for hydraulic work

3.6.9 Practice how to inspect and use hydraulic PPE

ELEMENT 3.7 - IMPORTANCE OF APPROPRIATE ISOLATION

Learning objective:

- 38) 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
- 3.7.2 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



The participants shall:

- 3.7.3 Engage in a group discussion about why it is important to use appropriate isolation and to prevent 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:

- 39) The participants can **describe** the function of pumps (Knowledge, basic level)
- 40) The participants can **recognise** pumps on a diagram (Knowledge, basic level)
- 41) 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



The 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:

- 42) 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
- 4.2.3 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



The participants shall:

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

LESSON 5 - ACTUATORS

30 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:

- 43) The participants can **describe** function of actuators (Knowledge, basic level)
- 44) 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



The 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:

- 45) 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...)
- 6.1.3 Give constructive feedback on the participants' explanations about the function of valves



The participants shall:

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

ELEMENT 6.2 - DIRECTIONAL CONTROL VALVES

Learning objectives:

- 46) The participants can **recognise** the function of different types of directional control valves (Knowledge, basic level)
- 47) The participants can **describe** the operation of different types of directional control valves (Knowledge, basic level)
- 48) 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:

- 49) The participants can **describe** the function and operation of the pressure relief valve (Knowledge, basic level)
- 50) The participants can **recognise** the pressure relief valve on a diagram (Knowledge, basic level)
- 51) 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
- 6.3.8 Give constructive feedback on the participants' practice of checking and adjusting the pressure relief valve in a circuit



The participants shall:

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

ELEMENT 6.4 - PRESSURE REDUCTION VALVES

Learning objectives:

- 52) The participants can describe the function and operation of the pressure reduction valve (Knowledge, basic level)
- 53) 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:

- 54) The participants can **describe** the function and operation of the needle valve (Knowledge, basic level)
- 55) The participants can **recognise** a needle valve on a diagram (Knowledge, basic level)
- 56) 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
- 6.5.7 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



The participants shall:

- 6.5.8 Describe in their own words and share understandings about the function and operation of the needle valve
- 6.5.9 Practice the operation of the needle valve in a circuit



6.5.10 Practice the ability to use a needle valve to depressurize the hydraulic system

ELEMENT 6.6 - NON-RETURN VALVES

Learning objectives:

- 57) The participants can **describe** the function and operation of different types of non-return valves (Knowledge, basic level)
- 58) 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:

- 59) The participants can **describe** the function of the throttle valve (Knowledge, basic level)



60) 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 objectives:

- 61) The participants can **describe** the function and operation of the restrictor valve (Knowledge, basic level)
- 62) 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:

- 63) The participants can **describe** the function of the different accumulators (Knowledge, basic level)
- 64) 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:

- 65) 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
- 7.2.7 Give constructive feedback on the participants' abilities to check the pre-charge pressure of an accumulator and to refill the accumulator



The participants shall:

- 7.2.8 Practice the ability to check the pre-charge pressure of an accumulator
- 7.2.9 Practice the ability 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:

- 66) 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:

- 67) The participants can **describe** the function of a pressure sensor (Knowledge, basic level)
- 68) 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:

- 69) The participants can **describe** the function and inspection of the components that transfer the oil (Knowledge, basic level)
- 70) 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:

- 71) The participants can **describe** how to use different fittings to make a hydraulic connection (Knowledge, basic level)
- 72) 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 (threated, 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

45 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 HANDLING OF OIL

Learning objectives:

- 73) The participants can **describe** basic procedures for the handling of oil (Knowledge, basic level)
- 74) 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 OIL AND GREASE SAMPLE

Learning objective:

- 75) 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 or grease sample
- 10.2.2 Emphasize the importance of properly collecting an oil or grease sample according to given instructions



10.2.3 Ask the participants relevant questions about the purpose and importance of a proper oil or grease sample

10.2.4 Facilitate discussions about oil and grease cleanliness



The participants shall:

10.2.5 Describe in their own words and share understandings about the purpose and importance of a proper oil or grease sample

ELEMENT 10.3 - CHECKING OIL LEVELS

Learning objective:

76) 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)

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



The participants shall:

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

ELEMENT 10.4 - FILTERS

Learning objectives:

77) The participants can **describe** the function of filters (Knowledge, basic level)

78) The participants can **describe** the maintenance of filters (Knowledge, basic level)

79) 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:

- 80) The participants can **account for** the main symbols and components in a hydraulic system diagram (e.g., pump, tank, hoses, valves) (Knowledge, intermediate level)
- 81) 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
- 11.1.5 Give constructive feedback on the participants' explanations about the different components in the diagram and how to interpret the hydraulic diagram:



The participants shall:

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

ELEMENT 11.2 - IDENTIFYING MEASURING POINTS

Learning objectives:

- 82) The participants can **recognise** the function of measuring points (Knowledge, basic level)
- 83) 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:

- 84) The participants can **recognise** the function and symbol of pressure gauges/manometers (Knowledge, basic level)
- 85) The participants can **describe** the use of pressure gauges/manometers (Knowledge, basic level)
- 86) 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:

87) 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
- 12.2.3 Give constructive feedback on the participants' ability to measure the hydraulic pressure accurately



The participants shall:

- 12.2.4 Practice the 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:

88) 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:

- a. Pass the final test



The instructor shall:

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

13.2.3 Conduct the test with the participants

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.



The participants shall:

13.2.6 Complete the test

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.:

14.1.3 Group discussions or walk & talk



14.1.4 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

BTT Bolt Tightening Module

(BTTB)



12. THE BTT BOLT TIGHTENING MODULE

12.1 Aims and Objectives of the BTT Bolt Tightening Module

The aim of this module is to prepare participants for company specific bolt tightening training, through scenario-based training.

After having successfully completed the BTT Bolt Tightening Module, participants will have the ability to:

- 1) **Act independently** to safely plan, carryout and complete generic bolt torquing and tensioning tasks to specification using energy powered equipment (Ability, intermediate level).

12.2 Duration of the Bolt Tightening Module

The total contact time for completing the BTT Bolt tightening module is 8 hours and 0 minutes.

The training provider must not exceed the time per day given in the table 12.2.1 below.

	Maximum Duration Per Day
Contact time	8 hours
Total training day	10 hours

Table 12.2.1 - Maximum duration 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).

12.3 BTT Bolt Tightening Participant Ratio

The ratio shown for theory sessions indicates the maximum number of participants per instructor attending the course.

Practical ratios indicate the maximum number of participants to be supervised by an instructor during each activity.

Module	Session	Instructor to Participant Ratio
BTT Bolt Tightening	Theory	1:12



Practical

1:8

Table 12.3.1 - Instructor to participant ratio

12.4 Participant Prerequisites for the BTT Bolt Tightening Module

Before attending the BTT Bolt Tightening Module participants must first complete the BBT Mechanical Module

12.5 Developing Training Scenarios for this Module

12.5.1 Structure of the Bolt Tightening Module

During delivery of the GWO Bolt Tightening Module the instructor shall deliver the training in a practical format whenever possible, achieving a ratio of maximum 30% theoretical training to 70% practical training. The following structure should be followed when delivering the GWO Bolt Tightening Module:

- a. Theoretical section (lessons 1 and 2)
- b. Bolt torquing scenario (lessons 3, 4, 5 and 6)
- c. Bolt Tensioning scenario (lessons 7, 8, 9 and 10)
- d. Mechanical handling aids and training review (lessons 11 and 12)

12.5.2 Designing the scenarios

This module utilises scenario-based training to train bolt tightening based on the job performance requirements that participants can expect to find in the wind industry. The training provider is therefore required to develop two separate training scenarios: one for torquing and one for tensioning. Each scenario should be created around an example of a bolt tightening task that is typically found in a wind turbine, for example: bolting a tower flange between tower sections 8 and 9 in an onshore wind turbine.

The specific torquing and tensioning activities required for each scenario are described in the work instructions provided in annexes 2 and 3. The participants shall use the work instructions and supporting documents to **plan**, **complete** and **review** the specified bolt tightening tasks. Therefore, participants should begin each scenario by reviewing the work instructions to determine what the task entails, what safety and quality considerations they must make, and why these are important. The PDR document is intended to guide the participants through this process.

To ensure alignment between the scenario and tasks required by the work instructions, training providers should design each scenario around the work instructions aiming to frame the prescribed tasks within the scenario narrative. Where possible the scenario should require the participants to consider implications of their decisions in relation to safety and quality, for example, the implications of using non-calibrated tools, the safety considerations around reaction arms etc.

It is recommended that the participants are grouped into teams and work through the tasks collectively, reflecting the teamwork situations they will encounter when working in the wind industry. However, it is important that the instructor ensure that **each participant**, individually complete the torquing and tensioning tasks. The purpose of these tasks is for participants to practice adjusting equipment settings and tightening



according to the specifications in the work instructions. Therefore, that each participant must use an electrical torque wrench to conduct 1-stage torquing on three bolts using three different torque settings (e.g. one bolt requiring a torque force of 50 Nm, the second 75 Nm and the third 125 Nm). Each participant must also use a hydraulic torque wrench/cassette to conduct 2-stage torquing on two bolts using at least four different settings (e.g. one bolt requiring a torque force of 150 Nm and the other requiring a force of 200 Nm). For the tensioning task each participant must conduct 2-stage tensioning on at least two different bolts using at least two different settings (e.g. one bolt requiring a tension force of 55 kN and the other requiring a force of 95 kN).

Note *When designing the training scenarios, the training provider must include the elements described in lessons, 4,5,6, 8, 9 and 10 of this module, this is described in more detail below.*

12.5.3 Facilitating scenario-based training

The instructor shall begin by describing the scenario that the training provider has developed for the training. Once the scenario has been explained, participants shall use the work instructions and accompanying paperwork (torquing/tensioning manual, PDR, checklist) to develop a plan for how they will complete the bolt tightening task described in the work instructions. They shall then meet the learning objectives by completing the scenario.

Throughout the facilitation of the scenarios the instructor should strive to ensure that the focus remains on the performance levels that are required in real work settings, whilst linking activities and learning back to the specified bolt tightening tasks and procedures defined by the scenario work instructions and torquing/tensioning manual. The instructors shall take on the facilitator role. This means ensuring safety throughout the scenarios, whilst giving participants the opportunity to discover what they are doing and the effect this has on safety and the task, so that they can make decisions to change their behaviour or reinforce positive behaviour.

Throughout the scenario the instructor should call timeouts to create learning moments, that include, but are not limited to:

- a. Drawing focus to safety and quality – in particular safety reaction arms/line of fire
- b. Providing individual and group feedback, e.g. on performance
- c. Assessing participant understanding and engagement
- d. Correctly demonstrate procedures, techniques and how to use equipment
- e. Provide time for participants to ask questions and reflect on performance

Note *When introducing new tools and methods in lesson 3 and 7 it is recommended that the instructor use the I.D.E.A.S method:*

I – Introduce the tool or method



D – Demonstrate the correct way to use the tool or complete a task

E – Explain what you are doing and why you are doing it

A – Activity where the participants use the tool or complete the task

S – Summary, provide feedback to the participant

12.5.4 Safety during the scenarios

The instructor is responsible for safety at all times during the scenario and shall stop the scenario should they deem a situation to be unsafe. The scenario may only recommence once the safety situation has been resolved.

12.5.5 Scenario Documents

- a. The work instructions, torquing manual, PDR and checklist for the bolt torquing scenario is found in Annex 2.
- b. The work instructions, tensioning manual, PDR and checklist for the bolt tensioning scenario is found in Annex 3.

Note *In instances where a training provider is delivering the training on behalf of an OEM or owner-operator, the task may be replaced with a similar company specific task, providing it meets the minimum equipment and practise requirements of this standard (the number of equipment adjustments and bolts being tightened).*

12.5.6 Meeting the learning objectives of the bolt torquing scenario

The scenario has learning objectives that must be met by the participants. These objectives are divided into four lessons as follows:

Lesson 3 - Framing the Scenario: Bolt Torquing Using Energy Powered Tools

Lesson 4 - Pre-task Phase: Planning and Preparation (should be done in groups)

Lesson 5 -Task Phase: Safely and Correctly Torquing Bolts Using Electrical and Hydraulic Tools (should be done individually)

Lesson 6 - Post-task Phase: Pack up and Review (should be done in groups)

Note *Lesson 3 is intended to frame the scenario and introduce participants to energy powered torquing tools, meaning that the lesson should not be part of the scenario itself. It should be delivered prior to commencing the scenario, with the remaining three lessons making up the scenario and follow the phases of typical bolt torquing work activities found in the wind industry.*



Lesson 5 is designed to provide participants with the ability to adjust equipment according to task specifications, therefore the work instruction requires that they change the torque settings on electrical equipment at least three times and on hydraulic equipment at least twice.

12.5.7 Meeting the learning objectives of the bolt tensioning scenario

The scenario has learning objectives that must be met by the participants. These objectives are divided into four lessons as follows:

Lesson 7 - Framing the scenario: Bolt Tensioning Using Energy Powered Tools

Lesson 8 - Pre-task Phase: Planning and Preparation (should be done in groups)

Lesson 9 -Task Phase: Safe and Correct Tensioning of Bolts Using Hydraulic Tools (should be done individually)

Lesson 10 - Post-task Phase: Pack up and Review (should be done in groups)

Note *Lesson 7 is intended to frame the scenario and introduce participants to energy powered torquing tools, meaning that the lesson should not be part of the scenario itself. It should be delivered prior to commencing the scenario, with the remaining three lessons making up the scenario and follow the phases of typical bolt tensioning work activities found in the wind industry.*

Lesson 9 is designed to provide participants with the ability to adjust equipment according to task specifications, therefore the work instruction requires that they change the tension settings on hydraulic equipment at least twice.

12.6 Equipment

The equipment required for training as listed in Annex 1 must be available and must fulfil national legal requirements. In addition, this standard requires specific combinations of bolts to be tightened to ensure that participants practise changing the settings on equipment in relation to job task specifications. To create a performance condition similar to that found in the wind industry, it is necessary for the training provider to align the supporting documents found in annexes 2 and 3 to the specific equipment being used in the training.

Note *It is the training providers responsibility to ensure that the supporting documents are always updated in relation to the training equipment being used.*



12.7 BTT Bolt Tightening Module Timetable

The Training Provider should deliver the training in sequential order, with the exception of the scenarios, here the training provider may choose the order of the scenarios (bolt torquing or tensioning) – the content of the scenario must be delivered in sequential order.

The delivery of this module must comply with the requirements described in the GWO Requirements for Training.

Lesson	Element	Duration
1. Introduction	1.1 Safety and emergency procedures	
	1.2 Facilities	
	1.3 Introduction	
	1.4 Aims and objectives	
	1.5 Ongoing assessment	
	1.6 Motivation	
	1.7 Human factors	
	TOTAL	30 min.
2. Bolt tightening in the wind industry	2.1 Limitations of the training	
	2.2 Recap of the BTT Mechanical	
	2.3 Bolt tightening theory	
	2.4 Quality assurance in bolt tightening	
	TOTAL	50 min.
3. Framing the scenario: Bolt torquing using energy powered tools	3.1 Introduction to bolt torquing in the wind industry using energy powered tools and accessories	
	3.2 Attitude requirements for working with energy powered torquing tools and accessories	
	TOTAL	50 min.
4. Pre-task phase: Planning and preparation	4.1 Planning the task	
	4.2 Preparing for the task	
	4.3 Planning for safety	
	TOTAL	20 min.
5. The task phase: Safely and correctly torque bolts using a combination of electrical and hydraulic tools	5.1 Setting up equipment for use	
	5.2 Bolt torquing	
	5.3 Bolt loosening	
	5.4 Safety, quality and trouble shooting	



			TOTAL	90 min.
6.	Post task phase: Pack up and review	6.1	Post-use inspection and packing	
		6.2	Post-job documentation	
			TOTAL	15 min.
7.	Framing the scenario: Bolt tensioning using energy powered tools	7.1	Introduction to bolt tensioning in the wind industry using energy powered tools and accessories	
		7.2	Attitude requirements for working with energy powered tensioning tools and accessories	
			TOTAL	50 min.
8.	Pre-task phase: Planning and preparation	8.1	Planning the task	
		8.2	Preparing for the task	
		8.3	Planning for safety	
			TOTAL	20 min.
9.	The task phase: Safely and correctly tension bolts using hydraulic tools	9.1	Setting up equipment for use	
		9.2	Bolt tensioning	
		9.3	Bolt loosening	
		9.4	Safety, quality and trouble shooting	
			TOTAL	90 min.
10.	Post task phase: Pack up and review	10.1	Post-use inspection and packing	
		10.2	Post-job documentation	
			TOTAL	15 min.
11.	Using mechanical handling aids with bolt tightening tasks	11.1	Mechanical handling aids typically used in the wind industry	
		11.2	Using mechanical handling aids	
		11.3	Hazards associated with using mechanical handling aids	
		11.4	Mitigating hazards associated with mechanical handling aids	
			TOTAL	35 min.
12.	Training review	12.1	Training review	
			TOTAL	15 min.
			GRAND TOTAL	480 min.

Table 12.7.1 – BTT Bolt Tightening timetable



12.8 Detailed Description of the BTT Bolt Tightening Module

LESSON 1 - INTRODUCTION

30 min.

The aim of this lesson is for the participants to be motivated and to engage in the training safely at a training facility, while recognising what is expected of them during the training.

After having successfully completed Lesson 1 of Bolt Tightening Module, the participants can:

- 2) **Recognise** what is expected of them throughout the module (Knowledge, basic level)
- 3) **Name** and point out local emergency procedures and facilities (Knowledge, basic level)
- 4) **Discuss** the relevant human factors and explain their implications (Knowledge, intermediate level)

ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Learning objective:

- 5) The participants **show interest** or curiosity in the safety and emergency procedures at the training facility or site (Ability, basic level)



The instructor shall:

- 1.1.1 Explain and ask involving questions aimed at:
 - a. safety instructions according to internal procedures
 - b. emergency procedures and emergency exit in the areas where the participants can be expected to be located during the course



The participants shall:

- 1.1.2 Engage in answering questions on local safety and emergency procedures

ELEMENT 1.2 - FACILITIES

Learning objective:



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



The instructor shall:

- 1.2.1 Present a general description of the facilities at the training location or site (administration, dining area, restrooms, toilets etc.)
- 1.2.2 Alternatively lead a tour and point out facilities



The participants shall:

- 1.2.3 Note relevant facilities and ask questions when in doubt

ELEMENT 1.3 - INTRODUCTION

Learning objective:

- 7) The participants **show interest** in fellow participants and the course content and design (Ability, basic level)



The instructor shall:

- 1.3.1 Explain and ask involving questions aimed at the Bolt Tightening Module including during breaks and mealtimes
- 1.3.2 Give a short introduction to themselves including their backgrounds as instructors
- 1.3.3 Ask for participants' expectations of the training and their learning or development



The participants shall:

- 1.3.4 Give a short introduction to themselves including job function and expected primary geographic work location and share expectations of the training



ELEMENT 1.4 - AIMS AND OBJECTIVES

Learning objective:

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



The instructor shall:

- 1.4.1 Present the scope and main learning objectives of the Bolt Tightening Module
- 1.4.2 Involve participants with questions on understanding and individual experiences of bolt tightening



The participants shall:

- 1.4.3 Engage in answering questions and share experiences of bolt tightening

ELEMENT 1.5 - ONGOING ASSESSMENTS

Learning objective:

- 9) The participants can **recognise** the assessment procedure and the aim of the ongoing assessment (Knowledge, basic level)



The instructor shall:

- 1.5.1 Explain the reasons for the ongoing assessment
- 1.5.2 Explain the layout of the GWO Participant Performance Assessment Form and how it will be used

Note The GWO Participant Performance Assessment Form is found in the GWO Requirements for Training.



The participants shall:



- 1.5.3 Engage themselves in discussions and ask questions when in doubt in relation to the assessment procedure

ELEMENT 1.6 - MOTIVATION

Learning objective:

- 10) 6. The participants **show interest** and willingness to engage in the learning activities (Ability, basic level)



The instructor shall:

- 1.6.1 Explain and lead a discussion on:
- a. the importance of personal involvement in the course
 - b. the definition of and the need for bolt tightening understandings and abilities

Note *Positive motivation is the driving force for commitment and the instructor should make a focused effort to support growth of the necessary attitude and motivation in the participant.*



The participants shall:

- 1.6.2 Engage themselves in discussions and share experiences of bolt tightening
- 1.6.3 Share understandings and considerations with instructors and other participants
- 1.6.4 Take responsibility for their learning by seeking guidance and clarification when in doubt

Note *When the participants succeed by trying out on their own, bring their relevant experience into play and apply learning points from the instructor's feedback they develop a positive attitude and responsibility towards the subject and the performance in the work situation.*

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 - BOLT TIGHTENING IN THE WIND INDUSTRY

50 min.

The aim of this lesson is to revisit the key learnings from GWO BTT Mechanical Training and prepare the participants for further learning.

After having successfully completed Lesson 2 of the Bolt Tightening Module, participants can:



- 13) **Discuss** the primary learnings from the BTT-Mechanical and how they relate to this standard (Knowledge, Intermediate)
- 14) **Explain** the need for continuing professional development with company specific training (Knowledge, Intermediate)
- 15) **Show interest** in quality assurance for bolt tightening tasks (Ability, basic level)

ELEMENT 2.1 - LIMITATIONS OF THE TRAINING

Learning objectives:

- 16) The participants can **explain** how the GWO bolt tightening training and company specific training prepares them to perform bolt tightening tasks in the wind industry (Knowledge, intermediate level)
- 17) The participants can **recognise** the limitations of the training and the need for continuing education to remain competent within the wind industry (Knowledge, basic level)



The instructor shall:

- 2.1.1 Explain and lead a discussion on the limitations of the GWO Bolt Tightening Module and the need for further company specific training prior to work in the wind industry
- 2.1.2 Explain and lead a discussion on how the Bolt Tightening Module prepares participants for company specific training and work in the wind industry



The participants shall:

- 2.1.3 Engage in discussions and share understandings about from company specific training
- 2.1.4 Share understandings and considerations with instructors and other participants
- 2.1.5 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 2.2 - RECAP OF THE BTT MECHANICAL

Learning objective:



- 18) The participants can **discuss** how the BTT- M training has prepared them for completing the training outlined in the GWO Bolt Tightening Standard (Knowledge, intermediate level)

Note *Element 2.2 can be omitted from the training if this standard is delivered in conjunction with the GWO Basic Technical Training Mechanical Module.*



The instructor shall:

- 2.2.1 Ask involving questions about the key learnings from the BTT mechanical, including:
- Bolt types and condition
 - Documentation, as described in section 6.4 of this BTT standard: Handouts
 - PPE
 - Planning, carrying out and completion of tasks
 - Torque
 - Tension
 - Importance of lubrication – when and when not to lubricate
 - Tightening and loosening
 - Manuals and instructions
 - Safety and risk prevention including Reumers syndrome (when using rattle guns)
 - Explain and lead a discussion about how the BTT mechanical training relates to, and serves as a precursor to the training in this Bolt Tightening Standard



The participants shall:

- 2.2.2 Engage in discussions and share experiences from the BTT Mechanical and how it relates to the training in this Bolt Tightening standard
- 2.2.3 Share understandings and considerations with instructors and other participants
- 2.2.4 Take responsibility for their learning by seeking guidance and clarification when in doubt



ELEMENT 2.3 - BOLT TIGHTENING THEORY

Learning objectives:

- 19) The participants can **describe** 1-stage and 2-stage tightening and why it is important for bolt torquing and tensioning (Knowledge, basic level)
- 20) The participants can **recognise** different types of bolts and the implications for bolt tightening (Knowledge, basic level)
- 21) The participants can **explain** why there are correct storage and transport procedures for bolts, washers and nuts (Knowledge, intermediate level)



The instructor shall:

- 2.3.1 Explain and lead a discussion on 1-stage and 2-stage tightening and why it is important for bolt torquing and tensioning
- 2.3.2 Explain and lead a discussion on the difference types of bolts and what participants must be aware of when using each type for bolt tightening, including:
 - a. Stud bolts and turning during tightening
 - b. Bolts with bolt heads
 - c. Bolt sizes and considerations for dealing with heavy bolts e.g. M60-M100
- 2.3.3 Lead a discussion and ask engaging questions the importance of following storage and transport procedures for bolts, nuts and washers



The participants shall:

- 2.3.4 Engage in discussions and share understandings about 1-stage and 2-stage bolt torquing and tensioning
- 2.3.5 Engage in discussions and share understandings about the differences and advantages and disadvantages of torquing and tensioning
- 2.3.6 Engage in discussions and share understandings about different types of bolts and how they are used
- 2.3.7 Engage in discussions and answer questions about storage and transport of bolts, nuts and washers for bolt torquing tasks
- 2.3.8 Share understandings and considerations with instructors and other participants



2.3.9 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 2.4 - QUALITY ASSURANCE IN BOLT TIGHTENING

Learning objectives:

- 22) The participants can **describe** general rules and quality assurance measures for bolt torquing and tensioning (Knowledge, basic level)
- 23) The participants **show interest** in how to perform a plan-do-review (PDR) for an assigned bolt torquing task using a combination of electric and hydraulic torquing tools (Ability, basic level)



The instructor shall:

- 2.4.1 Explain and lead a discussion on the general rules about when to reuse/not reuse bolts, nuts and washers, including importance of following company specific procedures
- 2.4.2 Explain and lead a discussion on quality assurance measures in bolt tightening, including:
 - a. Importance of following procedures
 - b. Condition of bolts, nuts and washer
 - c. Marking of bolts (provide visual examples, highlight it is company specific)
 - d. Using correct and functional equipment
 - e. Importance of following task specifications, including that different WTG may have different tightening specifications for the same bolt type
 - f. Importance of reporting
 - g. Calibration of tools
 - h. Handling of HV bolts, e.g. emphasising "No Water"
- 2.4.3 Explain and lead a discussion on what a PDR is, why it is used and present some examples of different types, e.g. Safe Work Approach (SWA), Job safety analysis (JSA), task plan, etc



The participants shall:

- 2.4.4 Engage themselves in discussions and share understandings about reusing bolts, nuts and washers



- 2.4.5 Engage themselves in discussions and share understandings about quality assurance in bolt tightening
- 2.4.6 Engage themselves in discussions and share understandings about PDR procedures for bolt tightening
- 2.4.7 Share understandings and considerations with instructors and other participants
- 2.4.8 Take responsibility for their learning by seeking guidance and clarification when in doubt

LESSON 3 - FRAMING THE SCENARIO: BOLT TORQUING USING ENERGY POWERED TOOLS

50 min.

The aim of this lesson is to frame the scenario by providing participants with an introduction to bolt torquing using energy powered tools.

After having successfully completed lesson three of the Bolt Tightening Module, the participants can, the participant can:

- 24) **Describe** the correct attitude for safely working with energy powered bolt torquing equipment (Knowledge, basic)
- 25) **Explain** how bolt torquing is typically carried out wind industry using energy powered tools (Knowledge, intermediate level)

ELEMENT 3.1 - INTRODUCTION TO BOLT TORQUING IN THE WIND INDUSTRY USING ENERGY POWERED TOOLS AND ACCESSORIES

Learning objectives:

- 26) The participants can **explain** the similarities and differences between electric and hydraulic torquing tools and how they relate to different bolt torquing tasks (Knowledge, intermediate level)
- 27) The participants can **explain** when, how and why lubrication is used for bolt torquing (Knowledge, intermediate level)
- 28) The participants can **explain** how bolt torquing is conducted using energy powered equipment (Knowledge, intermediate level)
- 29) The participants can **discuss** why it is important to correctly adhere to procedures and administrative tasks in relation to completing bolt torquing tasks (Knowledge, intermediate level)



- 30) The participants can **discuss** the consequences of incorrect bolt torquing and parameters that influence bolt torquing (Knowledge, intermediate level)
- 31) The participants can **recognise** the scope and requirements of the bolt torquing scenario (Knowledge, basic level)



The instructor shall:

- 3.1.1 Explain and ask reflective questions about how bolt torquing is performed in the wind industry using energy powered equipment
- 3.1.2 Explain and ask reflective questions about the importance of lubrication for bolt torquing, e.g. by showing a video of different bolt preload with and without lubrication and providing examples of bolts
- 3.1.3 Explain and ask reflective questions about the loosening of bolts that have not been lubricated or installed incorrectly
- 3.1.4 Present and explain the similarities and differences between electric and hydraulic torquing tools, how they work and how they relate to different torquing tasks, including:
 - a. Torque head sockets
 - b. Cassettes
 - c. Nut runners (reaction arm engagement speed)
 - d. Counter wrench/counter support
- 3.1.5 Present the work instructions for the scenario and lead a discussion on adhering to bolt torquing work instructions, company procedures, manuals and equipment care and maintenance, including:
 - a. Safety consequences
 - b. Quality consequences
 - c. Equipment consequences
- 3.1.6 Ask participants involving questions about the importance of adhering to procedures and administrative tasks for bolt torquing, including maintenance requirements
- 3.1.7 Lead a discussion on the consequences of incorrect bolt torquing and the parameters that influence bolt torquing using energy powered equipment, including:
 - a. Tightening sequence



- b. Incorrect conversions
- c. Incorrect tool use
- d. Cross threading
- e. Screw jamming
- f. Slippage (reaction arm setup)
- g. Misalignment (bolt - nut)
- h. Incorrect bolt/nut/washer
- i. Bolt conditions after storage (rust, dirt between threads)
- j. Tightening tool angular position
- k. Over/under torquing bolts
- l. Engagement of tool (wrong socket size)
- m. Incorrect lubrication and coatings
- n. Incorrect torque values
- o. Handling of HV bolts

3.1.8 Present the purpose and scope of scenario-based learning, highlighting the focus on real work performance and participants responsibility for their learning



The participants shall:

- 3.1.9 Actively engage in discussions and answer questions about bolt torquing tasks using energy powered equipment
- 3.1.10 Share understandings and considerations with instructors and other participants
- 3.1.11 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 3.2 - ATTITUDE REQUIREMENTS FOR WORKING WITH ENERGY POWERED TORQUING TOOLS AND ACCESSORIES

Learning objective:



- 32) The participants can **describe** how correct attitude, documentation requirements and company procedures mitigate safety hazards and quality incidents associated with bolt torquing (Knowledge, basic level)



The instructor shall:

- 3.2.1 Lead a discussion on, and provide examples of the role of correct attitudes for improving safety and quality of bolt torquing using energy powered equipment, including:
- Collective responsibility for safety
 - Reporting
 - Planning
 - Stop work
 - Following procedures
 - Ask participants involving questions about how attitude can help improve safety and quality of bolt torquing



The participants shall:

- 3.2.2 Engage themselves in discussions and share understandings about the role of attitude in relation to safety and quality of bolt torquing
- 3.2.3 Answer questions about how attitude can improve safety and quality of bolt torquing
- 3.2.4 Share understandings and considerations with instructors and other participants
- 3.2.5 Take responsibility for their learning by seeking guidance and clarification when in doubt

LESSON 4 - PRE-TASK PHASE: PLANNING AND PREPARATION

20 min.

The aim of this lesson is to train participants to plan and prepare to safely and correctly complete bolt torquing tasks to specification.

After having successfully completed lesson four of the Bolt Tightening Module, the participant can:



- 33) **Act independently** to plan and prepare to carry out bolt torquing tasks to specification (Ability, Intermediate)

ELEMENT 4.1 - PLANNING THE TASK

Learning objectives:

- 34) The participants take **responsibility** for using instruction manuals, safety guidelines, procedures and other relevant documents, to prepare a plan for completing a bolt torquing task using a combination of electric and hydraulic torquing tools (Ability, intermediate level)
- 35) The participants can **take initiative** to select the correct bolts and bolt components to carry out the task defined by the scenario (Ability, intermediate level)
- 36) The participants can **take initiative** to correctly select and prepare the tools, equipment and PPE required to carry out the task defined by the scenario (Ability, intermediate level)



The instructor shall:

- 4.1.1 Initiate the scenario by providing the participants with:
 - a. GWO Work Instructions for Bolt Torquing (the scenario)
 - b. GWO Bolt Torquing Manual
 - c. GWO PDR
 - d. GWO Job Checklist
- 4.1.2 Based on the scenario documents, facilitate activities where participants create a plan for performing the described bolt torquing task. The following topics should be covered:
 - a. PPE
 - b. Documentation requirements for the task (serial numbers, batch numbers, pressures etc.)
 - c. Check that calibration documents match tool calibration labelling
 - d. Conversions and pressure charts
 - e. LOTO
 - f. Site procedures



g. Tool maintenance requirements

4.1.3 Based on the scenario documents, facilitate activities where participants identify and select the correct bolts, washers and nuts needed to complete the task to specification. The activities should require participants to consider:

- a. Lubrication requirements
- b. Types, sizes and coatings
- c. Torquing specifications

4.1.4 Based on the scenario documents, facilitate activities where participants identify and select appropriate equipment needed to complete the task to specification. The activities should require participants to:

- a. Perform the P in PDR
- b. Match bolt and socket sizes
- c. Select torque counter hold
- d. Select hydraulic and electric torquing tools
- e. Select the correct pumps and hoses for the job
- f. Select appropriate hand tools for completing the job
- g. Identify and plan for equipment documentation and maintenance requirements and how this could affect the completing the task

4.1.5 Continuously assess participant engagement and learning by actively asking participants to share their understandings and reflect on their actions and considerations

4.1.6 Provide participants with instruction, guidance and feedback as required to ensure that learning objectives are met

Note *To ensure generic learning, it is recommended that participants are required to select appropriate bolt components and tools from a variety of different options. This does not require the training provider to own a variety of bolts and tools and can be done by using image cards showing different options.*



The participants shall:

4.1.7 Complete scenario-based activities to specification



- 4.1.8 Share understandings and considerations with instructors and other participants
- 4.1.9 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 4.2 - PREPARING FOR THE TASK

Learning objectives:

- 37) The participants can **distinguish** between suitable and damaged or compromised bolts, nuts and washers (Skill, intermediate level)
- 38) The participants can **perform** a visual inspection of bolts (Skill, intermediate level)
- 39) The participants can **distinguish** between functioning and damaged pump and hose components (Skill, intermediate level)
- 40) Participants can **perform** appropriate actions to mitigate damaged or malfunctioning pumps and hose components as to ensure that they do not pose a safety or quality risk to the specified bolt torquing task (Skill, intermediate level)
- 41) The participants can **distinguish** between functioning and damaged tool components (Skill, intermediate level)
- 42) Participants can **perform** appropriate actions to mitigate damaged or malfunctioning tool components as to ensure that they do not pose a safety or quality risk to the specified bolt torquing task (Skill, intermediate level)
- 43) Participants can **perform** any pre-job maintenance on tools in accordance with manufacturers manuals (Skill, intermediate level)



The instructor shall:

- 4.2.1 Based on the scenario documents, facilitate activities where participants are required to perform visual inspection of bolts and bolt components to distinguish between suitable and damaged or compromised bolts and components
- 4.2.2 Based on the scenario documents, facilitate activities where participants are required to perform pre-use inspection of hydraulic pumps and hose components to ensure that they do not pose a safety or quality risk to the specified bolt torquing task
- 4.2.3 Based on the scenario documents, facilitate activities where participants are required to perform pre-use maintenance, calibration and inspection of hydraulic and electrical torque tools and components to ensure that they do not pose a safety or quality risk to the specified bolt torquing task



- 4.2.4 Based on the scenario documents, facilitate activities where participants are required to take appropriate actions to mitigate damaged or malfunctioning pump, hose and tool components as to ensure that they do not pose a safety or quality risk to the specified bolt torquing task, including:
 - a. Stop work
 - b. Quarantine and reporting
 - c. Repairs including documentation
- 4.2.5 Continuously assess participant engagement and learning by actively asking participants to share their understandings and reflect on their actions and considerations
- 4.2.6 Provide participants with instruction, guidance and feedback as required to ensure that learning objectives are met



The participants shall:

- 4.2.7 Complete the scenario-based activities to specification
- 4.2.8 Share understandings and considerations with instructors and other participants
- 4.2.9 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 4.3 - PLANNING FOR SAFETY

Learning objectives:

- 44) Participants can **recognise** the safety hazards commonly present when conducting bolt torquing tasks using electric and hydraulic tools (Knowledge, basic level)
- 45) Participants can **take initiative** to mitigate the safety hazards associated with a specified bolt torquing task (Ability, intermediate level)



The instructor shall:

- 4.3.1 Lead a discussion and ask engaging question about the safety hazards commonly present when conducting bolt torquing using electric and hydraulic tools, including:
 - a. PPE
 - b. Reaction arms (pinching, crushing, hand position, placement of reaction arm)



- c. Heavy lifting
- d. Dropped objects (tethering)
- e. Hydraulics (heat, fluids, pressure, hydraulic injection, hose coupler ratings, fire hazard vaporised hydraulic fluid)
- f. Electrical equipment (supply, electrocution, batteries, fuses, voltage)
- g. Slipping/tripping
- h. Counter holds
- i. Two-man torquing procedures (line of sight, communication, following company and site rules and procedures)
- j. Working with pump pendant (single and dual action)
- k. Noise (in particular with loosening)
- l. Safety handles as a prerequisite to perform operation

4.3.2 Lead a discussion and ask engaging question about how to mitigate the hazards commonly present when conducting bolt torquing using electric and hydraulic tools, including:

- a. PPE
- b. Reaction arms (pinching, crushing, hand position, placement of reaction arm)
- c. Heavy lifting
- d. Dropped objects (tethering)
- e. Hydraulics (heat, fluids, pressure, hydraulic injection, hose coupler ratings, fire hazard vaporised hydraulic fluid)
- f. Electrical equipment (supply, electrocution, batteries, fuses, voltage)
- g. Slipping/tripping
- h. Counter wrench/counter support
- i. Two-man torquing procedures (line of sight, communication, following company and site rules and procedures)
- j. Working with pump pendant (single and dual action)
- k. Noise (in particular with loosening)
- l. Safety handles as a prerequisite to perform operation



The participants shall:

- 4.3.3 Actively engage in discussions and answer questions about safety hazards commonly present when conducting bolt torquing using electric and hydraulic tools
- 4.3.4 Actively engage in discussions and answer questions about mitigating the hazards commonly present when conducting bolt torquing using electric and hydraulic tools
- 4.3.5 Share understandings and considerations with instructors and other participants
- 4.3.6 Take responsibility for their learning by seeking guidance and clarification when in doubt

LESSON 5 - THE TASK PHASE: SAFELY AND CORRECTLY TORQUING BOLTS USING ELECTRICAL AND HYDRAULIC TOOLS

90 min.

The aim of this lesson is to train participants to, safely and correctly, carry out bolt torquing tasks to specification using both electric and hydraulic torquing equipment.

After having successfully completed lesson five of Bolt Tightening Module, the participant can:

- 46) **Act independently** to perform bolt torquing tasks to specification using both electric and hydraulic torquing equipment (Ability, intermediate level)
- 47) **Act independently** to perform bolt loosening tasks using either electric and hydraulic torquing equipment (Ability, intermediate level)

ELEMENT 5.1 - SETTING UP EQUIPMENT FOR USE

Learning objectives:

- 48) The participants can **act independently** to, safely and correctly, setup electrical bolt torquing equipment needed to perform a specified bolt torquing task (Ability, intermediate level)
- 49) The participants can **act independently** to, safely and correctly, setup hydraulic bolt torquing equipment needed to perform a specified bolt torquing task (Ability, intermediate level)
- 50) Participants **act independently** to, safely and correctly, pressurise and depressurise hydraulic equipment when conducting hydraulic bolt torquing (Ability, intermediate level)



The instructor shall:

- 5.1.1 Based on the scenario documents, facilitate activities where participants are required to conduct pre-checks, including completing related documentation. As a minimum, participants should:
 - a. Setup the equipment
 - b. Inspect the setup equipment prior to use
 - c. Ensure safety handles are mounted for use
 - d. Ensure that the tools have an approved calibration
 - e. Manage the work environment (tripping and slipping hazards)
 - f. Checking pressure settings
 - g. Secure the socket to the tool using pins or o-rings (not cable ties)
 - h. Set the value with the gauge according to the calibration chart
 - i. Discuss how to apply the hierarchy of control: e.g. safest being hands free, then using handles, then 1 person then 2 person with specific controls, e.g. use of equipment like gripper sockets
 - j. Fill-out PDR and task documentation found in annex 2
- 5.1.2 Based on the scenario documents, facilitate activities where participants are required to correctly pressurise and depressurise hydraulic equipment according to the equipment manuals, including correct communication and body positioning in relation to equipment to avoid injury from failing components and hydraulic injection
- 5.1.3 Continuously assess participant engagement and learning by actively asking participants to share their understandings and reflect on their actions and considerations
- 5.1.4 Provide participants with instruction, guidance and feedback as required to ensure that learning objectives are met



The participants shall:

- 5.1.5 Complete the scenario-based activities to specification
- 5.1.6 Share understandings and considerations with instructors and other participants
- 5.1.7 Take responsibility for their learning by seeking guidance and clarification when in doubt



ELEMENT 5.2 - BOLT TORQUING

Learning objective:

- 51) Participants can **act independently** to, safely and correctly, torque bolts using at least two different torque settings with electric and hydraulic torquing tools and accessories (Ability, intermediate level)



The instructor shall:

- 5.2.1 Based on the scenario documents, facilitate activities where participants are required to use a combination of electric and hydraulic torquing tools to correctly carry out 1 stage and 2 stage torquing in accordance with the specifications described in the work instructions and bolt torquing manual (found in appendix 2)
- 5.2.2 Continuously assess participant engagement and learning by actively asking participants to share their understandings and reflect on their actions and considerations
- 5.2.3 Provide participants with instruction, guidance and feedback as required to ensure that learning objectives are met



The participants shall:

- 5.2.4 Complete the scenario-based activities to specification
- 5.2.5 Share understandings and considerations with instructors and other participants
- 5.2.6 Take responsibility for their learning by seeking guidance and clarification when in doubt

Note *Instruction: the instructor should demonstrate how to correctly carry out 1 stage and 2 stage torquing prior to participants completing the activities, including a demonstration of how to mark the bolts.*

Safety: to reduce the risk of injury and damage to bolts and equipment it is recommended to use lower torque settings to complete practical torquing activities.

ELEMENT 5.3 - BOLT LOOSENING

Learning objective:



- 52) Participants can **act independently** to, safely and correctly, loosen bolts using electric or hydraulic torquing tools and accessories (Ability, intermediate level)



The instructor shall:

- 5.3.1 Facilitate activities where participants are required to loosen bolts using hydraulic torquing tools and accessories
- 5.3.2 Continuously assess participant engagement and learning by actively asking participants to share their understandings and reflect on their actions and considerations
- 5.3.3 Provide participants with instruction, guidance and feedback as required to ensure that learning objectives are met



The participants shall:

- 5.3.4 Complete the scenario-based activities to specification
- 5.3.5 Share understandings and considerations with instructors and other participants
- 5.3.6 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 5.4 - SAFETY, QUALITY AND TROUBLE SHOOTING

Learning objectives:

- 53) Participants can **take responsibility** to mitigate the safety hazards present during bolt torquing using energy powered equipment (Ability, intermediate level)
- 54) Participants can **act independently** identify common faults and failures when using energy powered torquing equipment (Ability, intermediate level)
- 55) Participants can **take initiative** to safely rectify faults and failures that commonly arise using when using energy powered torquing equipment (Ability, intermediate level)



The instructor shall:

- 5.4.1 Lead a reflective discussion and ask engaging questions about mitigating the safety hazards present in bolt torquing tasks using energy powered equipment, paying special attention to:



- a. Reaction arms
 - b. Reaction surfaces
 - c. Socket safety
 - d. Body positioning
 - e. Engagement speeds of electrical torquing tools (nut runners)
- 5.4.2 Present the causes and types of equipment faults that commonly occur when using energy powered torquing equipment in WTG environments
- 5.4.3 Discuss the need to stop work as soon as something is out of the ordinary
- 5.4.4 Present how to identify and rectify common faults and failures with energy powered equipment, including:
- a. Sudden changes in pressure
 - b. Loose hoses
 - c. Tool failure
 - d. Incorrect use of tools (incorrect torque wrench setting)
 - e. Pump electrical supply problems (generators if used for the powering the pump)
 - f. Leakages of hydraulic fluid
 - g. Incorrect setup under covers/handles
 - h. Depressurising the system and checking for faults
 - i. Bolt not tightened correctly
 - j. Broken gearboxes
 - k. Insufficient pressure
 - l. Tool electrical supply problem (generators, power supply)
- 5.4.5 Lead a discussion and ask engaging questions about the importance of following manuals, company procedures and documentation requirements when encountering equipment faults and failures
- 5.4.6 Give constructive feedback on the participants on their performance during discussions



The participants shall:



- 5.4.7 Actively engage in discussions and answer questions about safety hazards commonly present when conducting bolt torquing using electric and hydraulic tools
- 5.4.8 Actively engage in discussions and answer questions about rectifying typical faults and failures associated with energy powered bolt torquing equipment
- 5.4.9 Share understandings and considerations with instructors and other participants
- 5.4.10 Take responsibility for their learning by seeking guidance and clarification when in doubt

LESSON 6 - POST-TASK PHASE: PACK UP AND REVIEW

15 min.

The aim of this lesson is to train participants to, safely and correctly, carry out bolt torquing tasks to specification using a combination of electric and hydraulic torquing equipment.

After having successfully completed lesson six of the Bolt Tightening Module, the participant can:

- 56) **Act independently** to correctly review and complete bolt torquing tasks to specification (Ability, intermediate level)

ELEMENT 6.1 - POST-USE INSPECTION AND PACKING

Learning objective:

- 57) The participants can **act independently** to, safely and correctly, inspect, disassemble, and pack electric and hydraulic bolt torquing equipment after use (Ability, intermediate level)



The instructor shall:

- 6.1.1 Based on the scenario documents, facilitate activities where participants are required to:
 - a. Correctly conduct a post-use inspection of equipment
 - b. Disassemble and pack equipment for transport including: de-energising, disconnecting hoses, placing caps on hoses and gather all equipment
 - c. Assess maintenance procedures and limitations in relation to the next job (e.g. time of use in manufacturers manual)



The participants shall:

- 6.1.2 Complete the scenario-based activities to specification
- 6.1.3 Share understandings and considerations with instructors and other participants
- 6.1.4 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 6.2 - POST-JOB DOCUMENTATION

Learning objectives:

- 58) The participants can **act independently** to, correctly complete task paperwork and documentation (Ability, intermediate level)
- 59) The participants can **explain** the implications of failing to correctly complete task paperwork and documentation (Knowledge, intermediate level)



The instructor shall:

- 6.2.1 Based on the scenario documents, facilitate activities where participants are required to complete task paperwork and documentation, the post-job checklist can be found in annex 2
- 6.2.2 Lead a discussion and ask engaging questions about the importance of completing task paperwork and documentation, including the implications of not completing the paperwork (e.g. traceability and being able replace bolts)
- 6.2.3 Provide examples of the implications that can result from incorrect and inadequate documentation and task paperwork, including the potential safety implications



The participants shall:

- 6.2.4 Complete the scenario-based activities to specification
- 6.2.5 Actively engage in discussions and answer questions about the importance of completing task paperwork and documentation, including the implications of not completing the paperwork
- 6.2.6 Share understandings and considerations with instructors and other participants
- 6.2.7 Take responsibility for their learning by seeking guidance and clarification when in doubt



LESSON 7 - FRAMING THE SCENARIO: BOLT TENSIONING USING ENERGY POWERED TOOLS

50 min.

The aim of this lesson is to frame the scenario by providing participants with an introduction to bolt tensioning using energy powered tools.

After having successfully completed lesson seven of the Bolt Tightening Module, the participant can:

- 60) **Describe** the correct attitude for safely working with energy powered bolt tensioning equipment (Knowledge, basic level)
- 61) **Explain** how bolt tensioning is typically carried out wind industry using energy powered tools (Knowledge, intermediate level)

ELEMENT 7.1 - INTRODUCTION TO BOLT TENSIONING IN THE WIND INDUSTRY USING ENERGY POWERED TOOLS AND ACCESSORIES

Learning objectives:

- 62) The participants can **explain** how hydraulic tensioning tools relate to different bolt tensioning tasks (Knowledge, intermediate level)
- 63) The participants can **explain** how to determine if equipment is correctly calibrated and ready to be used (Knowledge, intermediate level)
- 64) The participants can **explain** how bolt tensioning is carried out using energy powered equipment (Knowledge, intermediate level)
- 65) The participants can **discuss** why it is important to correctly adhere to procedures and administrative tasks in relation to completing bolt tensioning tasks (Knowledge, intermediate level)
- 66) The participants can **discuss** the consequences of incorrect bolt tensioning and parameters that influence bolt tensioning (Knowledge, intermediate level)
- 67) The participants can **recognise** the scope and requirements of the bolt tensioning scenario (Knowledge, basic level)



The instructor shall:

- 7.1.1 Explain and ask reflective questions about how bolt tensioning is performed in the wind industry using energy powered equipment, including:



- a. 1-stage and 2-stage tensioning and when they are used
 - b. 2-stage tensioning and why the bolt is tensioned twice at 100%
- 7.1.2 Present and explain how hydraulic tensioning tools work and how they relate to different tensioning tasks, including:
 - a. Tensioners
 - b. Thread holding devices for threads on the opposite end to the tensioner
 - c. The importance of thread pitch protrusion
 - d. Spacers
- 7.1.3 Present the work instructions for the scenario and lead a discussion on adhering to bolt tensioning work instructions, company procedures, manuals and equipment care and maintenance, including:
 - a. Safety consequences
 - b. Quality consequences
 - c. Equipment consequences
- 7.1.4 Ask participants involving questions about the importance of adhering to procedures and administrative tasks for bolt torquing, including maintenance requirements
- 7.1.5 Lead a discussion on the consequences of incorrect bolt tensioning and the parameters that influence bolt tensioning including:
 - a. Tightening sequence
 - b. Incorrect tool use
 - c. Thread pitch
 - d. Tensioner size
 - e. Incorrect bolt/nut
 - f. Bolt conditions after storage (rust, dirt between threads) resulting in improper engagement and bolt unintendedly screwing through the connection
 - g. Ensure correct tool engagement with thread (as specified by the manual)
 - h. The need for correct nut engagement
 - i. Over/under tensioning
 - j. Tool maintenance



- k. Stroke levels
- l. Incorrect setup of hoses
- m. Tool calibration and inspection of the tensioner's cycle counter

7.1.6 Present the purpose and scope of scenario-based learning, highlighting the focus on real work performance and participants responsibility for their learning



The participants shall:

- 7.1.7 Actively engage in discussions and answer questions about bolt tensioning tasks using energy powered equipment
- 7.1.8 Share understandings and considerations with instructors and other participants
- 7.1.9 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 7.2 - ATTITUDE REQUIREMENTS FOR WORKING WITH ENERGY POWERED TENSIONING TOOLS AND ACCESSORIES

Learning objective:

- 68) The participants can **describe** how correct attitude, documentation requirements and company procedures mitigate safety hazards and quality incidents associated with bolt tensioning (Knowledge, basic level)



The instructor shall:

- 7.2.1 Lead a discussion on, and provide examples of the role of correct attitudes for improving safety and quality of bolt tensioning using energy powered equipment, including:
 - a. Collective responsibility for safety
 - b. Reporting
 - c. Planning
 - d. Stop work
 - e. Following procedures
- 7.2.2 Ask participants involving questions about how attitude can help improve safety and quality of bolt tensioning



The participants shall:

- 7.2.3 Engage in discussions and share understandings about the role of attitude in relation to safety and quality of bolt tensioning
- 7.2.4 Answer questions about how attitude can improve safety and quality of bolt tensioning
- 7.2.5 Share understandings and considerations with instructors and other participants
- 7.2.6 Take responsibility for their learning by seeking guidance and clarification when in doubt

LESSON 8 - PRE-TASK PHASE: PLANNING AND PREPARATION

20 min.

The aim of this lesson is to train participants to plan and prepare for safely and correctly completing bolt tensioning tasks to specification.

After having successfully completed lesson eight of the Bolt Tightening Module, the participant can:

- 69) **Act independently** to plan and prepare to carry out bolt tensioning tasks to specification (Ability, intermediate level)

ELEMENT 8.1 - PLANNING THE TASK

Learning objectives:

- 70) The participants **take responsibility** for using instruction manuals, safety guidelines, procedures and other relevant documents, to prepare a plan for completing a bolt tensioning task using hydraulic tensioning tools (Ability, intermediate level)
- 71) The participants can **take initiative** to select the correct bolts and bolt components to carry out the task defined by the scenario (Ability, intermediate level)
- 72) The participants can **take initiative** to correctly select and prepare the tools, equipment and PPE required to carry out the task defined by the scenario (Ability, intermediate level)



The instructor shall:

- 8.1.1 Initiate the scenario by providing the participants with:



- a. GWO Work Instructions for Bolt Tensioning (the scenario)
- b. GWO Bolt Tensioning Manual
- c. GWO PDR
- d. GWO Job Checklist

8.1.2 Based on the scenario documents, facilitate activities where participants create a plan for performing the described bolt tensioning task. The following topics should be covered:

- a. PPE
- b. Documentation requirements for the task (serial numbers, batch numbers, pressures etc.)
- c. Conversions and pressure charts
- d. LOTO
- e. Site procedures
- f. Tool maintenance requirements, e.g. control tool lubrication levels etc.

8.1.3 Based on the scenario documents, facilitate activities where participants identify and select the correct bolts, washers and nuts needed to complete the task to specification. The activities should require participants to consider:

- a. Types, sizes and coatings
- b. Bolt length and protrusion

8.1.4 Based on the scenario documents, facilitate activities where participants identify and select appropriate equipment needed to complete the task to specification. The activities should require participants to:

- a. Perform the P in PDR
- b. Determine if they should perform a 1-stage or 2-stage tensioning according to turbine manufacturer's manual
- c. Use a thread holding device on the thread at the opposite end to the tensioner
- d. Select a tensioner according to bolt size, thread pitch and protrusion
- e. Determine if they require spacers (if the protrusion is too long)
- f. Select correct pumps and hoses
- g. Select hydraulic tensioning tools – dropper tensioner



- h. Select the correct pumps and hoses for the job, including the need to ensure that pumps are meet the correct power supply requirements (frequency, voltage, phase)
- i. Select appropriate hand tools for completing the job
- j. Identify and plan for equipment documentation and maintenance requirements and how this could affect the completing the task
- k. Stroke limits and considerations in relation to the selected equipment

8.1.5 Continuously assess participant engagement and learning by actively asking participants to share their understandings and reflect on their actions and considerations

8.1.6 Provide participants with instruction, guidance and feedback as required to ensure that learning objectives are met

Note *To ensure learning, we recommend that participants are required to select appropriate bolt components and tools from a variety of different options. This does not require the training provider to own a variety of bolts and tools and can be done by using image cards showing different options.*



The participants shall:

8.1.7 Complete scenario-based activities to specification

8.1.8 Share understandings and considerations with instructors and other participants

8.1.9 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 8.2 - PREPARING FOR THE TASK

Learning objectives:

- 73) The participants can **distinguish** between suitable and damaged or compromised bolts, nuts and washers (Skill, intermediate level)
- 74) The participants can **perform** a visual inspection of bolts (Skill, intermediate level)
- 75) The participants can **distinguish** between functioning and damaged pump and hose components (Skills, intermediate level)
- 76) Participants can **perform** appropriate actions to mitigate damaged or malfunctioning pumps and hose components as to ensure that they do not pose a safety or quality risk to the specified bolt tensioning task (Skills, intermediate level)



- 77) The participants can **distinguish** between functioning and damaged tool components (Skills, intermediate level)
- 78) Participants can **perform** appropriate actions to mitigate damaged or malfunctioning tool components as to ensure that they do not pose a safety or quality risk to the specified bolt tensioning task (Skills, intermediate level)



The instructor shall:

- 8.2.1 Based on the scenario documents, facilitate activities where participants are required to perform visual inspection of bolts and bolt components to distinguish between suitable and damaged or compromised bolts and components
- 8.2.2 Based on the scenario documents, facilitate activities where participants are required to perform pre-use inspection of hydraulic pumps and hose components to ensure that they do not pose a safety or quality risk to the specified bolt tensioning task
- 8.2.3 Based on the scenario documents, facilitate activities where participants are required to perform pre-use inspection of hydraulic tensioning tools and components to ensure that they do not pose a safety or quality risk to the specified bolt tensioning task – including cycle counts and maintenance requirements in relation to the specified tensioning task
- 8.2.4 Based on the scenario documents, facilitate activities where participants are required to take appropriate actions to mitigate damaged, unmaintained, uncalibrated, or malfunctioning pump, hose and tool components as to ensure that they do not pose a safety or quality risk to the specified bolt tensioning task, including:
 - a. Stop work
 - b. Quarantine and reporting
 - c. Repairs including documentation
- 8.2.5 Continuously assess participant engagement and learning by actively asking participants to share their understandings and reflect on their actions and considerations
- 8.2.6 Provide participants with instruction, guidance and feedback as required to ensure that learning objectives are met



The participants shall:

- 8.2.7 Complete the scenario-based activities to specification
- 8.2.8 Share understandings and considerations with instructors and other participants



8.2.9 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 8.3 - PLANNING FOR SAFETY

Learning objectives:

- 79) Participants can **recognise** the safety hazards commonly present when conducting bolt tensioning using hydraulic tools (Knowledge, basic level)
- 80) Participants can **take initiative** to mitigate the safety risks associated with a specified bolt tensioning task (Ability, intermediate level)



The instructor shall:

- 8.3.1 Lead a discussion and ask engaging question about the safety hazards commonly present when conducting bolt tensioning using hydraulic tools, including:
 - a. PPE
 - b. Line of fire (head not over pressurised equipment, body placement, hydraulic leaks/over stroke)
 - c. Thread engagement
 - d. Heavy lifting
 - e. Dropped objects (tethering)
 - f. Hydraulics (heat, fluids, pressure, hydraulic injection, hose coupler ratings, fire hazard vaporised hydraulic fluid)
 - g. Electrical equipment (supply, electrocution, batteries, fuses, voltage)
 - h. Slipping/tripping
 - i. Counter holds
 - j. Two-man tensioning procedures (line of sight, communication, following company and site rules and procedures)
 - k. Working with pump pendants (single and dual action)
 - l. Noise
- 8.3.2 Lead a discussion and ask engaging question about how to mitigate the safety hazards commonly present when conducting bolt tensioning using hydraulic tools, including:



- a. PPE
- b. Line of fire (head not over pressurised equipment, body placement, hydraulic leaks/over stroke)
- c. Thread engagement
- d. Heavy lifting
- e. Dropped objects (tethering)
- f. Hydraulics (heat, fluids, pressure, hydraulic injection, hose coupler ratings, fire hazard vaporised hydraulic fluid)
- g. Electrical equipment (supply, electrocution, batteries, fuses, voltage)
- h. Slipping/tripping
- i. Counter holds
- j. Two-man tensioning procedures (line of sight, communication, following company and site rules and procedures)
- k. Working with pump pendants (single and dual action)
- l. Noise



The participants shall:

- 8.3.3 Actively engage in discussions and answer questions about safety hazards commonly present when conducting bolt tensioning using hydraulic tools
- 8.3.4 Actively engage in discussions and answer questions about mitigating the hazards commonly present when conducting bolt tensioning using hydraulic tools
- 8.3.5 Share understandings and considerations with instructors and other participants
- 8.3.6 Take responsibility for their learning by seeking guidance and clarification when in doubt

LESSON 9 - THE TASK PHASE: SAFE AND CORRECT TENSIONING OF BOLTS USING HYDRAULIC TOOLS

90 min.

The aim of this lesson is to train participants to, safely and correctly, carry out 2 stage bolt tensioning tasks to specification using hydraulic tensioning equipment.



After having successfully completed lesson nine of the Bolt Tightening Module, the participant can:

- 81) **Act independently** to perform a 2 stage bolt tensioning tasks to work instruction specification using hydraulic tensioning equipment (Ability, Intermediate)
- 82) **Act independently** to perform bolt loosening tasks using hydraulic tensioning equipment (Ability, Intermediate)

ELEMENT 9.1 - SETTING UP EQUIPMENT FOR USE

Learning objectives:

- 83) The participants can **act independently** to, safely and correctly, setup hydraulic bolt tensioning needed to perform a specified bolt tensioning task (Ability, intermediate level)
- 84) Participants **act independently** to, safely and correctly, pressurise and depressurise hydraulic equipment when conducting hydraulic bolt tensioning (Ability, intermediate level)



The instructor shall:

- 9.1.1 Based on the scenario documents, facilitate activities where participants are required to conduct pre-checks, including completing related documentation. As a minimum, participants should:
 - a. Setup the equipment
 - b. Inspect the setup equipment prior to use
 - c. Manage the work environment (tripping and slipping hazards)
 - d. Checking pressure settings
 - e. Completing related checks and documentation according to manuals and instructions
 - f. Control calibration and cycles (if applicable)
 - g. Set the value with the gauge according to the calibration chart
 - h. Discuss how to apply the hierarchy of control – e.g. safest being hands free, then using handles, then 1 person then 2 person with specific controls, e.g. use of equipment like equipment like gripper sockets
 - i. Fill-out PDR and task documentation found in annex 3



- 9.1.2 Based on the scenario documents, facilitate activities where participants are required to correctly pressurise and depressurise hydraulic equipment according to the equipment manuals, including:
 - a. Correct communication and body positioning in relation to equipment to avoid injury from failing components and hydraulic injection
 - b. Pressure adjustment without the tensioner attached using the correct pressure chart, tensioner specifications, and turbine manufacturer value (kN)
- 9.1.3 Continuously assess participant engagement and learning by actively asking participants to share their understandings and reflect on their actions and considerations
- 9.1.4 Provide participants with instruction, guidance and feedback as required to ensure that learning objectives are met



The participants shall:

- 9.1.5 Complete the scenario-based activities to specification
- 9.1.6 Share understandings and considerations with instructors and other participants
- 9.1.7 Take responsibility for their learning by seeking guidance and clarification when I doubt

ELEMENT 9.2 - BOLT TENSIONING

Learning objective:

- 85) Participants can **act independently** to, safely and correctly, tension and loosen a bolt to work instruction specification using hydraulic tensioning tools and accessories (Ability, intermediate level)



The instructor shall:

- 9.2.1 Based on the scenario documents, facilitate activities where participants are required to correctly carryout 2 stage tensioning of a bolt to specification using hydraulic tensioning tools, including:
 - a. Visual control of nut rotation if possible (exercising awareness of line of fire)
 - b. Checking for gearbox movement
 - c. Manage maximum stroke levels according to manufacturer's manual
 - d. Marking of bolts according to procedures



- 9.2.2 Continuously assess participant engagement and learning by actively asking participants to share their understandings and reflect on their actions and considerations
- 9.2.3 Provide participants with instruction, guidance and feedback as required to ensure that learning objectives are met



The participants shall:

- 9.2.4 Complete the scenario-based activities to specification
- 9.2.5 Share understandings and considerations with instructors and other participants
- 9.2.6 Take responsibility for their learning by seeking guidance and clarification when in doubt

Note *Instruction: the instructor should demonstrate how to correctly carryout 2 stage tensioning prior to participants completing the activities, including a demonstration of how to mark the bolts, highlighting that different companies will have their own specific marking procedures.*

Safety: to reduce the risk of injury and damage to bolts the instructor should always check tensioner engagement with the bolt and ensure that participants are not in line of fire prior to tensioning.

ELEMENT 9.3 - BOLT LOOSENING

Learning objective:

- 86) Participants can **act independently** to, safely and correctly, loosen bolts using hydraulic tensioning tools and accessories (Ability, intermediate level)



The instructor shall:

- 9.3.1 Based on the scenario documents, facilitate activities where participants are required to loosen a bolt using hydraulic tensioning tools and accessories according to the manufacturer's manual (loosening gap), including the prechecking the condition and status of the stud/bolt to be loosened (is the bolt actually tightened prior to loosening?)
- 9.3.2 Continuously assess participant engagement and learning by actively asking participants to share their understandings and reflect on their actions and considerations
- 9.3.3 Provide participants with instruction, guidance and feedback as required to ensure that learning objectives are met



The participants shall:

- 9.3.4 Complete the scenario-based activities to specification
- 9.3.5 Share understandings and considerations with instructors and other participants
- 9.3.6 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 9.4 - SAFETY, QUALITY AND TROUBLE SHOOTING

Learning objectives:

- 87) Participants can **take responsibility** to mitigate the safety hazards present during bolt tensioning using energy powered equipment (Ability, intermediate level)
- 88) Participants can **act independently** identify common faults and failures when using energy powered tensioning equipment (Ability, intermediate level)
- 89) Participants can **take initiative** to safely rectify faults and failures that commonly arise using when using energy powered tensioning equipment (Ability, intermediate level)



The instructor shall:

- 9.4.1 Lead a reflective discussion and ask engaging questions about mitigating the safety hazards present in bolt tensioning tasks using energy powered equipment, paying special attention to line of fire:
 - a. Thread engagement
 - b. Discuss the need to stop work as soon as something is out of the ordinary
- 9.4.2 Present how to identify and rectify common faults and failures with energy powered tensioning equipment, including:
 - a. Sudden changes in pressure
 - b. Loose hoses
 - c. Tool failure
 - d. Incorrect use of tools (including over stroking)
 - e. Pump electrical supply problems (generators if used for the powering the pump)



- f. Leakages of hydraulic fluid
- g. Incorrect setup under covers/handles on hoses and pumps
- h. Depressurising the system and checking for faults
- i. Bolt not tightened correctly
- j. Broken gearboxes
- k. Insufficient pressure
- l. Thread engagement

9.4.3 Lead a discussion and ask engaging questions about the importance of following manuals, company procedures and documentation requirements when encountering equipment faults and failures

9.4.4 Give constructive feedback to the participants on their performance during discussions



The participants shall:

- 9.4.5 Actively engage in discussions and answer questions about safety hazards commonly present when conducting bolt tensioning using hydraulic equipment
- 9.4.6 Actively engage in discussions and answer questions about rectifying typical faults and failures associated with energy powered bolt torquing equipment
- 9.4.7 Share understandings and considerations with instructors and other participants
- 9.4.8 Take responsibility for their learning by seeking guidance and clarification when I doubt

LESSON 10 - POST-TASK PHASE: PACK UP AND REVIEW

15 min.

The aim of this lesson is to train participants to, safely and correctly, complete bolt tensioning tasks to specification using a combination of electric and hydraulic torquing equipment.

After having successfully completed lesson 10 of the Bolt Tightening Module, the participant can:

- 90) **Act independently** to correctly review and complete bolt torquing tasks to specification (Ability, intermediate level)



ELEMENT 10.1 - POST-USE INSPECTION AND PACKING

Learning objective:

- 91) The participants can **act independently** to, safely and correctly, inspect, disassemble, and pack hydraulic bolt tensioning equipment after use (Ability, intermediate level)



The instructor shall:

- 10.1.1 Based on the scenario documents, facilitate activities where participants are required to:
- 10.1.2 Correctly conduct a post-use inspection of equipment
- 10.1.3 Disassemble and pack equipment for transport – including de-energizing, disconnecting hoses, placing caps on hoses and gather all equipment
- 10.1.4 Assess maintenance procedures and limitations in relation to the next job and in accordance with manuals (e.g. time of use in manufacturers manual)



The participants shall:

- 10.1.5 Complete the scenario-based activities to specification
- 10.1.6 Share understandings and considerations with instructors and other participants
- 10.1.7 Take responsibility for their learning by seeking guidance and clarification when I doubt

ELEMENT 10.2 - POST-JOB DOCUMENTATION

Learning objectives:

- 92) The participants can **act independently** to, correctly complete task paperwork and documentation (Ability, intermediate level)
- 93) The participants can **explain** the implications of failing to correctly complete task paperwork and documentation (Knowledge, intermediate level)



The instructor shall:



- 10.2.1 Based on the scenario documents, facilitate activities where participants are required to complete task paperwork and documentation, including:
 - a. The post-job checklist can be found in Annex 3
 - b. Report any failures or abnormalities according to company procedures
 - c. Applicable equipment documentation (e.g. tensioner logbook, pump logbook, etc)
- 10.2.2 Lead a discussion and ask engaging questions about the importance of completing task paperwork and documentation, including the implications of not completing the paperwork (e.g. traceability and being able replace bolts)
- 10.2.3 Provide examples of the implications that can result from incorrect and inadequate documentation and task paperwork, including the potential safety implications



The participants shall:

- 10.2.4 Complete the scenario-based activities to specification
- 10.2.5 Actively engage in discussions and answer questions about the importance of completing task paperwork and documentation, including the implications of not completing the paperwork
- 10.2.6 Share understandings and considerations with instructors and other participants
- 10.2.7 Take responsibility for their learning by seeking guidance and clarification when in doubt

LESSON 11 - USING MECHANICAL HANDLING AIDS TO ASSIST WITH BOLT TIGHTENING TASKS

35 min.

The aim of this lesson is to provide participants with an introduction to mechanical handling aids and the hazards associated with using them.

After having successfully completed Lesson 11 of Bolt Tightening Module, the participants can:

- 94) **Recognise** different types of mechanical handling aids that are typically used for bolt tightening activities (Knowledge, basic level)
- 95) **Show interest** in the use of mechanical handling aids for transporting, preparing and disassembling heavy bolt tightening equipment and components (Ability, basic level)
- 96) **Solve** the challenge of mitigating hazards associated with using mechanical handling aids for bolt tightening (Ability, basic level)



ELEMENT 11.1 - MECHANICAL HANDLING AIDS TYPICALLY USED IN THE WIND INDUSTRY

Learning objectives:

- 97) The participants can **name** the different types of mechanical aids typically used for bolt tightening tasks involving heavy equipment and components (Knowledge, basic level)
- 98) The participants **show interest** in consulting manuals before using mechanical aids for bolt tightening tasks (Ability, basic level)
- 99) Participants can **solve** the challenge of identifying the correct lifting points when using mechanical handling aids to move heavy bolt tightening equipment and components (Ability, basic level)



The instructor shall:

- 11.1.1 Lead a discussion about handling of heavy equipment and bolt components and when to use mechanical handling aids, including the hazards associated with heavy equipment including manual handling
- 11.1.2 Present the different types of mechanical handling aids typically used in the wind industry, for example:
 - a. Tool balancers (yoyo), retractors
 - b. Trollies
 - c. Winches and hoists
- 11.1.3 Present the importance of reading manuals before using mechanical handling aids for bolt tightening tasks
- 11.1.4 Present examples of lifting points on heavy equipment and the importance of using them (this can be done by showing a short video or images)
- 11.1.5 Ask participants involving questions about mechanical handling aids and their applications to bolt tightening



The participants shall:

- 11.1.6 Actively engage in discussions and answer questions about the application of mechanical handling aids in bolt tightening tasks, including the hazards associated with their use and the importance of reading manuals



11.1.7 Share understandings and considerations with instructors and other participants

11.1.8 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 11.2 - USING MECHANICAL HANDLING AIDS

Learning objective:

100) The participants **solve** the challenge of using mechanical handling aids to complete bolt tightening tasks involving heavy equipment and components (Ability, basic level)



The instructor shall:

- 11.2.1 Facilitate practical exercises where participants practice using mechanical handling aids. The exercise should include:
 - a. Transport and installation
 - b. Preparing, including documentation and pre-use checks – including identifying bolt and equipment weights
 - c. Correct setup and Use
 - d. Disassembly
- 11.2.2 Lead a discussion and ask engaging questions about the using mechanical aids in wind turbine environments
- 11.2.3 Give constructive feedback to the participants on their performance during practice activities and discussions

Note *To deliver this lesson the training provider should provide a mock-up that requires participants to practise using mechanical aids where they as a minimum practise using a balancer of 5 kg tension, with a load of 4-5 kg this may be a small tool or practice weight.*



The participants shall:

- 11.2.4 Practice using mechanical handling aids



- 11.2.5 Actively engage in discussions and answer questions about the importance of completing task paperwork and documentation, including the implications of not completing the paperwork
- 11.2.6 Share understandings and considerations with instructors and other participants
- 11.2.7 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 11.3 - HAZARDS ASSOCIATED WITH USING MECHANICAL HANDLING AIDS

Learning objective:

- 101) The participants can **recognise** the hazards associated with using mechanical aids to complete bolt tightening tasks (Knowledge, basic level)



The instructor shall:

- 11.3.1 Explain the safety hazards associated with heavy equipment and bolt components including:
 - a. Transport
 - b. Trapping
 - c. Dropped objects
 - d. Crushing
- 11.3.2 Explain the safety hazards associated with using mechanical handling aids to move heavy equipment and bolt components including:
 - a. Positioning of the load when connect to the mechanical aid
 - b. Unintended retraction of the mechanical aid/release of energy (spring balancers)
 - c. Checks and maintenance of equipment
 - d. Body positioning and manual handling
 - e. Dropped objects
- 11.3.3 Ask participants involving questions about the risks and hazards associated with heavy equipment and bolt components, and the use of mechanical aids during bolt tensioning
- 11.3.4 Give constructive feedback to the participants on their performance during questions and discussions



Note *Instructor may use video or other appropriate learning aids to improve understanding of the risks associated with heavy bolt equipment and components and the subsequent use of mechanical handling aids.*



The participants shall:

- 11.3.5 Actively engage in discussions and answer questions about the hazards associated with using mechanical aids to move heavy equipment and bolt components
- 11.3.6 Share understandings and considerations with instructors and other participants
- 11.3.7 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 11.4 - MITIGATING HAZARDS ASSOCIATED WITH MECHANICAL HANDLING AIDS

Learning objective:

- 102) The participants can **show interest** in taking mitigating actions to reduce the safety and quality risks associated with using mechanical handling aids for bolt tightening tasks (Ability, basic level)



The instructor shall:

- 11.4.1 Lead a discussion about how to mitigate the risks and hazards associated with the use of mechanical handling aids in bolt tightening tasks, including:
 - a. Unintended retraction
 - b. No lone set-up
 - c. Getting the load onto the device
 - d. Positioning of the load when connect to the mechanical aid
- 11.4.2 Manual handling including a recommendation to take the GWO manual handling course if they have not already done so
- 11.4.3 Ask participants involving questions about mitigating the risks and hazards associated with using mechanical aids



The participants shall:



- 11.4.4 Actively engage in discussions and answer questions about the risks and hazards associated with the use of mechanical aids during the bolt tightening
- 11.4.5 Share understandings and considerations with instructors and other participants
- 11.4.6 Take responsibility for their learning by seeking guidance and clarification when in doubt

LESSON 12 - TRAINING REVIEW

15 min.

The aim of this lesson is to enable participants to reflect on and process their learning outcomes and key takeaways from the module, aiming to achieve a high learning transfer from the module to the company specific training and performance in future bolt tightening tasks.

ELEMENT 12.1 - TRAINING REVIEW



The instructor shall:

- 12.1.1 Facilitate a review of the training using the, what, so what, now what model (Driscoll 2007), whereby participants reflect upon their learning outcomes and achievements in relation to their previously stated expectations for the module perceived understanding of how the learning will be applied to their future work. The instructor should structure the session in the following way:
 - a. What?
 - a.i Describe how you experienced the bolt tightening module
 - a.ii Reflect on what surprised you about bolt tightening module, what parts of the module did you enjoy and what parts you did not, and why
 - b. So what?
 - b.i Describe how your understanding of bolt tightening in WTG environments has changed from before to after the module
 - b.ii Describe what you have learned, what areas of your performance need more attention, and what areas you think require more training
 - c. Now what?
 - c.i Describe how you intend to use what you have learned during the bolt tightening module, during company specific training and in future bolt tightening tasks
- 12.1.2 Provide an opportunity for participants to share their answers in plenary or in small groups e.g. in pairs



The participants shall:

- 12.1.3 Reflect on their learning outcomes and key take aways from the GWO Bolt Tightening Model, aiming to achieve a higher learning transfer from the module to their way of working by answering the: what, so what and now what questions
- 12.1.4 Share understandings and considerations with instructors and other participants
- 12.1.5 Take responsibility for their learning by seeking guidance and clarification when in doubt

ELEMENT 12.2 - FEEDBACK SESSION



The instructor shall:

- 12.2.1 Give an overall feedback and feed forward on the participants' learning outcomes inspired by the training as well as from the training-review-session
- 12.2.2 Encourage the participants to examine and grow awareness of which specific elements in their own WTG type/WTG environments differ from the training scenario environment (to visualise and enhance learning transfer)
- 12.2.3 Encourage the participants to discuss with colleagues about how the GWO Bolt Tightening Module content, methods and techniques are similar or different to the local specific conditions identified after the module completion

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



GLOBAL WIND
ORGANISATION

BTT Installation Module

(BTTI)



13. THE BTT INSTALLATION MODULE

13.1 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 level)
- 3) **Discuss** the checklist system throughout the complete installation process (Knowledge, intermediate level 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 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 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)

13.2 Duration of the BTT Installation Module

The total contact time for completing the BTT Installation module is 17 hours and 40 minutes.

The training provider must not exceed the time per day given in the table 13.2.1 below.

Maximum Duration Per Day



Contact time	8 hours
Total training day	10 hours

Table 13.2.1 - Maximum duration 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).

13.3 BTT Installation Participant Ratio

The ratio shown for theory sessions indicates the maximum number of participants per instructor attending the course.

Practical ratios indicate the maximum number of participants to be supervised by an instructor during each activity.

Module	Session	Instructor to Participant Ratio
BTT Bolt Tightening	Theory	1:12
	Practical	1:8

Table 13.3.1 - Instructor to participant ratio

13.4 Participant Prerequisites for the BTT Installation Module

Before attending the BTT Installation Module participants must first complete both the BTT Mechanical and BTT Bolt Tightening modules

13.5 Equipment

The equipment required for training as listed in Annex 1 must be available and must fulfil national legal requirements.

13.6 BTT Installation Module Timetable

Lesson	Element	Duration
1. Introduction	1.1 Safety and emergency procedures	
	1.2 Facilities	
	1.3 Introduction	



	1.4	Aims and objectives	
	1.5	Ongoing assessment	
	1.6	Motivation	
	1.7	Human factors	
	TOTAL		30 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	Unloaded and storage of blades, nacelle, tower sections and hub	
	5.4	Tools and equipment	
	5.5	Return of goods and components	
	TOTAL		70 min.
6. Lifting operations	6.1	Post-use inspection	
	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	Introduction to mechanical completion	
	8.2	Examples of mechanical completion	
	8.3	Risks and hazards associated with mechanical completion	
TOTAL			75 min.
9. Principles of electrical completion including cable work	9.1	Introduction to electrical completion	
	9.2	Examples of electrical completion	
	9.3	Risks and hazards associated with handling and working with cables	
	9.4	Different types of cables	
	9.5	Simple installation diagrams	
	9.6	Cutting and crimping cables	
	9.7	Marking, routing and termination of all cable types	
TOTAL			420 min.
10. Principles of hydraulic completion	10.1	Introduction to hydraulic completion	
	10.2	Examples of hydraulic completion	
	10.3	Risks and hazards associated with hydraulic completion	
TOTAL			40 min.
11. Principles of operation with external generators	11.1	Principles of yaw, rotor and blade operation with external generator	
	11.2	Risks and hazards associated with the operation of auxiliary systems with an external generator	
	11.3	Preconditions for the operation of a lift with an external generator	
	11.4	Preconditions for the operation of an internal crane with an external generator	
	11.5	Use of external generators for other auxiliary uses	
TOTAL			50 min.
12. Introduction to handover to the commissioning	12.1	Handover to commissioning	
	12.2	Risks and hazards associated with handing over to the commissioning	



TOTAL			30 min.
13. Summary and theoretical test	13.1	Summary	
	13.2	Theoretical test	
TOTAL			50 min.
14. Training review	14.1	Training review	
TOTAL			15 min.
GRAND TOTAL			1060min.

Table 13.6.1 - BTT Installation timetable

13.7 Detailed Description of the BTT Installation Module

LESSON 1 - INTRODUCTION

30 min.

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:
- 1.1.2 safety instructions according to internal procedures
- 1.1.3 emergency procedures and emergency exits in the areas where the participants can be expected to be located during the module



The participants shall:

- 1.1.4 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 - AIMS 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:
 - 1.6.2 the importance of personal involvement in the module
 - 1.6.3 the need for the BTT Installation module when working in the wind industry



The participants shall:

- 1.6.4 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 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
- 2.2.3 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
- 2.2.4 Ask the participants relevant questions about the health risks associated with the hazardous situations
- 2.2.5 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

- 2.2.6 Ask the participants relevant questions about the means to reduce the exposure to acceptable levels
- 2.2.7 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
- 2.2.8 Give constructive feedback on the participants' group discussion about the importance of installation safety when working in an installation environment:



The participants shall:

- 2.2.9 Describe in their own words and share understandings about how to identify known and suspected hazards involved in the installation of turbines
- 2.2.10 Describe in their own words and share understandings about the health risks associated with the hazardous situations
- 2.2.11 Describe in their own words and share understandings about the means to reduce the exposure to acceptable levels
- 2.2.12 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

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
- 2.4.3 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



The participants shall:

- 2.4.4 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

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



The participants shall:

- 2.5.4 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)

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



The participants shall:

- 5.1.3 Engage in a 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
- 5.2.6 Give constructive feedback on the participants' inspection and documentation of this on a checklist



The participants shall:

- 5.2.7 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)

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

5.5.3 Show examples of and describe the return goods report

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

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



The participants shall:

5.5.6 Engage in discussions about how to return tools

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



The participants shall:

- 6.2.9 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.)
- 6.2.10 Engage in discussions about the consequences of procedural errors in lifting operations and damage to the equipment

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 offshore 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:
- 7.1.2 Preparation – e.g. gathering tools, mounting stud bolts on blades, installing spinner shells on hub, removing transport frames or equipment, cleaning flanges, etc.
- 7.1.3 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
- 7.1.4 Assembly – e.g. assembly of main components into the turbine itself (tower sections, nacelle, hub, rotor, etc.)
- 7.1.5 Explain why preparation is performed before pre-installation and installation
- 7.1.6 Explain and show the importance of cleaning the main components before they are installed
- 7.1.7 Explain and show why it is important to repair damage to components before installation
- 7.1.8 Show examples of and explain cleaning.



- 7.1.9 Describe the difference between onshore and offshore approaches to preparation and pre-installation of main components
- 7.1.10 Facilitate discussions about different tasks for preparation, pre-installation and installation of WTG at onshore and offshore sites.



The participants shall:

- 7.1.11 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



- 7.2.5 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



The participants shall:

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

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:
- Foundation alignment
 - Tower-Tower alignment
 - 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.
- 8.2.4 Give constructive feedback on the participants' documentation in a checklist of the mechanical completion of a partly complete WTG



The participants shall:

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

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



The participants shall:

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



LESSON 9 - PRINCIPLE OF ELECTRICAL COMPLETION

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
- 9.3.6 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



The participants shall:

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

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:
- 9.4.2 Small signal cables: shielded and unshielded, rubber, PVC, cable glands
- 9.4.3 Main power (HV&LV) cables: copper, aluminium, rubber and PVC insulation types
- 9.4.4 Fibre optic cables: glass core, plastic core
- 9.4.5 Ask the participants relevant questions about the purposes and application of the different cable types in the WTG
- 9.4.6 Give constructive feedback on the participants' explanations of the purposes and application of the different cable types in the WTG



The participants shall:



- 9.4.7 Explain in their own words and share understandings about 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:
- a. Colour and numbering codes (explain that there should be a reference to applicable local standards: i.e. ISO or ANSI and also company-specific Work Instructions)
 - b. Cable list (explain that there should be a reference to applicable local standards: i.e. ISO or ANSI and also company-specific Work Instructions)
 - c. 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)
- 9.5.3 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



The participants shall:

- 9.5.4 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)

ELEMENT 9.6 - CUTTING AND CRIMPING 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:
 - a. Knives and special cutting tools
 - b. Stripping tools to remove cable insulation
 - c. 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:
 - a. Shielded and unshielded
 - b. Rubber and PVC insulation types
- 9.6.3 Explain and demonstrate how to cut and crimp main power (LV) cables:
 - a. Copper and aluminium (special attention to correct cable die-set)
 - 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
- 9.6.4 Facilitate practice for the participants in cutting and crimping small signal cables and main power (LV) cables
- 9.6.5 Give constructive feedback on the participants' cutting and crimping of small signal and main power LV cables



The participants shall:

- 9.6.6 Practice cutting and crimping small signal cables:
 - a. 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
- 9.6.7 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.



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 cable 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

9.7.8 Give constructive feedback on the participants' marking, routing and termination of all cable types



The participants shall:

9.7.9 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

9.7.10 Practice mounting markings in accordance with an electrical diagram:

- a. Cable and conductor
- b. Cabinet (diagram)

9.7.11 Practice routing all cable types applying these factors:

- a. Bending radius
- b. Distance between cable types and groups
- c. Fastening of cables: fixed vs flexible
- d. Cable protection tubes or edge protection
- e. Cable glands

9.7.12 Practice routing fibre optic cables

9.7.13 Practice correctly terminating signal cables:



- a. Mounting of ferrules
- b. Mounting in clamp and screw terminals
- c. Shield termination types

9.7.14 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)

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 injuries)
- 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 injuries)
- 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
- 10.3.6 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



The participants shall:

- 10.3.7 Engage in a group discussion about the hazards associated with hydraulic completion
- 10.3.8 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 10.3.9 Engage in discussions about the correct PPE

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 BLADE 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
- 11.1.4 Give constructive feedback on the participants' practice for connecting the auxiliary power to an electrical system while ensuring the main power is disconnected



The participants shall:

- 11.1.5 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)

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.
- 11.2.3 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



The participants shall:

- 11.2.4 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
- 11.2.5 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 11.2.6 Engage in discussions about the correct PPE.

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.:
 - a. The lift must be inspected and certified
 - b. 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 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
- 12.2.5 Give constructive feedback on the participants' group discussions about the possible risks, hazards and consequences of the handover to commissioning



The participants shall:

- 12.2.6 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
- 12.2.7 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

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:

a. Pass the final test



The instructor shall:

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

13.2.3 Conduct the test with the participants (20 questions / 30 min)

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



The participants shall:

13.2.6 Complete the test (20 questions / 30 min)

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 following pages contain the lists of equipment required for delivering the Basic Technical Training standard. 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.

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.*



1. Equipment list: BTT Mechanical

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)
- 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. Equipment list: BTT Electrical

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. Equipment list: BTT Hydraulic

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. Equipment list: BTT Bolt Tightening

The following equipment is required during the entire duration of this BTT Bolt Tightening Training to meet the need of the BTT Bolt Tightening Module:

Bolt Torquing Scenario:

- PPE suitable for bolt tightening 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)
- Hydraulic pump with pendant
- Hydraulic hoses and couplings
- Hydraulic torque wrench socket type minimum 4500 Nm and minimum socket size 55 millimetres with safety handles
- Hydraulic torque wrench cassette type minimum 4500 Nm and minimum socket size 55 millimetres with safety handles
- Electrical torque wrench with reaction arm, variable torque settings and a minimum socket size of 55 millimetres
- Mock-up for bolt torquing with various sets of bolts, matching the tools being used in the tools on this equipment list
- Counter support/counter wrench/backup wrench matching the tools and bolts being used
- Up-to-date pressure charts
- Pins/o-rings for socket securing (cable ties are not acceptable)
- Markers for bolts (demonstration)

Bolt Tensioning Scenario:

- PPE suitable for bolt tightening 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
- Hydraulic pump with pendant
- Hydraulic hoses and couplings
- Hydraulic tensioner minimum M36
- Ratchet
- Vernier calliper



- Mock up for bolt tensioning with various sets of bolts, matching the tools being used in the tools on this equipment list
- Stud thread holder/bolt fixation tool matching the tools and bolts being used
- Up-to-date pressure charts
- Markers for bolts (demonstration)

Mechanical Aids Lesson:

- Adjustable spring balancer (+5kg)
- Tool or weight for demonstration and activity purposes

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.

5. Equipment list: 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:
 - Electrical cabinets with standard DIN rails for mounting terminals (clamp, screw type)
 - Clamp, screw type terminals
 - Cable glands
 - Cable trays
 - 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 - SCENARIO DOCUMENTS: BOLT TORQUING

1. Documents included in Annex 2:

- a. GWO Work instructions for Torquing
- b. GWO Bolt Torquing Manual (template and example)
- c. GWO PDR
- d. GWO Post-Job Checklist

2. Instructions for Adapting the GWO Bolt Torquing Manual to Training Facilities

The GWO Bolt Torquing Manual provided in the following pages is a generic document, with blank spaces for the training provider to fill in. This is to allow for differences in training facilities, bolts, equipment and mock-ups. Therefore, the training provider should fill in the blank spaces with information that matches the specific facilities, bolts, equipment and mock up. The blank spaces to be filled in are marked with red text instructions, and are found in the following sections of the GWO Bolt Torquing Manual:

- a. Section 4.1 Safety data sheets (SDS) for chemicals
- b. Section 4.3 Labels based on the maintenance/calibration requirements of the tool manufacturers should be placed on the tools being used in a way that participants can judge if a tool is ready for use, an example image of the tool label should be inserted into the work instructions. The label must include:
 - b.i A calibration due date that can be checked against the date of the course
 - b.ii A calibration ID number for filling out the checklist
- c. Section 5 To be filled to match the bolts being used in training
- d. Section 6 To be filled out to match the bolts being used, for the purpose of training the Training Provider should also fill out an additional two type of bolts with different lubrication requirements to the bolts being used in training
- e. Section 7 align the bolt torque values in the table to the bolts being used in the training mock-up (remembering that different torque values are required for a minimum of three M36 bolts)
- f. Section 8 Marking procedures for training purposes



Note This is a fictive generic work instruction intended for training purposes and therefore may vary from the work instructions provided by a company. It is important that a technician always read work instructions carefully prior to any bolt torquing task.

3. GWO Work Instructions for Bolt Torquing (For Training Purposes Only)

Work Instruction: Bolt Torquing Scenario	Document No.: GWO 123456
	Prepared by: John Doe
	Reviewed By: Jane Doe
	Released by: GWO training simulation
Site: Generic Wind Turbine Generator	Version: 2.0
Turbine Serial Number: 654321	Exemption Certificate No. (ENC): 123456
Checklist: GWO Post-Job Checklist	Date: 01-01-2023
Task Description	
1. Conduct a briefing and fill-out the relevant parts of the PDR and job checklist 2. Following the procedures and specifications described in the GWO Bolt Torquing Manual, each participant shall use: i) electrical torquing tools to first complete 1-stage tightening of at least three M36 bolts, each bolt requiring a different torque value. ii) hydraulic torquing tools to complete 2-stage tightening of at least two M36 bolts, each bolt requiring a different torque value. 3. Complete the PDR and job checklist 4. Loosen the bolts using either electric or hydraulic torquing tools. Making sure to check that the bolt is actually tightened prior to loosening.	



Note This is a fictive generic manual intended for training purposes and therefore may vary from the manual provided by a company. It is important that a technician always read manuals carefully prior to any bolt torquing task.

4. GWO Manual for Bolt Torquing (For Training Purposes Only)

Manual: Bolt Torquing Scenario	Document No.: GWO 123456
	Prepared by: John Doe
	Reviewed By: Jane Doe
	Released by: GWO training simulation
Product: Generic Training Product	Version: 2.0
Version Release Date: 01-01-2023	Exemption Certificate No. (ENC): 123456

1. Revision Sheet

Version	ECN no.	Date	Change description	Author
2	123456	01-01-2023	- Updated reference document list to include GWO PDR - Updated to include reporting of defects	James Doe

2. Introduction

Scope	This work instruction provides the scenario template for the GWO bolt torquing scenario 1.
Training Level Required	Participants must have completed the GWO BTT-M in order to participate in this training scenario. The training provider must facilitate this scenario according the GWO Bolt Tightening Module ensuring that all learning objectives are met.
Safety	All participants must don correct PPE when participating in this scenario. All participants must follow the safety instructions given by the training provider. Extra care will be taken in relation to hand placement and reaction arms when torquing bolts.



To reduce the risk of injury and damage to bolts and equipment it is recommended to use lower torque settings to complete practical torquing activities. If no safety handle is present do not perform operation.

Risk Assessment This scenario must be carried out in accordance with the training providers risk assessment of the training and training facilities.

In any WTG environment it is important for participants to read a job risk assessment prior to commencing work.

Hazardous Energies In the real world it is important for participants to understand and follow company procedures for mitigating the risk of hazardous energies.

Lifting Equipment This training scenario involves lifting and it is recommended that the instructor and participants follow the learnings provided by the GWO Basic Safety Manual Handling Module.

3. Reference Documents

Risk Assessment The training provider may choose to make the risk assessment of the training available for the participants.

4. Bolt Torquing in General

4.1 Safety Precautions for the Use of Bolt Torquing Tools		
It is mandatory to comply with the following safety precautions when handling tools for any bolt torquing task		
Electrical Torque Wrench with Reaction Arm		
	Mandatory! Wear Eye Protection Type: to be filled out bey training provider	Training provider: Insert image of electrical torque wrench with reaction arm being used for training



	Mandatory! Wear Hearing Protection Type: to be filled out by training provider	
	Mandatory! Wear Protective Gloves Type: to be filled out by training provider	
Hydraulic Torquing Tools		
	Mandatory! Wear Eye Protection Type: to be filled out by training provider	Training provider: Insert image of hydraulic torque wrench being used for training
	Mandatory! Wear Hearing Protection Type: to be filled out by training provider	
	Mandatory! Wear Protective Gloves Type: to be filled out by training provider	
4.2 Chemicals and Lubricants		
It is mandatory to comply with the following safety precautions when handling tools for any bolt torquing task		
Lubricants		
	Warning! Chemical Hazard Wear required PPE stated in the Safety Data Sheet (SDS) according to the chemical in question	Training provider: Insert image of the container for chemical being used for training
Hydraulic Fluid		

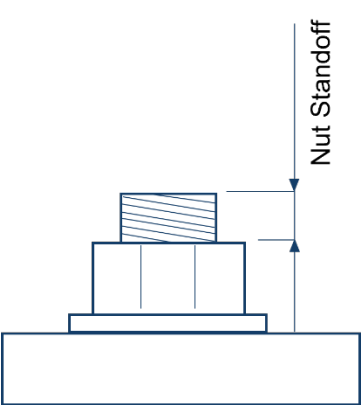


	Warning! Chemical Hazard Wear required PPE stated in the Safety Data Sheet (SDS) according to the chemical in question	Training provider: Insert image of the container for chemical being used for training
4.3 General Precautions When Torquing Bolts in turbines are always tightened to specific values. Over-tightening a bolt may lead to the bolt being damaged or failure (breaking) during turbine operation. Under-tightening a bolt may cause bolt to loosen during turbine operation, leading to the overload of neighbouring bolts, which may subsequently fail. It is important to follow the procedures described in this document to prevent personal injury, damage to bolts or equipment or bolt failure during turbine operation.		
4.4 Approved Tightening Tools Only calibrated tools may be used. The calibration due date must be checked with the date of the task. Tools that are missing a label or that have exceeded the calibration date may not be used. Training provider: insert photo of tool calibration label		
Figure 4.3: An example of a tool calibration label		
4.5 Reuse of Bolts and Nuts Prior to reusing bolts and nuts, check with the company and bolt manufacturer requirements, in particular any specific relubrication requirements. Locknuts and any bolts nuts and washes that have visible damage may not be reused and must be replaced with new ones.		
4.6 Lubricants Training provider: fill in lubrication instructions in accordance with the mock-up and bolts, nuts and washers being used in training.		



4.7 Nut Standoff

Training provider: fill in the nut standoff instructions in accordance with the mock-up and bolts, nuts and washers being used in training.

	Nut Standoff	
	Thread size	Torque
	M8	
	M10	
	M12	
	M16	
	M20	
	M24	
	M30	
	M33	
	M36	
	M42	
	M48	

5. Bolt Specifications

The table below is to be filled out by the training provider according to the bolts being used in training

Type	ISO			HV	Stainless	
Property Class						
Marking						
Nut						
Washer						
Width across flats						
Lubrication						
Assembly						
Reuse						



6. Lubrication of Bolts

Lubrication is used to achieve the correct amount of friction and as such the applied lubrication must cover the entire friction surface in an even layer.

The different bolt types must be lubricated in the following way:

Bolt type	Lubricant
Bolt A	
Bolt B	
Bolt C	

Training provider: fill in the lubrication instructions for the bolts being used in training.

Safety Note: Correct PPE, specified in the SDS must be donned when working with lubricants

7. Bolt torque values

Training provider: you should modify the table below to match bolts used in training. GWO recommends using tension values at 50% of bolt yield strength for safety purposes.

Bolt Type	Hot Dip Galvanized		Stainless and bolt tightened into aluminium
Property Class	8.8	10.9	All Property Classes
	Torque Force		
Size↓	Nm	Nm	Nm
M8	21	30	14
M10	42	60	29
M12	75	100	52
M16	175	250	125
M20	350	450	250
M24	600	800	425
M30	1150	1650	800
M33	1550	2200	-
M36	2000	2800	-
M42	3200	4500	-
M48	4700	6500	-



8. Marking for Bolts

Marking is a visual indication that a bolt has been tightened to specification. Therefore, bolts may NEVER be marked prior to tightening, marking must follow the below process:

IMPORTANT!

Always tight and mark before going to next bolt/stud

Description of 1-stage marking

Training provider: please fill in the marking procedure to be used in training.

Training provider: insert
photo of 1-stage marking

Figure 8.1 – Photograph of 1-stage marking

Description of 2-stage marking:

IMPORTANT!

Training provider: please fill in the marking procedure to be used in training.

Always tight and mark before going to next bolt/stud

Training provider: insert
photo of 2-stage marking

Figure 8.2 – Photograph of 2-stage marking

9. Securing Bolts During Torquing

In some instances, it may be necessary to secure bolts or nuts during tightening to prevent unintended rotation of components. Only correct tools, such as a counter support/counter wrench/backup wrench should be used for this task. Never use a spanner or other non-purpose tool as it may damage the nut, bolt, or even WTG.

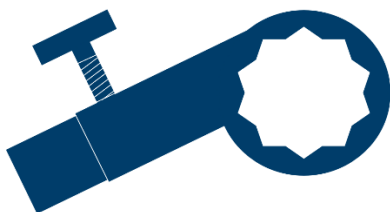




Figure 9.1 – Illustration of a typical counter support/ counter wrench/ backup wrench

10. Torquing Procedures

One and two-stage torquing in this scenario must follow the below steps:

- 1) Loosely mount all nuts and bolts in the joint and using, for example an electrical torque wrench or rattle gun.
- 2) **1-stage:** using an electrical torque wrench with reaction arm, tighten the nut to the value specified in table 2.1, mark the nut and bolt according to the procedure described in section 8 of this manual. **Always** tighten and mark before going to next bolt/nut!

Bolt	1-stage tightening
1	Value 1 of the given torque setting set by the scenario
2	Value 2 of the given torque setting set by the scenario
3	Value 3 of the given torque setting set by the scenario

Table 2.1: 1-Stage tightening specifications

Note *If you set the torque value at less than 70% of the 2-stage tightening process, then you will not have to loosen the bolts for the next step, saving time.*

- 3) **2-stage:** using hydraulic torquing tools, tighten all of the nuts to the % of the final torque value specified in table 3.1. Mark the nut and bolt according to the procedure described in section 8 of this manual. **Always** tighten and mark before going to next bolt/nut!

2-stage tightening specifications		
Bolt	Stage 1	Stage 2
1	70 % of the given torque setting set by the scenario	100 % of the given torque setting set by the scenario
2	70 % of the given torque setting set by the scenario	100 % of the given torque setting set by the scenario

Table 3.1: 2-stage tightening specifications



Note *The 70% in stage 1 may differ due to company work instructions and procedures*

Two-stage tightening is used on some joints to reduce the need for re-tightening during service. Any bolts that need loosening or replacing must be re-tightened using two-stage tightening if they were originally two-stage tightened.

When tightening using two stages it is crucial to follow the specific values given in the work instruction.

Safety: Always use appropriate PPE and be aware of reaction arms and surfaces when torquing



Note This is a fictive generic PDR (also called by other names) intended for training purposes and therefore may vary from the work evaluation documents provided by a company. It is important that a technician always read work evaluation documents carefully prior to any bolt torquing task.

5. GWO PDR (For Training Purposes Only)

This document has three pages!

Instructions: Each team fill out sections 1.1-1.8 before moving on to the planning section of this document.

1.1 Job Information		
Date:		
Site:		
Turbine Serial Number:		
1.2 Emergency Contact information		
Telephone Number:		
Radio Channel:		
Supervisor/person in Charge:		
1.3 Written Summary of the job to be completed:		
1.4 Risks, Hazards and Controls:		
1.5 Checklist		
Lock Out Tag Out (LOTO)	Yes	No
Hub Entry	Yes	No
Work Procedures	Yes	No
1.6 Supporting Documentation:		
1.7 Team members:		
1.8 Pre-job verification (Instructors signature):		



Instructions: Each team should conduct a pre-task briefing where they fill out sections 2 (Planning) and 3 (Doing) of this document

Section 2: Planning

2.1 Outline the work procedure and how you intend to complete it:

--

2.2 Identify critical steps and how you will manage these:

--

2.3 Identify risks, hazards and control measures in relation to the task:

--

2.4 Discuss how to reduce the risk of human errors in relation to the task:

--

Section 3: Doing

3.1 Outline how the team will monitor and control hazards during the task:

--

3.2 Outline how the team will pause to discuss and check the teams understanding of any deviations

--

3.3 Identify how team members will retain focus during the repetitive bolt tightening task:

--

3.4 Outline how the team will conduct self-checking and peer review throughout the task:

--



Instructions: following the task each team should conduct a debriefing where they fill out section 4 (Reviewing) of this document

Section 4: Reviewing
4.1 what could the team have done to make the job more efficient?
4.2 What challenges problems arose during the task?
4.3 What needs to be reported and corrected (injuries near misses, equipment, etc.), and who will report it?



Note This is a fictive generic job checklist intended for training purposes and therefore may vary from the job checklist provided by a company. It is important that a technician always read job checklist carefully prior to any bolt torquing task.

6. GWO Post-Job Checklist (For Training Purposes Only)

Instructions: The first section of this document is to be filled out prior to commencing the task. The second section is to be filled out as part of the QA procedure during the task.

Date (DD-MM-YYYY)		Title	ECN
		Bolt Torquing Scenario	123456
Site		Turbine Serial Number	Approval Date
ID	Technician Name	GWO WINDA ID Number	
1			
2			
3			
Calibrated Tools			
ID	Tool Type and Name	Calibration Number	
1			
2			
3			
4			
5			

Bolt Torquing Scenario					
Technician completing the task (name):					
Bolt being tightened (defined in torquing manual)	Remarks	Tool used	N/A	Not OK	OK



ANNEX 3 - SCENARIO DOCUMENTS: BOLT TENSIONING

1. Documents included in Annex 3:

- a. GWO Work instructions for Tensioning
- b. GWO Bolt Tensioning Manual (template and example)
- c. GWO PDR
- d. GWO Post-Job Checklist

2. Instructions for Adapting the GWO Bolt Tensioning Manual to Training Facilities

The GWO Bolt Tensioning Manual provided in the following pages is a generic document, with blank spaces for the training provider to fill in. This is to allow for differences in training facilities, bolts, equipment and mock-ups. Therefore, the training provider should fill in the blank spaces with information that matches the specific facilities, bolts, equipment and mock up. The blank spaces to be filled in are marked with red text instructions, and are found in the following sections of the GWO Bolt Tensioning Manual:

- a. 4.1 Safety data sheets (SDS) for chemicals
- b. 4.3 Labels based on the maintenance/calibration requirements of the tool manufacturers should be placed on the tools being used in a way that participants can judge if a tool is ready for use, an example image of the tool label should be inserted into the work instructions. The label must include:
 - b.i A calibration due date that can be checked against the date of the course
 - b.ii A calibration ID number for filling out the checklist
- c. 5 To be filled to match the bolts being used in training
- d. 6 To be filled out to match the bolts being used, for the purpose of training the Training Provider should also fill out an additional two type of bolts with different lubrication requirements to the bolts being used in training
- e. Section 7 align the bolt tensioning values in the table to the bolts being used in the training mock-up (remembering that different tensioning values are required for a minimum of two M36 bolts)
- f. Section 8 Marking procedures for training purposes



Note This is a fictive generic work instruction intended for training purposes and therefore may vary from the work instructions provided by a company. It is important that a technician always read work instructions carefully prior to any bolt tensioning task.

3. GWO Work Instructions for Bolt Tensioning (For Training Purposes Only)

Work Instruction: Bolt Tensioning Scenario	Document No.: GWO 987654
	Prepared by: John Doe
	Reviewed By: Jane Doe
	Released by: GWO training simulation
Site: Generic Wind Turbine Generator	Version: 2.0
Turbine Serial Number: 987654	Exemption Certificate No. (ENC): 456789
Checklist: GWO Job Checklist	Date: 01-01-2023
Task Description	
1. Conduct a briefing and fill-out the relevant parts of the PDR and job checklist 2. Following the procedures and specifications described in the GWO Tensioning Manual, use hydraulic tensioning tools to complete 2-stage tensioning of at least two M36 bolts, each bolt requiring a different tension value. 3. Complete the PDR and job checklist 4. Loosen the bolts using hydraulic tensioning tools. Making sure to check that the bolt is actually tightened prior to loosening.	



Note This is a fictive generic manual intended for training purposes and therefore may vary from the manual provided by a company. It is important that a technician always read manuals carefully prior to any bolt tensioning task.

4. GWO Manual for Bolt Tensioning (For Training Purposes Only)

Manual: Bolt Tensioning Scenario	Document No.: GWO 987654
	Prepared by: John Doe
	Reviewed By: Jane Doe
	Released by: GWO training simulation
Product: Generic Training Product	Version: 2.0
Version Release Date: 01-01-2023	Exemption Certificate No. (ENC): 456789

1. Revision Sheet

Version	ECN no.	Date	Change description	Author
2	456789	01-01-2023	- Updated reference document list to include GWO PDR - Updated to include reporting of defects	James Doe

2. Introduction

Scope	This work instruction provides the scenario template for the GWO bolt tensioning scenario 1.
Training Level Required	Participants must have completed the GWO BTT-M in order to participate in this training scenario. The training provider must facilitate this scenario according the GWO Bolt Tightening Module ensuring that all learning objectives are met.
Safety	All participants must don correct PPE when participating in this scenario. All participants must follow the safety instructions given by the training provider. Extra care will be taken to avoid line of fire when tensioning bolts.



To reduce the risk of injury and damage to bolts and equipment it is recommended to use lower tensioning settings to complete practical tensioning activities.

Risk Assessment This scenario must be carried out in accordance with the training providers risk assessment of the training and training facilities.

In any WTG environment it is important for participants to read a job risk assessment prior to commencing work.

Hazardous Energies In the real world it is important for participants to understand and follow company procedures for mitigating the risk of hazardous energies.

Lifting Equipment This training scenario involves lifting and it is recommended that the instructor and participants follow the learnings provided by the GWO Basic Safety Manual Handling Module.

3. Reference Documents

Risk Assessment The training provider may choose to make the risk assessment of the training available for the participants.

4. Bolt Tensioning in General

4.1 Safety Precautions for the Use of Bolt Tightening Tools		
It is mandatory to comply with the following safety precautions when handling tools for any bolt tensioning task		
Hydraulic Tensioning Tools		
	Mandatory! Wear Eye Protection Type: to be filled out by training provider	Training provider: Insert image of hydraulic tensioner being used for training
	Mandatory! Wear Hearing Protection Type: to be filled out by training provider	



	Mandatory! Wear Protective Gloves Type: to be filled out by training provider	
4.2 Chemicals and Lubricants It is mandatory to comply with the following safety precautions when handling tools for any bolt tensioning task		
Lubricants		
	Warning! Chemical Hazard Wear required PPE stated in the Safety Data Sheet (SDS) according to the chemical in question	Training provider: Insert image of the container for chemical being used for training
Hydraulic Fluid		
	Warning! Chemical Hazard Wear required PPE stated in the Safety Data Sheet (SDS) according to the chemical in question	Training provider: Insert image of the container for chemical being used for training
4.3 General Precautions When Tensioning Bolts in turbines are always tightened to specific values. Over-tightening a bolt may lead to the bolt being damaged or failure (breaking) during turbine operation. Under-tightening a bolt may cause bolt to loosen during turbine operation, leading to the overload of neighbouring bolts, which may subsequently fail. It is important to follow the procedures described in this document to prevent personal injury, damage to bolts or equipment or bolt failure during turbine operation.		



4.4 Approved Tightening Tools

Only calibrated tools may be used. The calibration due date must be checked with the date of the task.
Tools that are missing a label or that have exceeded the calibration date may not be used.

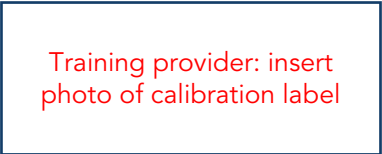


Figure 4.3: An example of a tool calibration label

4.5 Reuse of Bolts and Nuts

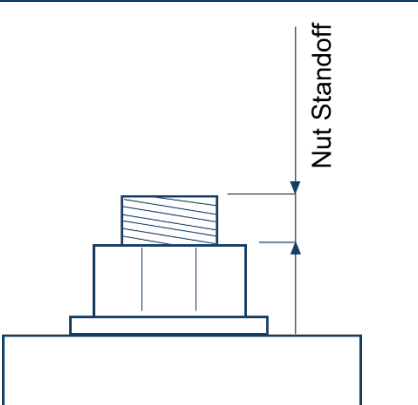
Prior to reusing bolts and nuts, check with the company and bolt manufacturer requirements, in particular any specific relubrication requirements.
Locknuts and any bolts, nuts and washes that have visible damage may not be reused and must be replaced with new ones.

4.6 Lubricants

Training provider: fill in lubrication instructions in accordance with the mock-up and bolts, nuts and washers being used in training.

4.7 Nut Standoff

Training provider: fill in the nut standoff instructions in accordance with the mock-up and bolts, nuts and washers being used in training.

	Nut Standoff	
	Thread size	Nut standoff
	M8	
	M10	
	M12	
	M16	
	M20	
	M24	
	M30	
	M33	



	M36	
	M42	
	M48	

5. Bolt Specifications

The table below is to be filled out by the training provider according to the bolts being used in training

Type	ISO			HV	Stainless	
Property Class						
Marking						
Nut						
Washer						
Width across flats						
Lubrication						
Assembly						
Reuse						

6. Lubrication of Bolts

Lubrication is used to achieve the correct amount of friction and as such the applied lubrication must cover the entire friction surface in an even layer.

The different bolt types must be lubricated in the following way:

Bolt type	Lubricant
Bolt A	
Bolt B	
Bolt C	

Training provider: fill in the lubrication instructions for the bolts being used in training.

Safety Note: Correct PPE, specified in the SDS must be donned when working with lubricants



7. Bolt tensioning values

Training provider: **you should modify the table below to match bolts being used in your training.** GWO recommends using tension values at 50% of bolt yield strength for safety purposes.

Bolt Type	Hot Dip Galvanized		Stainless and bolt tightened into aluminium
Property Class	8.8	10.9	All Property Classes
	Min. Tension Force		
Size↓	kN	kN	kN
M8	15	30	5
M10	30	55	10
M12	55	95	25
M16	95	145	40
M20	145	180	65
M24	180	210	80
M30	210	335	95
M33	335	490	-
M36	490	585	-
M42	585	640	-
M48	640	725	-

8. Marking for Bolts

Marking is a visual indication that a bolt has been tightened to specification. Therefore, bolts may NEVER be marked prior to tightening, marking must follow the below process:

IMPORTANT!

Always tight and mark before going to next bolt/stud

Description of 1-stage marking

Training provider: please fill in the marking procedure to be used in training.

Training provider: insert photo of 2-stage marking



Figure 8.1 – Photograph of 1-stage marking

Description of 2-stage marking:

IMPORTANT!

Always tight and mark before going to next bolt/stud

Training provider: insert
photo of 2-stage marking

Figure 8.2 – Photograph of 2-stage marking

9. Securing Bolts During Tensioning

In some instances, it may be necessary to secure bolts or studs during tightening activities to prevent unintended rotation of components. Only correct tools, such as a stud thread holder/bolt fixation tool should be used for this task. Never use a non-purpose tool as it may damage the bolts or studs, or even WTG.



Figure 9.1 – Photographic example of a correctly secured stud thread holder/bolt fixation tool

10. Tensioning Procedures

Two-stage tightening is used on some joints to reduce the need for re-tightening during service. Any bolts that need loosening or replacing must be re-tightened using two-stage tightening if they were originally two-stage tightened.

When tightening using two stages it is crucial to follow the specific values given in the work instruction.

Two-stage tensioning in this scenario must follow the below steps:

- 1) Loosely mount all nuts and bolts in the joint and using, for example with your hand.



- 2) **2-stage:** using hydraulic tensioning tools, tension all of the nuts to the % of the final tension value specified in table 2.1. Mark the nut and bolt according to the procedure described in section 8 of this manual. **Always** tension and mark before going to next bolt/nut!

2-stage tightening specifications		
Bolt	Stage 1	Stage 2
1	100 % of the given tension setting set by the scenario	100 % of the given tension setting set by the scenario
2	100 % of the given tension setting set by the scenario	100 % of the given tension setting set by the scenario

Table 2.1: 2-stage tightening specifications

Note The instructor shall explain the differences between and reasons for 1-stage and 2-stage tensioning and clarify that work instructions will always specify which type of tensioning is required.

Safety: Always use appropriate PPE and be aware of line of fire when tensioning



Note This is a fictive generic PDR (also called by other names) intended for training purposes and therefore may vary from the work evaluation documents provided by a company. It is important that a technician always read work evaluation documents carefully prior to any bolt tensioning task.

5. GWO PDR (For Training Purposes Only)

This document has three pages!

Instructions: Each team fill out sections 1.1-1.8 before moving on to the planning section of this document.

1.1 Job Information		
Date:		
Site:		
Turbine Serial Number:		
1.2 Emergency Contact information		
Telephone Number:		
Radio Channel:		
Supervisor/person in Charge:		
1.3 Written Summary of the job to be completed:		
1.4 Risks, Hazards and Controls:		
1.5 Checklist		
Lock Out Tag Out (LOTO)	Yes	No
Hub Entry	Yes	No
Work Procedures	Yes	No
1.6 Supporting Documentation:		
1.7 Team members:		
1.8 Pre-job verification (Instructors signature):		



Instructions: Each team should conduct a pre-task briefing where they fill out sections 2 (Planning) and 3 (Doing) of this document

Section 2: Planning

2.1 Outline the work procedure and how you intend to complete it:

--

2.2 Identify critical steps and how you will manage these:

--

2.3 Identify risks, hazards and control measures in relation to the task:

--

2.4 Discuss how to reduce the risk of human errors in relation to the task:

--

Section 3: Doing

3.1 Outline how the team will monitor and control hazards during the task:

--

3.2 Outline how the team will pause to discuss and check the teams understanding of any deviations

--

3.3 Identify how team members will retain focus during the repetitive bolt tightening task:

--

2.4 Outline how the team will conduct self-checking and peer review throughout the task:

--



Instructions: following the task each team should conduct a debriefing where they fill out section 4 (Reviewing) of this document

Section 4: Reviewing
4.1 what could the team have done to make the job more efficient?
4.2 What challenges problems arose during the task?
4.3 What needs to be reported and corrected (injuries near misses, equipment, etc.), and who will report it?



Note This is a fictive generic job checklist intended for training purposes and therefore may vary from the job checklist provided by a company. It is important that a technician always read job checklist carefully prior to any bolt tensioning task.

6. GWO Post-Job Checklist (For Training Purposes Only)

Instructions: The first section of this document is to be filled out prior to commencing the task. The second section is to be filled out as part of the QA procedure during the task.

Date (DD-MM-YYYY)		Title	ECN
		Bolt Tensioning Scenario	123456
Site		Turbine Serial Number	Approval Date
ID	Technician Name	GWO WINDA ID Number	
1			
2			
3			
Calibrated Tools			
ID	Tool Type and Name	Calibration Number	
1			
2			
3			
4			
5			

Bolt Tensioning Scenario					
Technician completing the task (name):					
Bolt being tightened (defined in Tensioning manual)	Remarks	Tool used	N/A	Not OK	OK



ANNEX 4 - VERSION HISTORY

Amendment date	Version	Approved by & date	Description of changes
May 2023	8	GWO TC May 2023	
Changes throughout:			
- New layout - GWO Requirements for Training – title updated			
Safety lessons:			
- Three safety lessons previously found in BTT V6 in the BTT Mechanical, Electrical and Hydraulic modules (Mechanical Safety, Electrical Safety and Hydraulic safety) have been re-added, with an exemption clause for participants who have completed the GWO CoHE training. - Duration instructions and timetables updated for all modules to align with the GWO Requirements for Training			
Section 4 Scope:			
Revised and updated			
Section 5 General requirements for GWO training:			
- Bolt tightening added - Medical requirements, WINDA ID, physical demands etc. removed as this is covered by the GWO Requirements for Training. - Aim adjusted to include bolt tightening and company specific training - Times adjusted to accommodate the new Bolt Tightening module - In the section on validity, the term “assumption” is replaced with “expectation” and bolt tightening has been added - Clarification on tiered prerequisites for Bolt Tightening and Installation Modules			
Section 6.4 Handouts:			
Bolt tightening handouts have been added			
GWO Taxonomy:			
Replaced - The section Understanding the GWO taxonomy has been replaced with a general instruction and referral to the GWO taxonomy found in the GWO Requirements for Training			
Section 7.5 Participant Performance Assessment:			
Written test requirement adjusted so as not to cover the Bolt Tightening module			



- List of forbidden objects expanded to include smartwatches and other similar devices

BTT Mechanical Module:

- Learning objective: "Perform the correct use of hydraulic torque and tensioning tools (Skills, intermediate level)" deleted.
- Timing adjusted according to the deleted lesson
- Hydraulic torquing and tensioning deleted from the timetable and times adjusted
- Lesson on Hydraulic Torquing and Tensioning deleted

Bolt Tightening Module:

- Bolt Tightening module added including BTTM prerequisite

Installation Module:

- Prerequisites for module updated following addition of Bolt Tightening Module

Annex 1 - Equipment List:

- Note on "not calibrating" tools deleted
- Hydraulic tools deleted from BTTM equipment list
- Equipment list for Bolt Tightening module added to Annex 1

Annex 2 – Scenario Documents for Bolt Torquing:

- Annex 2 added: GWO Work instructions for Torquing; GWO Bolt Torquing Manual (template and example); GWO PDR; GWO Post-Task Checklist

Annex 3 – Scenario Documents for Bolt Tensioning:

- Annex 3 added: GWO Work instructions for Tensioning; GWO Bolt Tensioning Manual (template and example); GWO PDR; GWO Post-Task Checklist

Amendment date	Version	Approved by & date	Description of changes
April 2022	7	GWO TC April 2022	
Taxonomy alignment throughout			
• The section Understanding GWO learning objectives has been updated to reflect the reviewed GWO Taxonomy Framework • Few learning objectives have been updated with action verbs that reflect the taxonomic levels (basic, intermediate, and advanced level) without changing the content of the element			



- Action verb 'demonstrate' in learning objectives is changed to relevant action verb level/domain
- Learning activity "demonstrate" was changed to 'practise' because during training activities, the participants are in a learning process and abilities should be trained, not evaluated
- Learning activities have been aligned to match the updated learning objectives with a focus on participant engagement
- The instructor's perspective has been changed to a generic perspective accommodating different types of training
- All instructor guidelines have been compiled in one section under the individual elements
- More guidelines on the use of feedback have been added to emphasise its importance and ensure its effective use by involving the participants
- All learning objectives have been numbered throughout the standard
- New learning objectives have been created for all lessons that describe the overall ability the participants should acquire during the specific lesson. This focuses the attention on how knowledge and skills support the responsible performance of the employee in the context of the job and the deeper involvement enables participants to learn and remember more deeply
- The Introduction lesson for all standards has been updated to ensure alignment between all GWO training standards for generic lessons
- The Training Review lesson for all standards has been updated to ensure alignment between all GWO training standards for generic lessons
- For all modules, the title of *lesson Learning outcomes of the BTT Module* changed to *Detailed description of the BTT Module*

There are changes to the content of standard as the three safety lessons in the BTT Mechanical, Electrical and Hydraulic modules (Mechanical Safety, Electrical Safety and Hydraulic safety) have been removed due to the release of the GWO CoHE standard. This removal of the three safety lessons has been decided by the GWO CoHE working group with the aim to reduce duplication of training. Connected to this, the timings of the three modules have been reduced by subtracting the following contact time:

BTT Mechanical Module: 30 mins

BTT Electrical Module: 70 mins

BTT Hydraulic Module: 60 mins

Amendment date	Version	Approved by & date	Description of changes
April 2021	6	GWO TC April 2022	
Taxonomy alignment throughout			



-
- 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.

Updates to equipment lists for mechanical and electrical modules

- 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.

Changes to section "Understanding GWO learning objectives"

- The section Understanding GWO learning objectives has been updated to reflect the reviewed GWO Taxonomy

Delegates to participants

- The Delegates have been changed to The Participants, as participant is the proper designation for a person participating in an activity.

Human factors

- 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.

Name and activity change for the Evaluation lesson to Training review

- The naming of the Evaluation lesson has been changed to Training review 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.

Activity change for the introduction lesson

- 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

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".
-

Amendment date	Version	Approved by & date	Description of changes
October 2020	5.1	GWO TC Oct. 2020	

- 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

The following sections have been removed due to this information now included in the new Requirements for Training and Requirements for Certification Bodies (released May 2020)

Section 5

- 5.4 Conformity with other training – section removed
- 5.5 Legal Requirements – Section Removed

Section 6

- 6.1 Instructors – section removed
- 6.3 Facilities and Equipment – section removed
- 6.5 Theoretical training facilities – section removed

Section 8

- 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

Annex 1

- Participant Performance Assessment Form – Section removed

Annex 2

- Medical Assessment Form – Section removed
- All section reference numbers have now been updated

Amendment date	Version	Approved by & date	Description of changes
October 2019	5	GWO TC Oct. 2019	

- Formatting changes throughout including numbering of all sections.
- Equipment list for modules moved to Annex 3.
- No content changes to lessons.

Amendment date	Version	Approved by & date	Description of changes
March 2019	5	GWO TC March 2019	

Taxonomy alignment throughout

Content changes:

- 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.

Mechanical Module:

- 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 ...'

Electrical Module time changes (not affecting overall module duration):

- 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.

Electrical module content change:

- 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...'

Hydraulic module time changes (Not affecting overall module duration):

- 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.'
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Amendment date	Version	Approved by & date	
2018	4	GWO TC 2018	Description of changes

- New module 'Installation' developed and inserted.

Amendment date	Version	Approved by & date	
2017	3	GWO TC 2017	Description of changes

Content changes:

- 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



Major editing and layout changes:

All redundant generic requirements placed in general sections of standard, and deleted from each of the module descriptions, including:

- Table of content
- List of abbreviations
- Target group
- Legal requirements
- Overview

Amendment date	Version	Approved by & date	
October 2016	2	GWO TC Oct. 2016	Description of changes

- 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.
- Changed requirement from handing out certificates to Participants to instead ensure that Participants have provided their WINDA ID.