



GLOBAL WIND ORGANISATION  
TRAINING STANDARD

Basic Technical Training (BTT)  
(Onshore/Offshore)

Version 5  
October 2019



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# 1 LIST OF ABBREVIATIONS

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



## 2 TERMS AND DEFINITIONS

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

|                          |  |
|--------------------------|--|
| Demonstrate              | Delegates have to prove he/she is able to apply the knowledge on a practice.   |
| Engage in discussions    | Instructor has to create discussions involving the delegates.  |
| Function                 | Purpose. What is it doing? What can it be used for?  |
| Hazard                   | A hazard is any source of potential damage, harm or adverse health effects on something or someone.  |
| Installation             | <ol style="list-style-type: none"><li>1. Preparation</li><li>2. Pre-assembly</li><li>3. Assembly</li></ol>   |
| Operation                | How does it work?  |
| Practice                 | Opportunity to apply knowledge received during a practice.   |
| Practice and demonstrate | Opportunity to try coached by the instructor. Before the end of the practice the delegate needs to prove he/she is able to perform the task without significant support from the instructor. |
| Risk                     | A risk is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard   |
| Use                      | How to operate it? How to make it work?  |



### 3 CHANGE LOG

|                |  |                        |  |
|----------------|--|------------------------|--|
| Amendment Date |  | Approved by & date     |  |
| Version        |  | Description of changes |  |
|                |  |                        |  |

|  |                     |                        |  |
|--|---------------------|------------------------|--|
| Amendment Date   | <b>October 2019</b> | Approved by & date     |  |
| Version  | <b>5</b>            | Description of changes |  |
| <ul style="list-style-type: none"> <li>- Formatting changes throughout including numbering of all sections.</li> <li>- Equipment list for modules moved to Annex 3.</li> <li>- No content changes to lessons.</li> </ul> |                     |                        |  |

|   |                   |                        |  |
|---|-------------------|------------------------|--|
| Amendment Date  | <b>March 2019</b> | Approved by & date     |  |
| Version   | <b>5</b>          | Description of changes |  |
| <p>Taxonomy alignment throughout</p> <p>Content changes</p> <ul style="list-style-type: none"> <li>- Delegate performance assessment updated with 'each module' to allow delegates to pass the individual modules &amp; time allowed for each question increased to 1.5 minutes.</li> </ul> <p>Mechanical Module</p> <ul style="list-style-type: none"> <li>- Element 3.4.2 inserted 'Explain the importance ...'</li> <li>- Element 3.4.4 inserted 'describe typical examples ...'</li> <li>- Element 5.2.1 inserted 'explain types of tools ...'</li> <li>- Element 5.2.1 &amp; 5.2.2 inserted importance of pre-use check</li> <li>- Element 5.3.1 &amp; 5.3.2 swapped to make chronological sense</li> <li>- Element 5.4.1 changed to 'function of feeler gauges'</li> <li>- Element 5.5.1 changed to 'function of callipers'</li> <li>- Element 5.6.1 changes to 'function of dial gauges'</li> <li>- Element 6.1.2 &amp; 6.1.4 inserted 'how to inspect hydraulic ...'</li> </ul> <p>Electrical Module time changes (not affecting overall module duration)</p> <ul style="list-style-type: none"> <li>- Introduction to electricity reduced from 90 to 70 min.</li> <li>- Electric circuits increased from 80 to 120 min.</li> <li>- Electric components reduced from 120 to 100 min.</li> </ul> <p>Electrical module content change</p> <ul style="list-style-type: none"> <li>- Element 3.1.2 inserted 'the importance of working to ...'</li> <li>- Element 3.2.3 inserted megohmmeter as a source of HV danger</li> <li>- Element 3.2.4 inserted 'the requirement for HV training'</li> <li>- Element 3.3.3 inserted 'not all circuits protected by RCD'</li> <li>- Lesson 4 LO's removed demonstrate to lesson 6</li> <li>- Element 4.6.5, 4.7.5 &amp; 4.8.6 moved to lesson 6</li> <li>- Lesson 7 LO 2 added PT100 and Bridge rectifier (moved from lesson 4)</li> <li>- Element 7.2.2 wording change</li> </ul> |                   |                        |  |



- 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.'

|   |             |                        |  |
|---|-------------|------------------------|--|
| Amendment Date                                    | <b>2018</b> | Approved by & date     |  |
| Version   | <b>4</b>    | Description of changes |  |
| New module 'Installation' developed and inserted. |             |                        |  |

|  |             |                        |  |
|--|-------------|------------------------|--|
| Amendment Date   | <b>2017</b> | Approved by & date     |  |
| Version  | <b>3</b>    | Description of changes |  |
| <p>Content changes</p> <ul style="list-style-type: none"> <li>- New name: Basic Technical Training (replaces Basic Maintenance Training) to reflect a wider target group for the standard</li> <li>- New intro "Scope" replaces "Foreword and Editorial"</li> <li>- General: new section on "Understanding GWO Learning Objectives" incl. Taxonomy Table</li> <li>- General: new section on "Conformity with other training" section added</li> <li>- 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</li> <li>- BTT now organised as three separate modules, and requires upload of 1 record per module to allow for greater flexibility</li> <li>- Module timetables are specified as approximations, as long as the total duration is not reduced, and practical elements are not reduced in length</li> <li>- If all three modules are delivered as a single training, introductory elements and evaluation elements may be combined</li> <li>- New lesson for Hydraulic tightening tools</li> <li>- Control Measure Form modified</li> <li>- Handout requirement included</li> <li>- Requirements for the test</li> <li>- Duplicated sensors removed</li> <li>- List of Definitions to avoid different interpretations by training providers</li> </ul> <p>Major editing and layout changes:</p> <p>All redundant generic requirements placed in general sections of standard, and deleted from each of the module descriptions, including:</p> <ul style="list-style-type: none"> <li>- Table of content</li> </ul> |             |                        |  |





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

| Amendment Date  | October 2016 | Approved by & date     |  |
|---|--------------|------------------------|--|
| Version   | 2            | Description of changes |  |
| <ul style="list-style-type: none"><li>- Delegate prerequisites</li><li>- Added prerequisite for Delegates to possess a personal WINDA ID and provide it to the Training Provider prior to completing the course.</li><li>- Changed certification requirement from issuing a certificate to instead upload a record of training to WINDA.</li></ul> <p>Changed requirement from handing out certificates to Delegates to instead ensure that Delegates have provided their WINDA ID.</p> |              |                        |  |



## 4 SCOPE

The Global Wind Organisation (GWO) is an association of Wind Turbine owners and manufacturers with the aim of supporting an injury-free work environment in the wind industry. An objective of GWO is to develop common industry training and best practice Standards for health and safety as a vital and necessary way forward to reduce risks for personnel in the wind industry working on site and to reducing environmental risks across Europe and the globe.

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

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

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

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

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

Training is verified through the GWO database WINDA.

Where national legislation sets higher requirements for the specific training, the Training Provider shall incorporate these requirements into the training program.

Additional training may be required for company or country specific reasons.

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

Disputes and potential non-conformities should be brought to the attention of the GWO Audit and Compliance Committee.

The standard has been approved by the GWO Steering Committee.



## 5 GENERAL REQUIREMENTS TO GWO TRAINING

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

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

### 5.1 Overview

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

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

### 5.2 Target Group

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

### 5.3 Aims and Objectives

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

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

### 5.4 Conformity with other Training

The GWO BTT standard sets out minimum requirements.

Provided the minimum requirements of the BTT Standard are met the Training Provider may choose to incorporate delivery of other similar certified training.



## 5.5 Legal Requirements

The Training Provider shall identify whether national legislation sets other requirements for Basic Technical Training. If so, the Training Provider shall incorporate these identified requirements into the training.

## 5.6 Duration of BTT Modules

The total contact time for completing the stand-alone modules in this basic technical training standard is estimated to be **32 hours**. This is based on the time estimates given in the module timetables and summarised in table 5-61 & 5-62 below.

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

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

Durations at the table below are meant to be an orientation for anyone delivering the training. Small variations are acceptable as far as they do not compromise reaching the objectives for all delegates.

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

| Modules    | Duration (*Effective time)<br>As stand-alone training | Duration (*Effective time)<br>As part of combined training |
|------------|---|--|
| Mechanical | 13,67 hours   | 13,67 hours  |
| Electrical | 9,92 hours  | 9,50 hours   |
| Hydraulic  | 8,92 hours  | 8,50 hours   |
| TOTAL      |   | 31,67 hours  |

Table 5-61 - Duration of GWO BTT Modules

| Modules      | Duration (*Effective time)<br>As stand-alone training | Duration (*Effective time)<br>As part of combined training |
|--------------|---|--|
| Mechanical   | 13,67 hours   | 13,67 hours  |
| Installation | 17,67 hours   | 17,25 hours  |
| TOTAL        |   | 30,92 hours  |

Table 5-62 - Duration of GWO Mechanical and installation Modules

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

Table 5-7 - Maximum durations for training days

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



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

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

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

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

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

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

- 1) The Mechanical module is estimated as a 2-day course (at least 13 hours and 40 minutes).
- 2) The Electrical and Hydraulic modules are estimated as 1,5-day courses (at least 9 hours 55 minutes for the Electrical module and at least 8 hours 55 minutes for the Hydraulic module).
- 3) The Installation module is estimated as a 2,5-day course (at least 17 hours and 40 minutes).

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

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

## 5.7 Validity Period

The Basic Technical Training is an enduring qualification and therefore a validity period does not apply to this training. This is based on the assumption that the Delegate 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 completions of the BTT Hydraulic, Mechanical, Electrical and Installation Modules do not apply. This is based on the assumption that the Delegate 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.



## 5.8 Delegate Prerequisites for the BTT

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

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

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

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

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

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

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

## 5.9 Physical Demands

BTT Modules do not have any specific anticipated physical demands.

However, if there is any doubt regarding the medical fitness of any Delegates, the Training Provider shall stop training the Delegate and seek a physician's advice.

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



## 6 GENERAL RESOURCES REQUIRED TO DELIVER BTT MODULES

The Training Provider shall ensure that staff, facilities and equipment are in place to support the training of Delegates.

### 6.1 Instructors

Instructors shall possess the appropriate qualifications and experience to ensure that all training and supportive activities are carried out in accordance with current legislation.

Instructors shall be:

- 1) Trained in instructional/lecture techniques and/or have documented/ instructional/ teaching experience.
- 2) Included in an on-going training programme, which includes visits to onshore and/or offshore WTGs (tower, nacelle, hub) prior to instructing Basic Technical Training Modules, to enable them to maintain and update skills related to the modules they instruct. Instructors shall physically visit the tower, nacelle and hub of the WTGs.

All instructors shall possess the appropriate competencies to conduct/assist the elements of training they have been assigned to.

### 6.2 Instructor/Delegate Ratio

The ratio shown for the theory session indicates the maximum number of Delegates attending the course.

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

| Modules         | Session   | Instructor – Delegate Ratio |
|-----------------|-----------|-----------------------------|
| All BTT Modules | Theory    | 1:12                        |
|                 | Practical | 1:8                         |

Table 6-2 - GWO BST Instructor to delegate ratios

### 6.3 Facilities and equipment

The full range of facilities shall be available during the training. The following facilities criteria shall be adhered to.

### 6.4 Theoretical Training Facilities

Facilities shall be designed to enable each Delegate to see, hear and fully participate in the taught subject matter.



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

## 6.5 Practical Training Facilities

Shall be designed to enable each Delegate to individually and/or as part of a team, see, hear and practice the taught material.

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

**Note:** All facilities shall be maintained and where appropriate, inspected and tested in accordance with current national legislation and manufacturers' recommendations.

Risk assessments shall be conducted and documented for all training facilities.

The Training Provider shall hold the required permits to operate facilities.

## 6.6 Equipment

The equipment required for the delivery of the BTT modules is shown in Annex 3.

The required equipment for training shall be available and shall fulfil national legal requirements.

The equipment shall be maintained, inspected and tested in accordance with current national legislation and manufacturers' recommendations. Risk assessments shall be conducted and documented for all training equipment. The Training Provider shall hold the required permits to operate relevant equipment.

## 6.7 Handouts

Handouts must be given to the delegates containing as a minimum:

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

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





## 7 UNDERSTAND GWO LEARNING OBJECTIVES

The described learning objectives (expected learning outcome) are the foundation of the course contents and what the delegate performance assessment must be based upon.

Traditionally learning objectives are prepared within three different domains of learning – knowledge, skills and attitude. A learning objective describes the expected learning outcome on completion of a module or a course, within one or more learning domains.

If a learning objective is related to more than one domain of learning, e.g. to knowledge *and* skills, one learning objective per learning domain is often prepared – to enable a better understanding of the learning objective.

The GWO Training Provider may apply teaching methods (didactics) that are appropriate to the course delegates prior training, education and cultural backgrounds, but should always aim to provide course delegates ample possibility to perform hands-on demonstrations and learning reflection.

### 7.1 Taxonomy

To formulate a measurable learning objective, taxonomy is used to describe the *level* of expected learning outcome within a learning domain.

As an example belonging to the learning domain of knowledge, to have a delegate to *name* or **recognize** something, as oppose to have him **explain** it in his own words, or even *apply* or **demonstrate** what he has learned – describes different performance levels, i.e. different taxonomy levels.

Different taxonomies are associated with different learning domains, for instance:

Knowledge: such as Bloom's "cognitive taxonomy"

- Intellectual knowledge, mental skills and procedures

Skills: such as Simpson's "psychomotor taxonomy"

- Physical skills, cognitive controlled and observable

Attitude: such as Krathwohl's "affective taxonomy"

- Attitude and feelings to the learning

Selecting a suitable taxonomy level, an **action verb** expresses the expected behaviour of the delegate, thus describing the taxonomy level of a learning objective. The table below presents the three learning domains with taxonomy level 1-3, provided with associated *action verbs* applicable in the learning objective wording, defining the taxonomy level. In the Basic Technical Training standard, the learning objectives are in general described as level 2 or 3.



|          | <b>Knowledge</b>   | <b>Skills</b>   | <b>Attitude</b>  |
|----------|--|---|--|
| <b>3</b> | <b>Application / Applying</b><br>To use in a new situation.<br>Solving problems by applying acquired knowledge, facts, techniques and rules in a different way.<br>Applying a procedure to a familiar or unfamiliar task.<br>Using a manual to calculate and operate.<br><br><b>Action verbs:</b><br>Apply, Change, Choose, Compute, Demonstrate, Modify, Operate, Practice, Prepare, Schedule, Solve, Write.              | <b>Guided response</b><br>Follows instructions to build a model.<br>Using a tool after observing an expert demonstrate how to use it.<br>Be able to demonstrate an activity to other learners.<br>Can complete the steps involved in the procedure as directed.<br><br><b>Action verbs:</b><br>Accomplish, Achieve, Calibrate, Complete, Control, Demonstrate, Perform, Refine, Show. | <b>Value</b><br>Demonstrates belief in the company described process.<br>Shows the ability to solve problems.<br>Informs management on matters that one feels strongly about.<br>Decide worth and relevance of ideas and tasks.<br><br><b>Action verbs:</b><br>Argue, Challenge, Confront, Complete, Debate, Criticize, Justify, Join, Propose.  |
| <b>2</b> | <b>Comprehension / Understanding</b><br>Construct a meaning from instructional messages, including oral, written and graphic communication.<br>Demonstrating basic understanding of facts and ideas.<br>Explain in your own words the steps of performing a complex task.<br><b>Action verbs:</b><br>Classify, Distinguish, Estimate, Explain, Express, Give, Illustrate, Indicate, Locate, Predict, Summarize, Translate. | <b>Set</b><br>Awareness or knowledge of the ability needed to use the skill.<br>Carry out tasks from verbal or written instructions.<br>Showing eagerness to assemble components to complete a task.<br>Knows and acts upon a sequence of steps in a process.<br><b>Action verbs:</b><br>Access, Build, Complete, Conduct, Execute, Implement, Operate, Perform, Recreate.            | <b>Respond</b><br>Completing work assignments with highly respect to the agreement.<br>Participating in team problem solving activities.<br>Questions new ideas and concepts in order to fully understand them.<br>Participate actively and respectfully in discussions.<br>Showing enthusiasm.<br><b>Action verbs:</b><br>Assist, Contribute, Discuss, Present, Question, Report, Respond, Tell, Write. |
| <b>1</b> | <b>Knowledge / Remembering</b><br>Memory of facts, terminology, rules, sequences, procedures, etc.<br>Locating knowledge in long-term memory and retrieving relevant knowledge from long-term memory.<br><b>Action verbs:</b><br>Arrange, Define, Describe, Find, Identify, List, Name, Outline, Recognize, Relate, Recall, Retrieve.  | <b>Perception</b><br>Watch instructor and repeat action, process or activity.<br>Recognizing sounds or pictures that indicate certain functionalities.<br>Estimate the event of a certain function and be prepared for it.<br><b>Action verbs:</b><br>Attempt, Copy, Duplicate, Follow, Organize, Repeat, Sketch, Replicate, Reproduce.   | <b>Receive</b><br>Listening to discussions of controversial issues with an open mind.<br>Respecting the rights of others.<br>Listen to others and remember their opinions.<br>Be positive and creative to what is being taught.<br><b>Action verbs:</b><br>Ask, Be open to, Concentrate, Discuss, Focus, Follow, Listen, Reply, Take part.   |

Table 7-1 - Taxonomy used by GWO

**NOTE:** Higher taxonomy levels exist.



## 8 ADMINISTRATION AND CERTIFICATION

### 8.1 Administrative Arrangements

Appropriate administrative arrangements for the enrolment and certification of Delegates and all aspects of the delivery of training shall be in accordance with this Standard.

### 8.2 Delegate Performance Assessment

Delegates shall be assessed separately on each module according to the learning objectives by means of direct observation during practices for level 3 objectives and written multiple choice questions on a test for level 1 and 2 objectives in order to be certified.

The multiple-choice test must be done in accordance to the following criteria:

- 1) At least 1 question per objective (level 1 and 2) with a minimum of 10 questions for each stand-alone module.
- 2) Time limit 1,5 minutes per question.
- 3) Test must be Individual.
- 4) Delegates can use:
  - a. Handouts.
  - b. Own notes.
- 5) Delegates cannot use:
  - a. Mobile phones (except for calculator).

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

The direct observation is to be conducted by practical scenarios on a WTG environment. Each Delegate shall demonstrate:

Assessment of learning objectives:

- 1) Correct use of appropriate PPE
- 2) Safe working procedures
- 3) Correct and proper methods of working

The formal evaluation of knowledge of practical scenarios shall be in accordance with the Control Measures below.

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

In case of a Delegate failing the test, the instructor will have a discussion with the Delegate in order to find out the reason behind. If the reason was due to misunderstanding



of a question or due to language the instructor can give for valid a question, as far as the Delegate demonstrates the right level of understanding. This must be properly documented by the instructor and kept together with the tests, control measures, evaluations...

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

As part of the training process, Instructors shall perform an on-going assessment for the delegates asking questions or creating discussions in order to evaluate the progress of the training and make the necessary adjustments to ensure the learning objectives are being achieved.

### 8.3 Control Measures

A Template Control Measures form is provided in Annex 1. The Training Provider may adapt the Control Measures Form to other media.

The Trainer keeps a Control Measures Form (or adaptation) for each delegate until the completion / evaluation of the BTT Module.

The Control Measures Form (or adaption) is a final evaluation tool for the instructors to assess Delegates during practical elements. It allows measurement of the number of violations in regard to safety, competency, or attitude.

It shall be used as a progressive evaluation tool to discuss the performance of a Delegate in guiding them to success and it also serves as supporting documentation if a Delegate passes or fails the Module.

If a Delegate fails to meet the demands of the BTT module, he/she will not be certified in the module.

### 8.4 Requirement to upload training record in WINDA

Training Providers are responsible for uploading a record of training to WINDA, the GWO online database of training records. This must be done as soon as possible and no later than 10 working days after completion of the training program.

Each record shall contain the following:

- 1) Delegate's WINDA ID
- 2) Course code (as shown in table 8-4)
- 3) Course completion date



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

*Table 8-4 - GWO BTT module course codes*

## 8.5 Training Providers own Records and Certificates issue

The Training Provider shall in accordance with the criteria for Training Provider maintain own records of Delegates.

Upon request from GWO or any of the members of GWO, the Training Provider shall be able to verify the training and competence records of any specific personnel either attending a course and/or performing training of a course by name and nationality.

Training providers may issue other additional proof of training, e.g. as paper certificate or plastic cards. If the training provider chooses to do so, it is recommended (not a requirement) to include the delegate WINDA id.



## 9 MODULE 1 – THE BTT MECHANICAL MODULE

### 9.1 Aims and objectives of the BTT Mechanical Module

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

The BTT Mechanical Module shall ensure Delegates are able to:

- 1) Explain the main components, mechanical systems and the basic operation of wind turbines (L2 – Knowledge).
- 2) Explain risks and hazards associated with mechanics (L2 – Knowledge).
- 3) Understand the principles of bolted and welded connections and their inspection (L2 – Knowledge).
- 4) Demonstrate practical skills to use manual tightening and measuring tools (L3 – Skill).
- 5) Demonstrate the correct use of hydraulic torque and tensioning tools (L3 – Skill).
- 6) Explain the principles of a gearbox (L2 – Knowledge).
- 7) Explain the function of the brake systems and demonstrate how to inspect them (L2 – Knowledge / L3 – Skill).
- 8) Explain the function of the yaw system and explain how to inspect it (L2 – Knowledge).
- 9) Explain the function of the cooling system and demonstrate how to inspect it (L2 – Knowledge / L3 – Skill).
- 10) Explain the function of the lubrication system and demonstrate how to inspect it (L2 – Knowledge / L3 – Skill).

### 9.2 Duration of the BTT Mechanical Module

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

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

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



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

Table 9-2 - Maximum durations for training day

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

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

### 9.3 Equipment

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

### 9.4 BTT Mechanical Module Time Table

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

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

| Lesson |                         | Element |  | Approx. Duration |
|--------|-------------------------|---------|--|------------------|
| 1      | Introduction            | 1.1     | Safety instructions and emergency procedures |                  |
|        |                         | 1.2     | Facilities                                   |                  |
|        |                         | 1.3     | Introduction                                 |                  |
|        |                         | 1.4     | Aim and objectives                           |                  |
|        |                         | 1.5     | On-going assessment                          |                  |
|        |                         | 1.6     | Motivation                                   |                  |
| 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      |                         | 4.1     | The principles of bolt connections           |                  |



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

Table 9-4 – GWO BTT Mechanical module timetable





## 9.5 Learning outcomes of the BTT Mechanical Module

The learning outcomes specified for the BTT Mechanical Module are:

### Lesson 1 - INTRODUCTION

30 min.

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

#### ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Instructors shall:

- 1.1.1 Explain safety instructions according to internal procedures
- 1.1.2 Explain the emergency procedures and emergency exits in the localities the Delegates can be expected to be located during the course

#### ELEMENT 1.2 - FACILITIES

Instructors shall:

- 1.2.1 Give a General description of the facilities on the location (Administration, dining area, restrooms and toilets, etc.)

#### ELEMENT 1.3 - INTRODUCTION

Instructors shall:

- 1.3.1 Give a short presentation of himself including his background as an instructor

Delegates shall:

- 1.3.2 Give a short introduction, including job function expectation for the course

Instructors shall:

- 1.3.3 Explain the programme of the BTT, including breaks and meal times

#### ELEMENT 1.4 - AIM AND OBJECTIVES

Instructors shall:

- 1.4.1 Explain the aims and objectives of this BTT Training



## ELEMENT 1.5 - ON-GOING ASSESSMENTS

Instructors shall:

- 1.5.1 Explain the reasons for the on-going assessment
- 1.5.2 Explain the GWO Control Measures and their use

## ELEMENT 1.6 - MOTIVATION

Instructors shall:

- 1.6.1 Explain the importance of personal involvement in the course

## Lesson 2 - MECHANICAL INTRODUCTION

60 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the main components in a wind turbine (L2 – Knowledge).
- 2) Explain the main mechanical systems in a wind turbine (L2 -Knowledge).
- 3) Explain how a wind turbine works (L2 – Knowledge).

## ELEMENT 2.1 - MAIN COMPONENTS OF THE STRUCTURE

Instructors shall:

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

Delegates shall:

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

## ELEMENT 2.2 - MAIN MECHANICAL SYSTEMS

Instructors shall:



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

- a. Pitch system
- b. Yaw system
- c. Main shaft
- d. Gearbox
- e. Coupling
- f. Generator

Delegates shall:

2.2.2 Engage in discussions about the basic mechanical systems in a wind turbine

## ELEMENT 2.3 - HOW A TURBINE WORKS

Instructors shall:

- 2.3.1 Explain how the turbine uses the wind to produce electricity
- 2.3.2 Define and explain wind speed and direction
- 2.3.3 Describe the basic aerodynamics of the blade
- 2.3.4 Explain control of the rotor speed using the blade regulation system

Delegates shall:

2.3.5 Engage in discussions about energy, wind speed and wind direction

## Lesson 3 - MECHANICAL SAFETY

30 min.

The aim of this lesson is to give the Delegates the needed awareness, knowledge and understanding in order to handle mechanical hazards in a wind turbine.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the importance of Mechanical Safety (L2 – Knowledge).
- 2) Identify Safety Signs (L1 – Knowledge).
- 3) Explain the required PPE for working with mechanics (L2 – Knowledge)
- 4) Explain the importance of proper isolation when working with mechanics (L2 – Knowledge).



### ELEMENT 3.1 - WHY MECHANICAL SAFETY

Instructors shall:

- 3.1.1 Explain 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
- 3.1.3 Explain the need for Safety Data Sheets (SDS)

Delegates shall:

- 3.1.4 Engage in discussions about safe working procedures, identifying the necessary PPE and appropriate tools

### ELEMENT 3.2 - SAFETY SIGNS

Instructors shall:

- 3.2.1 Explain how to identify different signs for Mechanical Danger
- 3.2.2 Show examples of safety signs on different locations in the WTG

Delegates shall:

- 3.2.3 Engage in discussions about different safety signs' meanings

### ELEMENT 3.3 - TYPES OF PPE

Instructors shall:

- 3.3.1 Explain and demonstrate examples of usage and the inspection of PPE suitable for mechanical work

### ELEMENT 3.4 - THE IMPORTANCE OF APPROPRIATE ISOLATION

Instructors shall:

- 3.4.1 Explain the importance of using appropriate isolation techniques when working with mechanics
- 3.4.2 Explain 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

Delegates shall:

- 3.4.4 Engage in discussions about 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 Delegates an understanding of bolted and welded connections and its inspection.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the principles of bolt connections (L2 – Knowledge).
- 2) Explain the location of important bolted and welded connections (L2 – Knowledge).
- 3) Explain how to visually inspect a welded connection (L2 – Knowledge).
- 4) Explain how to tighten and inspect bolt connections (L2 – Knowledge).

### ELEMENT 4.1 - THE PRINCIPLES OF BOLT CONNECTIONS

Instructors 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
- 4.1.2 Explain how bolt strength is proportional to the size of the bolt and dependant of material, quality.
- 4.1.3 Explain the function of and types of washers
- 4.1.4 Explain the importance of bolt thread lubrication
- 4.1.5 Explain the importance of same temperature for all set components
- 4.1.6 Define and explain torque and tension
- 4.1.7 Explain the principles of angular tightening
- 4.1.8 Explain the importance of correct tightening (e.g. collapsing towers, electrical fires)

Delegates shall:

- 4.1.9 Engage in discussions about bolts, threads, lubricant, strengths of materials and temperature influences
- 4.1.10 Engage in discussions about force and torque



## ELEMENT 4.2 - THE LOCATIONS OF IMPORTANT BOLTED AND WELDED CONNECTIONS

Instructors 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

## ELEMENT 4.3 - INSPECTION OF WELDED CONNECTIONS

Instructors shall:

- 4.3.1 Explain how to perform visual inspections of welded connections and document the findings (e.g.: paint damage, corrosion, cracks...)

## ELEMENT 4.4 - BOLT CONNECTIONS AND CORRECT TIGHTENING TOOLS

Instructors shall:

- 4.4.1 Explain how to tighten a bolt connection (torque and tension) using Torque Wrench and Hydraulic tightening tools
- 4.4.2 Explain how to inspect if a bolt is loose (visual or with tightening tools)

Delegates shall:

- 4.4.3 Engage in discussions about the importance of inspection processes for bolted connections

## Lesson 5 - USE OF MANUAL TIGHTENING AND MEASURING TOOLS

90 min.

The aim of this lesson is to give the Delegates the basic knowledge and practical skills to use manual tightening and measuring tools.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Identify the basic units for the metric system (L1 – Knowledge).
- 2) Demonstrate how to select and use the correct manual tightening tools (L3 – Skill).



- 3) Demonstrate how to set and use a torque wrench (L3 – Skill).
- 4) Demonstrate how to use feeler gauges (L3 – Skill).
- 5) Demonstrate how to use a calliper (L3 – Skill).
- 6) Demonstrate how to use a dial gauge (L3 – Skill).

#### ELEMENT 5.1 - METRIC SYSTEM

Instructors shall:

- 5.1.1 Explain the key units used in the metric system for:
  - a. Temperature
  - b. Length
  - c. Weight
  - d. Speed
  - e. Torque
  - f. Tension
  - g. Volume
  - h. Pressure

#### ELEMENT 5.2 - SELECTING AND USING THE CORRECT MANUAL TIGHTENING TOOLS

Instructors shall:

- 5.2.1 Explain the types of manual tightening tools (spanners, sockets, screwdrivers)
- 5.2.2 Explain the importance of and how to perform a pre-use check of tools
- 5.2.3 Demonstrate the correct application and size of manual tightening tool
- 5.2.4 Explain the consequences of incorrect manual tightening tool use
- 5.2.5 Demonstrate how to use an electrical impact gun (awareness of not surpassing bolt torque)

Delegates shall:

- 5.2.6 Practice and demonstrate the ability to select and use manual tightening tools

#### ELEMENT 5.3 - CORRECTLY SETTING AND USING A TORQUE WRENCH

Instructors shall:

- 5.3.1 Explain the function of a torque wrench



- 5.3.2 Explain the importance of pre-use check and calibration in terms of safety and quality
- 5.3.3 Demonstrate how to set and use the torque wrench

Delegates shall:

- 5.3.4 Practice and demonstrate setting and using torque wrenches

#### ELEMENT 5.4 - FEELER GAUGES

Instructors shall:

- 5.4.1 Explain the function of feeler gauges
- 5.4.2 Explain the the importance of pre-use check 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

Delegates shall:

- 5.4.5 Practice and demonstrate the correct use and care of feeler gauges

#### ELEMENT 5.5 - CALLIPERS

Instructors shall:

- 5.5.1 Explain the function of callipers
- 5.5.2 Explain 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

Delegates shall:

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

#### ELEMENT 5.6 - DIAL GAUGES

Instructors shall:

- 5.6.1 Explain the function of a dial gauge
- 5.6.2 Explain the importance of pre-use check 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





Delegates shall:

- 5.6.5 Practice and demonstrate the correct use and care of dial gauge

## Lesson 6 - HYDRAULIC TORQUE AND TENSION

300 min.

The aim of this lesson is to give the Delegates the basic knowledge and practical skills to use hydraulic tightening tools.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Demonstrate how to use a hydraulic torque tool (L3 – Skill).
- 2) Demonstrate how to use a hydraulic tensioning tool (L3 – Skill).

### ELEMENT 6.1 - USING A HYDRAULIC TORQUE WRENCH

Instructors shall:

- 6.1.1 Describe the components of a hydraulic torque wrench kit (Pump, hoses and head)
- 6.1.2 Explain how to inspect the hydraulic torque wrench kit including: pump, hoses, head and sockets
- 6.1.3 Demonstrate the correct use of a hydraulic torque wrench kit

Delegates shall:

- 6.1.4 Practice how to inspect the hydraulic torque wrench kit including pump, hoses, head and sockets
- 6.1.5 Demonstrate the correct use of a hydraulic torque wrench kit

### ELEMENT 6.2 - USING A HYDRAULIC TENSIONING TOOL

Instructors shall:

- 6.2.1 Describe the components of a hydraulic tensioning tool kit (Pump, hose and puller)
- 6.2.2 Explain and demonstrate the correct use of a hydraulic tensioning tool kit

Delegates shall:

- 6.2.3 Practice and demonstrate the correct use of a hydraulic tensioning tool kit



## Lesson 7 - GEARBOX

30 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the function and operating principles of the gearbox (L2 – Knowledge).
- 2) Explain how to check hoses and seals and explain the importance of the right oil level (L2 – Knowledge).

### ELEMENT 7.1 - THE FUNCTION AND OPERATING PRINCIPLES

Instructors shall:

- 7.1.1 Explain the main function of the gearbox
- 7.1.2 Explain the operation of the gearbox

Delegates shall:

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

### ELEMENT 7.2 - INSPECTION OF THE GEARBOX

Instructors shall:

- 7.2.1 Explain the checking of hoses, what to look for
- 7.2.2 Explain the checking of seals, what to look for
- 7.2.3 Explain the importance of the right oil level

Delegates shall:

- 7.2.4 Engage in discussions about listening for abnormal noise from the gearbox

## Lesson 8 - BRAKING SYSTEM

40 min.

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

To successfully complete this BTT Module, Delegates shall be able to:



- 1) Explain the function and operation of the mechanical and the aerodynamic brake (L2 – Knowledge).
- 2) Demonstrate how to perform the inspection of the mechanical brake system (L3 – Skill).

## ELEMENT 8.1 - THE FUNCTION OF THE MECHANICAL AND THE AERODYNAMIC BRAKE

Instructors shall:

- 8.1.1 Explain the function of the mechanical brake
- 8.1.2 Explain the function of the aerodynamic brake
- 8.1.3 Explain the consequences of them not functioning
- 8.1.4 Explain the operating principle of the mechanical brake
- 8.1.5 Explain the operating principle of the aerodynamic brake (i.e. stall, pitch...)

Delegates shall:

- 8.1.6 Engage in discussions about the Hazards associated with the Mechanical and aerodynamic brake
- 8.1.7 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. risk of moving parts, pressurized systems)
- 8.1.8 Engage in discussions about the correct PPE

## ELEMENT 8.2 - INSPECTION OF THE MECHANICAL BRAKE SYSTEM

Instructors shall:

- 8.2.1 Explain how to check the disc surface for wear and scuffing due to excess friction
- 8.2.2 Explain how to check the disc brake pads for wear

Delegates shall:

- 8.2.3 Practice and demonstrate checking the thickness of the brake pads
- 8.2.4 Practice and demonstrate measuring the thickness of the brake disc

## Lesson 9 - YAW SYSTEM

30 min.

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

To successfully complete this BTT Module, Delegates shall be able to:



- 1) Explain the function and operation of the yaw system (L2 – Knowledge).
- 2) Explain how to perform the inspection of the yaw system (L2 – Knowledge).

#### ELEMENT 9.1 - THE FUNCTION OF THE YAW SYSTEM

Instructors shall:

- 9.1.1 Explain the function of the yaw system
- 9.1.2 Explain the operation of the components in the yaw system (yaw motors, yaw gears, wind sensor, twist sensor and yaw bearing)

Delegates shall:

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

#### ELEMENT 9.2 - INSPECTION OF THE YAW SYSTEM

Instructors shall:

- 9.2.1 Describe typical inspections tasks in the Yaw System
  - a. Lubrication
  - b. Torque
  - c. Noise
  - d. Brake pad and disc inspection

### Lesson 10 - COOLING SYSTEM

30 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain which components in a WTG have to be cooled and why (L2 – Knowledge).
- 2) Demonstrate how to perform the visual inspection of the cooling system (L3 – Skill).



## ELEMENT 10.1 - COMPONENTS THAT REQUIRE COOLING AND WHY

Instructors shall:

- 10.1.1 Explain how heat is produced in the different systems and components (example: Gearbox, generator, hydraulic system...)
- 10.1.2 Explain that heat can be transferred from component to component
- 10.1.3 Explain overheating problems

Delegates shall:

- 10.1.4 Engage in discussions about consequences of not proper cooling
- 10.1.5 Engage in discussions about the hazards associated with the cooling systems
- 10.1.6 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 10.1.7 Engage in discussions about the correct PPE

## ELEMENT 10.2 - INSPECTION OF THE COOLING SYSTEMS

Instructors shall:

- 10.2.1 how to make a visual inspection of cooling systems (e.g. pin holes, cracks, cuts, friction marks, leaks)
- 10.2.2 Explain the importance of checking the cooling liquid
- 10.2.3 Explain how to check the cleanliness of the heat exchanger
- 10.2.4 Explain the importance of documenting any damage found

Delegates shall:

- 10.2.5 Practice and demonstrate visual inspection of cooling systems and documenting the findings
- 10.2.6 Demonstrate the correct use of PPE

## Lesson 11 - LUBRICATION SYSTEM

75 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain which components in a WTG have to be lubricated and why (L2 – Knowledge)



- 2) Demonstrate how to perform the visual inspection of the lubrication system (L3 – Skill).

#### ELEMENT 11.1 - COMPONENTS REQUIRING LUBRICATION AND WHY

Instructors shall:

- 11.1.1 Explain why components need lubrication (example: Gearbox, bearings...)
- 11.1.2 Explain how oil and grease reduce friction and lowers the production of heat
- 11.1.3 Explain that oil and grease pumps can be used to keep the bearings, teeth, gears... lubricated to reduce friction and corrosion

Delegates shall:

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

#### ELEMENT 11.2 - INSPECTION OF THE LUBRICATION SYSTEMS

Instructors shall:

- 11.2.1 Explain how to make a visual inspection of lubrication systems (e.g. pin holes, cracks, cuts, friction marks, leaks)
- 11.2.2 Explain the the importance of ensuring the right amount and type of lubricant (lubricant samples)
- 11.2.3 Explain the importance of documenting any damage found

Delegates shall:

- 11.2.4 Engage in discussions about oil Cleanliness rating and its impact on component performance
- 11.2.5 Practice and demonstrate visual inspection of lubricating systems and document the findings
- 11.2.6 Demonstrate the correct use of PPE



## Lesson 12 - SUMMARY AND THEORETICAL TEST

30 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Recall the objectives that have been covered within this module
- 2) Pass the Theoretical test

### ELEMENT 12.1 - SUMMARY

Instructors shall:

- 12.1.1 Summarise the BTT Module referring to the objectives

### ELEMENT 12.2 - THEORETICAL TEST

Instructors shall:

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

Delegates shall:

- 12.2.3 Conduct the test

Instructors shall:

- 12.2.4 Check the test results and give feedback to the Delegates about the test result
- 12.2.5 In case of a Delegate failing, conduct an interview with the Delegate according to "Delegates Performance Assessment" section.



## Lesson 13 - EVALUATION

15 min.

The aim of this is lesson to give the Delegates the opportunity to conduct an open-minded review of the training and the instructor in both oral and written.

### ELEMENT 13.1 - EVALUATION

Delegates shall:

13.1.1 Conduct a written evaluation

Instructors shall:

13.1.2 Give necessary feedback on the written evaluations





## 10 MODULE 2 - THE BTT ELECTRICAL MODULE

### 10.1 Aims and objectives of the BTT Electrical Module

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

The BTT Electrical Module shall ensure Delegates are able to:

- 1) Explain the basics of electricity (L2 – Knowledge).
- 2) Explain risks and hazards associated with electrical work (L2 – Knowledge).
- 3) Explain the function and symbol of electrical components (L2 – Knowledge).
- 4) Explain the function of different types of sensors (L2 – Knowledge).
- 5) Explain and interpret a simple electrical diagram and demonstrate how to assembly it on a circuit (L2 – Knowledge / L3 - Skill).
- 6) Demonstrate how to make correct and safe measurements (L3 – Skill).

### 10.2 Duration of the BTT Electrical Module

The total contact time for completing this BTT electrical module is estimated to be 9.22 hours. This is based on the time estimate given in the module timetable.

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

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

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

*Table 9-2 - Maximum durations for training day*

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

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



## 10.3 Equipment

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

## 10.4 BTT Electrical Module Time Table

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

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



| Lesson |                             | Element |  | Approx. Duration |
|--------|-----------------------------|---------|--|------------------|
| 1      | Introduction                | 1.1     | Safety instructions and emergency procedures |                  |
|        |                             | 1.2     | Facilities                                   |                  |
|        |                             | 1.3     | Introduction                                 |                  |
|        |                             | 1.4     | Aim and objectives                           |                  |
|        |                             | 1.5     | On-going assessment                          |                  |
|        |                             | 1.6     | Motivation                                   |                  |
|        |                             | TOTAL   |  |                  |
|        |                             |         | (if done after another BTT module) 5 min.    |                  |
| 2      | Introduction to Electricity | 2.1     | Direct current                               |                  |
|        |                             | 2.2     | Ohm’s Law                                    |                  |
|        |                             | 2.3     | Alternating current                          |                  |
|        |                             | 2.4     | Alternating current/Direct current           |                  |
| TOTAL  |                             |         | 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    | Processor 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 Measuring Instruments |          |
|                            |                                  | 7.2 | How to measure with Electrical Measuring Instruments     |          |
|                            |                                  | 7.3 | Measuring points   |          |
| TOTAL                      |                                  |     |  | 70 min.  |
| 8                          | Summary and Theoretical test     | 8.1 | Summary  |          |
|                            |                                  | 8.2 | Theoretical test   |          |
| TOTAL                      |                                  |     |  | 30 min.  |
| 9                          | Evaluation                       | 9.1 | Evaluation   |          |
| TOTAL                      |                                  |     |  | 15 min.  |
| GRAND TOTAL                |                                  |     |  | 595 min. |
| (if done after Mechanical) |                                  |     |  | 570 min. |

Table 10-4 - GWO BTT Electrical module timetable



## 10.5 Learning outcomes of the BTT Electrical Module

The learning outcomes specified for the BTT Electric Module are:

### Lesson 1 - INTRODUCTION

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

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

#### ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Instructors shall:

- 1.1.1 Explain the safety instructions according to internal procedures
- 1.1.2 Explain the emergency procedures and emergency exits in the localities the Delegates can be expected to be located during the course

#### ELEMENT 1.2 - FACILITIES

Instructors shall:

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

#### ELEMENT 1.3 - INTRODUCTION

Instructors shall:

- 1.3.1 Give a short presentation of himself including his background as an instructor

Delegates shall:

- 1.3.2 Give a short introduction, including job function expectation for the course

Instructors shall:

- 1.3.3 Explain the programme of the BTT, including breaks and meal times

#### ELEMENT 1.4 - AIM AND OBJECTIVES

Instructors shall:

- 1.4.1 Explain the aims and objectives of this BTT Training



## ELEMENT 1.5 - ON-GOING ASSESSMENTS

Instructors shall:

- 1.5.1 Explain the reasons for the on-going assessment
- 1.5.2 Explain the GWO Control Measures and their use

## ELEMENT 1.6 - MOTIVATION

Instructors shall:

- 1.6.1 Explain the importance of personal involvement in the course

## Lesson 2 - INTRODUCTION TO ELECTRICITY

70 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain what is direct current (L2 – Knowledge).
- 2) Demonstrate how to apply Ohm's Law (Voltage, Current & Resistance) (L3 – Skill).
- 3) Explain what is alternating current (L2 – Knowledge).
- 4) Explain the difference between direct and alternating current (L2 – Knowledge).

## ELEMENT 2.1 - DIRECT CURRENT

Instructors 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)

## ELEMENT 2.2 - OHM'S LAW

Instructors shall:

- 2.2.1 Explain practical examples of Ohm's Law (current, voltage and resistance) using a simple circuit diagram of battery and resistor

Delegates shall:



- 2.2.2 Engage in discussions about the relationship between current, voltage and resistance
- 2.2.3 Practice and demonstrate the use of Ohm's Law in exercises

### ELEMENT 2.3 - ALTERNATING CURRENT

Instructors shall:

- 2.3.1 Explain the theory behind alternating current
- 2.3.2 Explain the location of AC in a basic electrical circuit diagram

### ELEMENT 2.4 - ALTERNATING CURRENT/DIRECT CURRENT

Instructors shall:

- 2.4.1 Explain the difference between alternating and direct current.

## Lesson 3 - ELECTRICAL SAFETY

70 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the importance of Electrical Safety (L2 – Knowledge).
- 2) Explain the risks and hazards of low and high voltage (L2 – Knowledge).
- 3) Explain the function, importance and symbol of GFCI/RCD and PE (L2 – Knowledge).
- 4) Explain the risks and hazards of stored energy in electrical systems (L2 – Knowledge)
- 5) Explain the risks and hazards of static electricity (L2 – Knowledge)
- 6) Identify Safety Signs (L1 – Knowledge).
- 7) Demonstrate the usage of required PPE for working with electricity (L3 – Skill).
- 8) Explain the importance of proper isolation when working with electricity (L2 – Knowledge).

### ELEMENT 3.1 - WHY ELECTRICAL SAFETY

Instructors shall:

- 3.1.1 Explain the effects on the body due to contact with electricity



- 3.1.2 Explain the importance of working according to approved working practices

Delegates shall:

- 3.1.3 Engage in discussions about the relation between current and contact time

### ELEMENT 3.2 - LOW / HIGH VOLTAGE

Instructors shall:

- 3.2.1 Define low and high voltage (dependent on the country)
- 3.2.2 Explain the possible hazards related to high voltage
- 3.2.3 Describe examples of possible hazards (high voltage transformer, switchgear, megohmmeter)
- 3.2.4 Explain the requirement for HV training for performing any HV work

Delegates shall:

- 3.2.5 Engage in discussions about the awareness of high voltage

### ELEMENT 3.3 - PE AND GFCI/RCD

Instructors shall:

- 3.3.1 Explain the function and importance of GFCI/RCD and protective earth
- 3.3.2 Show examples of and explain the symbol of the GFCI/RCD and PE
- 3.3.3 Explain that not all circuits on a wind turbine are protected by GFCI/RCD's.

### ELEMENT 3.4 - STORED ENERGY

Instructors 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

### ELEMENT 3.5 - STATIC ELECTRICITY

Instructors shall:

- 3.5.1 Explain the danger of static electricity in connection with the blade





### ELEMENT 3.6 - SAFETY SIGNS

Instructors 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

Delegates shall:

- 3.6.3 Engage in discussions about different safety signs’ meanings

### ELEMENT 3.7 - TYPES OF PPE

Instructors shall:

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

Delegates shall:

- 3.7.2 Practice and demonstrate the usage of the required PPE for working with electricity

### ELEMENT 3.8 - THE IMPORTANCE OF APPROPRIATE ISOLATION

Instructors shall:

- 3.8.1 Explain the importance of using appropriate isolation techniques when working with electricity
- 3.8.2 Explain 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

Delegates shall:

- 3.8.5 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 Delegates the basic knowledge and understanding of electrical components.



To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the function of the resistor and how to identify it on a diagram.  
(L2 – Knowledge).
- 2) Explain the function of the battery, how to identify it on a diagram and the risk and hazards to the stored energy (L2 – Knowledge).
- 3) Explain the function of the switches and how to identify them on a diagram.  
(L2 - Knowledge).
- 4) Explain the function of the contactors and how to identify them on a diagram.  
(L2 - Knowledge).
- 5) Explain the function of the relays and how to identify them on a diagram.  
(L2 - Knowledge).
- 6) Explain the function of the diode, how to identify it on a diagram (L2 - Knowledge).
- 7) Explain the function of the bridge rectifier, how to identify it on a diagram.  
(L2 - Knowledge).
- 8) Explain the function of the capacitor, how to identify it on a diagram and the risk and hazards to the stored energy (L2 - Knowledge).
- 9) Explain the function of transformers and how to identify them on a diagram.  
(L2 - Knowledge).
- 10) Explain the function of generators and motors and how to identify them on a diagram. (L2 - Knowledge).
- 11) Explain the function of fuses and circuit breakers and how to identify them on a diagram. (L2 - Knowledge).
- 12) Explain the function of the processor control system and its position in the diagram. (L2 - Knowledge).

#### ELEMENT 4.1 - RESISTORS

Instructors 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

#### ELEMENT 4.2 - BATTERIES

Instructors 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

#### ELEMENT 4.3 - SWITCHES

Instructors 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

#### ELEMENT 4.4 - CONTACTORS

Instructors 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

#### ELEMENT 4.5 - RELAYS

Instructors 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

#### ELEMENT 4.6 - DIODES

Instructors 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



## ELEMENT 4.7 - BRIDGE RECTIFIERS

Instructors 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

## ELEMENT 4.8 - CAPACITORS

Instructors 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

## ELEMENT 4.9 - TRANSFORMERS

Instructors 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

## ELEMENT 4.10 - GENERATORS AND MOTORS

Instructors 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

## ELEMENT 4.11 - FUSES AND CIRCUIT BREAKERS

Instructors 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

## ELEMENT 4.12 - PROCESSOR CONTROL SYSTEMS

Instructors shall:

4.12.1 Explain the function of a Wind Turbine Processor Control Systems

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

## Lesson 5 - SENSORS

90 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the function of sensors (L2 – Knowledge).
- 2) Explain the function of the wind sensors and how to identify them on a diagram (L2 – Knowledge).
- 3) Explain the function of a temperature sensor and how to identify it on a diagram (L2 – Knowledge).
- 4) Explain the function of position sensors (L2 – Knowledge).
- 5) Discuss about other types of sensors that can be on a turbine (L2 – Attitude).

## ELEMENT 5.1 - INTRODUCTION TO SENSORS

Instructors shall:

5.1.1 Explain the function of sensors

5.1.2 Explain the difference between analogue & digital signals

Delegates shall:

5.1.3 Engage in discussions about the different types, locations and functions of sensors

## ELEMENT 5.2 - WIND SENSORS

Instructors 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

Delegates shall:

5.2.4 Engage in discussions about the different types, locations and functions of wind sensors

### ELEMENT 5.3 - TEMPERATURE SENSORS

Instructors 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)

Delegates shall:

5.3.5 Engage in discussions about the different types, locations and functions of temperature sensors (PT 100 and thermistor)

### ELEMENT 5.4 - POSITION SENSORS

Instructors shall:

5.4.1 Explain the function of position sensors

5.4.2 Explain position sensors in a circuit (yaw, nacelle, blades...)

Delegates shall:

5.4.3 Engage in discussions about the locations and functions of position sensors

### ELEMENT 5.5 - OTHER SENSORS

Delegates shall:

5.5.1 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 Delegates the basic knowledge to read and interpret a simple electrical diagram and demonstrate how to assemble it on a circuit

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain electrical components and how to interpret basic electrical diagrams (L2 – Knowledge).
- 2) Demonstrate how to assemble a simple electric circuit (L3 – Skill).

#### ELEMENT 6.1 - SYMBOLS AND DIAGRAMS

Instructors shall:

- 6.1.1 Show an example of an electrical diagram covering the components mentioned in 2.3
- 6.1.2 Explain how to interpret the electrical diagram

Delegates shall:

- 6.1.3 Identify different components in the diagram
- 6.1.4 Explain how to interpret the electrical diagram

#### ELEMENT 6.2 - ASSEMBLY OF AN ELECTRICAL CIRCUIT

Delegates shall:

- 6.2.1 Demonstrate the ability to assemble an electrical circuit following a basic electrical diagram including the components mentioned in the equipment list in Section 2.3 as a minimum
- 6.2.2 Demonstrate the correct operation of the circuit

### Lesson 7 - ELECTRICAL MEASURING INSTRUMENTS

70 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the symbols and settings used for current, voltage and resistance in the measuring instruments (L2 – Knowledge).
- 2) Demonstrate how to measure current, voltage, resistance, PT100, continuity, diodes, bridge rectifiers and capacitance (L3 – Skill).
- 3) Discuss how to identify measuring points in the diagram (L2 -Knowledge).



## ELEMENT 7.1 - SYMBOLS AND SETTINGS ON ELECTRICAL MEASURING INSTRUMENTS

Instructors 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 visual inspection of test instruments and leads

Delegates shall:

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

## ELEMENT 7.2 - HOW TO MEASURE WITH ELECTRICAL MEASURING INSTRUMENTS

Instructors shall:

- 7.2.1 Explain and demonstrate the measurement of
  - a. VAC and VDC
  - b. A and mA
  - c. Ohms / continuity
  - d. Diode and bridge rectifier
  - e. Capacitor
  - f. PT100

Delegates shall:

- 7.2.2 Practice and demonstrate the ability to measure Voltage, Current and resistance
- 7.2.3 Practice and demonstrate the ability to measure continuity
- 7.2.4 Practice and demonstrate the ability to measure a diode and a bridge rectifier
- 7.2.5 Practice and demonstrate the ability to measure a capacitor
- 7.2.6 Practice and demonstrate the ability to measure a PT100

## ELEMENT 7.3 - MEASURING POINTS

Delegates shall:

- 7.3.1 Engage in discussions about the measuring points in a physical circuit
- 7.3.2 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 Delegates.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Recall the objectives that have been covered within this module
- 2) Pass the Theoretical test

### ELEMENT 8.1 - SUMMARY

Instructors shall:

- 8.1.1 Summarise the BTT Module referring to the objectives

### ELEMENT 8.2 - THEORETICAL TEST

Instructors shall:

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

Delegates shall:

- 8.2.3 Conduct the test

Instructors shall:

- 8.2.4 Check the test results and give feedback to the Delegates about the test result
- 8.2.5 In case of a Delegate failing, conduct an interview with the Delegate according to "Delegates Performance Assessment" section.

## Lesson 9 - EVALUATION

15 min.

The aim of this is to give the Delegates the opportunity to conduct an open-minded review of the training and the instructor in both oral and written.

### ELEMENT 9.1 - EVALUATION

Delegates shall:



9.1.1 Conduct a written evaluation

Instructors shall:

9.1.2 Give necessary feedback on the written evaluations



## 11 MODULE 3 - THE BTT HYDRAULIC MODULE

### 11.1 Aims and objectives of the BTT Hydraulic Module

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

The BTT Hydraulic Module shall ensure Delegates are able to:

- 1) Explain the basics of hydraulics (L2 – Knowledge).
- 2) Explain risks and hazards associated with hydraulic work (L2 – Knowledge).
- 3) Explain the function of different types of pumps and demonstrate how to check start/stop pressure of a pump (L2 – Knowledge / L3 – Skill).
- 4) Explain the function of different types of actuators (L2 – Knowledge).
- 5) Explain the function of different types of valves (L2 – Knowledge).
- 6) Explain the function of accumulators and demonstrate how to check and precharge them (L2 – Knowledge / L3 – Skill).
- 7) Explain the function of different types of sensors (L2 – Knowledge).
- 8) Identify the components which transfer the oil (L2 – Knowledge).
- 9) Describe the handling of oil procedures (L2 – Knowledge).
- 10) Identify and find different components on a hydraulic diagram (L2 – Knowledge).
- 11) Demonstrate how to measure the hydraulic pressure accurately (L3 – Skill).

### 11.2 Duration of the BTT Hydraulic Module

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

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

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

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

*Table 11-2 - Maximum durations for training day*



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

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

### 11.3 Equipment

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

### 11.4 BTT Hydraulic Module Time Table

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

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

| Lesson |                        | Element  |  | Approx. Duration  |
|--------|------------------------|--|--|-------------------|
| 1      | Introduction           | 1.1  | Safety instructions and emergency procedures |                   |
|        |                        | 1.2  | Facilities                                   |                   |
|        |                        | 1.3  | Introduction                                 |                   |
|        |                        | 1.4  | Aim and objectives                           |                   |
|        |                        | 1.5  | On-going assessment                          |                   |
|        |                        | 1.6  | Motivation                                   |                   |
|        |                        | TOTAL (as stand-alone)<br>(if done after other BTT module) |  | 30 min.<br>5 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  | Pumps exercise                               |                   |
|        |                        | TOTAL  |  | 30 min.           |
| 5      | Actuators              | 5.1  | Introduction to actuators                    |                   |



|                                  |                              |      |  |  |
|----------------------------------|------------------------------|------|--|--|
| TOTAL                            |                              |      | 15 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              | 101  | Handling oil procedures/cleanliness      |  |
|                                  |                              | 10.2 | Collecting an oil sample                 |  |
|                                  |                              | 10.3 | Check oil level                          |  |
|                                  |                              | 10.4 | Filters                                  |  |
| TOTAL                            |                              |      | 45 min.                                  |  |
| 11                               | Hydraulic Diagrams           | 11.1 | Main symbols and component               |  |
|                                  |                              | 11.2 | Identifying measuring points             |  |
| TOTAL                            |                              |      | 45 min.                                  |  |
| 12                               | Pressure measuring tools     | 12.1 | Pressure gauge/manometer characteristics |  |
|                                  |                              | 12.2 | Pressure measuring                       |  |
| TOTAL                            |                              |      | 20 min.                                  |  |
| 13                               | Summary and Theoretical test | 13.1 | Summary                                  |  |
|                                  |                              | 13.2 | Theoretical test                         |  |
| TOTAL                            |                              |      | 30 min.                                  |  |
| 14                               | Evaluation                   | 14.1 | Evaluation                               |  |
| TOTAL                            |                              |      | 15 min.                                  |  |
| GRAND TOTAL                      |                              |      | 535 min.                                 |  |
| (If done after other BTT module) |                              |      | 510 min.                                 |  |

Table 11-4 - BTT Hydraulic module timetable



## 11.5 Learning outcomes of the BTT Hydraulic Module

The learning outcomes specified for the BTT Hydraulic Module are:

### Lesson 1 - INTRODUCTION

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

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

#### ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Instructors shall:

- 1.1.1 Explain the safety instructions according to internal procedures
- 1.1.2 Explain the emergency procedures and emergency exits in the localities the Delegates can be expected to be located during the course

#### ELEMENT 1.2 - FACILITIES

Instructors shall:

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

#### ELEMENT 1.3 - INTRODUCTION

Instructors shall:

- 1.3.1 Give a short presentation of himself including his background as an instructor

Delegates shall:

- 1.3.2 Give a short introduction, including job function expectation for the course

Instructors shall:

- 1.3.3 Explain the programme of the BTT, including breaks and meal times

#### ELEMENT 1.4 - AIM AND OBJECTIVES

Instructors shall:

- 1.4.1 Explain the aims and objectives of this BTT Training



## ELEMENT 1.5 - ON-GOING ASSESSMENTS

Instructors shall:

- 1.5.1 Explain the reasons for the on-going assessment
- 1.5.2 Explain the GWO Control Measures and their use

## ELEMENT 1.6 - MOTIVATION

Instructors shall:

- 1.6.1 Explain the importance of personal involvement in the course

## Lesson 2 - HYDRAULIC INTRODUCTION

30 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the function and principles of a basic hydraulic system (L2 – Knowledge).
- 2) Explain hydraulic power transmission / Pascal's Law (L2 – Knowledge).

## ELEMENT 2.1 - THE HYDRAULIC SYSTEM

Instructors 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)

## ELEMENT 2.2 - PASCAL'S LAW

Instructors 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

Delegates shall:

- 2.2.4 Engage in discussions about how it is possible to increase and decrease the force by using the same pressure



## Lesson 3 - HYDRAULIC SAFETY

60 min.

The aim of this lesson is to give the Delegates the needed awareness, knowledge and understanding in order to handle hydraulic hazards in a wind turbine.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the importance of Hydraulic Safety (L2 – Knowledge).
- 2) Explain the risks and hazards of high pressure in hydraulic systems (L2 – Knowledge).
- 3) Explain the risks and hazards of stored energy in hydraulic systems (L2 – Knowledge).
- 4) Identify Safety Signs (L1 – Knowledge).
- 5) Explain the risks and hazards of oil in hydraulic systems and SDS (L2 – Knowledge).
- 6) Demonstrate how to choose and inspect the required PPE for working with hydraulics (L3 – Skill).
- 7) Explain the importance of proper isolation when working with hydraulics (L2 – Knowledge).

### ELEMENT 3.1 - WHY HYDRAULIC SAFETY

Instructors 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 Explain the importance of working according to approved work practices

Delegates shall:

- 3.1.3 Engage in discussions about the consequences of hydraulic incidents (pressure, nitrogen...)

### ELEMENT 3.2 - HIGH PRESSURE SYSTEMS

Instructors 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 Explain 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

### ELEMENT 3.3 - STORED ENERGY

Instructors 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)

### ELEMENT 3.4 - SAFETY SIGNS

Instructors 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

Delegates shall:

- 3.4.3 Engage in discussions about different safety signs' meanings

### ELEMENT 3.5 - CHEMICALS

Instructors shall:

- 3.5.1 Explain the hazards caused by being exposed 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 involved when handling oil

### ELEMENT 3.6 - TYPES OF PPE

Instructors 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 Explain the consequence of not wearing the right PPE



- 3.6.5 Demonstrate how to test if the glove is fit for use;
  - a. Check the glove for holes
  - b. Check that the glove is suitable for hydraulic oil

Delegates shall:

- 3.6.6 Practice and demonstrate how to choose the right PPE to wear for hydraulic work
- 3.6.7 Practice and demonstrate how to inspect and use hydraulic PPE

### ELEMENT 3.7 - THE IMPORTANCE OF APPROPRIATE ISOLATION

Instructors shall:

- 3.7.1 Explain the importance of using appropriate isolation techniques when working with hydraulics

Delegates shall:

- 3.7.2 Engage in discussions about why it is important to prevent unexpected start-up

## Lesson 4 - PUMPS

30 min.

The aim of this lesson is to train the Delegates to be able to explain the main type of pumps of hydraulic circuits and demonstrate how to check the start and stop pressure on pumps.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the function of pumps, how to identify them on a diagram and examples of how they can be operated (L2 – Knowledge).
- 2) Demonstrate how to check the start and stop pressure of a pump following the instructions (L3 – Skill).

### ELEMENT 4.1 - INTRODUCTION TO PUMPS

Instructors 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

#### ELEMENT 4.2 - PUMPS EXERCISE

Instructors shall:

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

Delegates shall:

- 4.2.2 Demonstrate the ability to check the start and stop pressure on a pump following the instructions from the instructor

### Lesson 5 - ACTUATOR

15 min.

The aim of this lesson is to train the Delegates to be able explain the main type of actuators (e.g. cylinders).

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the function of Actuators and how to identify them on a diagram (L2 – Knowledge).

#### ELEMENT 5.1 - INTRODUCTION TO ACTUATORS

Instructors shall:

- 5.1.1 Explain the function of actuators
- 5.1.2 Explain different types of actuators (e.g. cylinders and callipers) and its operation
- 5.1.3 Show examples of and explain the symbols for actuators
- 5.1.4 Explain the position of actuators in a circuit

### Lesson 6 - VALVES

105 min.

The aim of this lesson is to train the Delegates to be able to explain the function of valves.

To successfully complete this BTT Module, Delegates shall be able to:



- 1) Explain the function of valves (L2 – Knowledge).
- 2) Explain the function of different types of directional control valves, describe their principle of operation and how to identify them on a diagram (L2 – Knowledge).
- 3) Explain the function of the pressure relief valve, how to identify it on a diagram and demonstrate how to adjust it (L2 – Knowledge / L3 – Skill).
- 4) Explain the function of the pressure reduction valve and how to identify it on a diagram (L2 – Knowledge).
- 5) Explain the function of the needle valve, how to identify it on a diagram and demonstrate how to use it to depressurize a system (L2 – Knowledge / L3 – Skill).
- 6) Explain the function of different types of non-return valve and how to identify them on a diagram (L2 – Knowledge).
- 7) Explain the function of the throttle valve and how to identify it on a diagram (L2 – Knowledge).
- 8) Explain the function of the restrictor valve and how to identify it on a diagram (L2 – Knowledge).

## ELEMENT 6.1 - INTRODUCTION TO VALVES

Instructors shall:

- 6.1.1 Explain the function of valves (controlling flow, oil direction, pressure...)

## ELEMENT 6.2 - DIRECTIONAL CONTROL VALVES

Instructors 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, hydraulic, manual...)
- 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

Delegates shall:

- 6.2.10 Engage in discussions about the operation of directional valves



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

### ELEMENT 6.3 - PRESSURE RELIEF VALVES

Instructors 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 Demonstrate how to check and adjust the pressure relief valve
- 6.3.4 Show examples of and explain the symbol for a pressure relief valve
- 6.3.5 Explain the position of pressure relief valves in a circuit

Delegates shall:

- 6.3.6 Practice and demonstrate checking and adjusting the pressure relief valve in a circuit

### ELEMENT 6.4 - PRESSURE REDUCTION VALVES

Instructors 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 Show examples of and explain the symbol for a pressure reduction valve
- 6.4.4 Explain the position of pressure reduction valves in a circuit

### ELEMENT 6.5 - NEEDLE VALVES

Instructors 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 Show examples of and explain the symbol for a needle valve
- 6.5.4 Explain the position of a needle valve in a circuit

Delegates shall:

- 6.5.5 Practice the operation of the needle valve in a circuit
- 6.5.6 Demonstrate the ability to use a needle valve to depressurize the hydraulic system

### ELEMENT 6.6 - NON-RETURN VALVES



Instructors 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 Show examples of and explain the symbol for a non-return valve
- 6.6.6 Show examples of and explain the symbol for a pilot operated non-return valve
- 6.6.7 Explain the position of a non-return valve in a circuit

## ELEMENT 6.7 - THROTTLE VALVES

Instructors shall:

- 6.7.1 Explain the function of a throttle valve
- 6.7.2 Explain the operation of a throttle valve
- 6.7.3 Show examples of and explain the symbol for a throttle valve
- 6.7.4 Explain the position of a throttle valve in a circuit

## ELEMENT 6.8 - RESTRICTOR VALVES

Instructors shall:

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

## Lesson 7 - ACCUMULATORS

80 min.

The aim of this lesson is to train the Delegates to be able to explain the function of accumulators and how to do the pre-charge of Nitrogen under safe conditions.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the function of the different accumulators and how to identify them on a diagram (L2 – Knowledge).
- 2) Demonstrate how to check the pre-charge pressure and refill the accumulator (L3 – Skill).



## ELEMENT 7.1 - INTRODUCTION TO ACCUMULATORS

Instructors 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

## ELEMENT 7.2 - PRE-CHARGE PRESSURE

Instructors 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

Delegates shall:

- 7.2.6 Practice and demonstrate the ability to check the pre-charge pressure of an accumulator
- 7.2.7 Practice and demonstrate the ability to refill the accumulator

## Lesson 8 - SENSORS

15 min.

The aim of this lesson is to train the Delegates to be able to explain the function of different sensors.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the function of sensors (L2 – Knowledge).
- 2) Explain the function of a pressure sensor and how to identify them on a diagram (L2 – Knowledge).

## ELEMENT 8.1 - INTRODUCTION TO SENSORS

Instructors shall:



8.1.1 Explain the function of sensors

Delegates shall:

8.1.2 Engage in discussions about different types of hydraulic sensors

## ELEMENT 8.2 - PRESSURE SENSORS

Instructors 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

## Lesson 9 - PIPES, HOSES AND CONNECTIONS

20 min.

The aim of this lesson is to enable the Delegates to be able to identify the components which transfer the oil on the hydraulic system.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the function and inspection of the components which transfer the oil and how to identify them on a diagram (L2 – Knowledge).
- 2) Explain how to use different fittings to make a hydraulic connection and how to identify them on a diagram (L2 – Knowledge).

## ELEMENT 9.1 - OIL TRANSFER

Instructors 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

## ELEMENT 9.2 - HYDRAULIC CONNECTIONS

Instructors 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

## Lesson 10 - OIL AND FILTERS

40 min.

The aim of this lesson is to train the Delegates to be able to describe the handling of oil procedures.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Describe the basic handling of oil procedures (L1 – Knowledge).
- 2) Explain the importance of a proper oil sample (L2 – Knowledge).
- 3) Demonstrate how to check oil level (L3 – Skill).
- 4) Explain the function of filters, how to identify them on a diagram and their maintenance (L2 – Knowledge).

### ELEMENT 10.1 - HANDLING OIL PROCEDURES/CLEANLINESS

Instructors shall:

- 10.1.1 Describe that there are different types of oils with different properties and uses
- 10.1.2 Explain the importance of using the right one and not mixing different oils
- 10.1.3 Explain the importance of cleanliness

### ELEMENT 10.2 - COLLECTING AN OIL SAMPLE

Instructors shall:

- 10.2.1 Explain the purpose of taking an oil sample
- 10.2.2 Explain the importance of properly collecting an oil sample according to given instructions

### ELEMENT 10.3 - CHECKING OIL LEVEL

Instructors 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

Delegates shall:

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

## ELEMENT 10.4 - FILTERS

Instructors shall:

10.4.1 Explain the function of the filters

10.4.2 Explain 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

## Lesson 11 - HYDRAULIC DIAGRAMS

45 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Identify the main symbols and components in a hydraulic system diagram (e.g. pump, tank, hoses, valves...) (L1 – Knowledge).
- 2) Explain the function of measuring points and how to identify them on a diagram (L2 – Knowledge).

## ELEMENT 11.1 - SYMBOLS AND DIAGRAMS

Instructors 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

Delegates shall:

11.1.4 Explain the different components in the diagram



- 11.1.5 Explain how to interpret the hydraulic diagram

## ELEMENT 11.2 - IDENTIFYING MEASURING POINTS

Instructors 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

Delegates shall:

- 11.2.4 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 train the Delegates to be able to demonstrate how to measure the hydraulic pressure accurately.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the function, symbol and use of pressure gauges/manometers (L2 – Knowledge).
- 2) Demonstrate how to measure hydraulic pressure (L3 – Skill).

## ELEMENT 12.1 - PRESSURE GAUGE/MANOMETER

Instructors 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

Delegates shall:

- 12.1.4 Engage in discussions about how to use a pressure gauge/manometer
- 12.1.5 Engage in discussions about the importance of calibration



## ELEMENT 12.2 - PRESSURE MEASURING

Instructors shall:

- 12.2.1 Explain and demonstrate how to take an accurate pressure measurement

Delegates shall:

- 12.2.2 Practice and demonstrate 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 Delegates.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Recall the objectives that have been covered within this module
- 2) Pass the Theoretical test

### ELEMENT 13.1 - SUMMARY

Instructors shall:

- 13.1.1 Summarise the BTT Module referring to the objectives

### ELEMENT 13.2 - THEORETICAL TEST

Instructors shall:

- 13.2.1 Introduce the test to the Delegates explaining the rules to be followed during the test
- 13.2.2 Conduct the test with the Delegates

Delegates shall:

- 13.2.3 Conduct the test

Instructors shall:

- 13.2.4 Check the test results and give feedback to the Delegates about the test result
- 13.2.5 In case of a Delegate failing, conduct an interview with the Delegate according to "Delegates Performance Assessment" section.



## Lesson 14 - EVALUATION

15 min.

The aim of this lesson is to give the Delegates the opportunity to conduct an open-minded review of the training and the instructor in both oral and written.

### ELEMENT 14.1 - EVALUATION

Delegates shall:

14.1.1 Conduct a written evaluation

Instructors shall:

14.1.2 Give necessary feedback on the written evaluations



## 12 MODULE 4 - THE BTT INSTALLATION MODULE

### 12.1 Aims and objectives of the BTT Installation Module

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

The BTT Installation Module shall ensure Delegates are able to:

- 1) Identify the main installation activities and explain the overall risks and hazards associated with the installation environment (L1 – Knowledge).
- 2) Explain the checklist system throughout the complete installation process (L2 – Knowledge).
- 3) Explain the characteristics of the installation environments (L2 – Knowledge).
- 4) Explain the principles and standards for handling and storing goods and components onsite or within a storage area before and after installation (L2 – Knowledge).
- 5) Explain the basic principles of the lifting equipment (L2 – Knowledge).
- 6) Explain the basic preparation of main components before installation (L2 – Knowledge).
- 7) Explain the basic mechanical completion (L2 – Knowledge).
- 8) Demonstrate how to perform the basic electrical completion including the principles and standards for handling and installing cables (L3 – Skill).
- 9) Explain the basic hydraulic completion (L2 – Knowledge).
- 10) Explain the principles of operating external generators during installation (L2 – Knowledge).
- 11) Explain the basis of how to do a handover to commissioning (L2 – Knowledge).

### 12.2 Duration of the BTT Installation Module

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

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

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



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

Table 12-2 - Maximum durations for training day

**Note:** Contact time includes delivery of course lesson contents, 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 Delegate Prerequisites for the BTT Installation Module

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

### 12.4 Equipment

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

### 12.5 BTT Installation Module Time Table

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

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

| Lesson                           |              | Element |  | Approx. Duration |
|----------------------------------|--------------|---------|--|------------------|
| 1                                | Introduction | 1.1     | Safety instructions and emergency procedures |                  |
|                                  |              | 1.2     | Facilities                                   |                  |
|                                  |              | 1.3     | Introduction                                 |                  |
|                                  |              | 1.4     | Aim and objectives                           |                  |
|                                  |              | 1.5     | On-going assessment                          |                  |
|                                  |              | 1.6     | Motivation                                   |                  |
| TOTAL                            |              |         |  | 30 min.          |
| (if done after other BTT module) |              |         |  | 5 min.           |
| 2                                |              | 2.1     | Installation overview                        |                  |



|       |   |     |   |          |
|-------|---|-----|---|----------|
|       | Introduction to Installation                            | 2.2 | Why Installation Safety   |          |
|       |   | 2.3 | Safety Signs  |          |
|       |   | 2.4 | Types of PPE  |          |
|       |   | 2.5 | The importance of appropriate isolation   |          |
| TOTAL |   |     |   | 55 min.  |
| 3     | General procedures for working onsite with installation | 3.1 | Checklists, Work Instructions, etc.   |          |
|       |   | 3.2 | Housekeeping  |          |
| TOTAL |   |     |   | 30 min.  |
| 4     | Installation environments                               | 4.1 | Installation environments   |          |
| TOTAL |   |     |   | 45 min.  |
| 5     | Handling and storing                                    | 5.1 | Risks and hazards associated with handling and storing                                  |          |
|       |   | 5.2 | Reception / Inspection  |          |
|       |   | 5.3 | Unloading and storage of blades, nacelle, tower sections & hub                          |          |
|       |   | 5.4 | Tools and equipment   |          |
|       |   | 5.5 | Return of goods and components  |          |
| TOTAL |   |     |   | 70 min.  |
| 6     | Lifting operations                                      | 6.1 | Types of lifting  |          |
|       |   | 6.2 | Risks and hazards associated with lifting operations                                    |          |
|       |   | 6.3 | Roles and responsibilities  |          |
| TOTAL |   |     |   | 100 min. |
| 7     | Main components 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 the mechanical completion                             |          |
| TOTAL |   |     |   | 75 min.  |
| 9     |   | 9.1 | Introduction to electrical completion   |          |





|                                   |  |  |  |           |
|-----------------------------------|--|--|--|-----------|
|                                   | Principles of electrical completion including cable work | 9.2<br>9.3<br>9.4<br>9.5<br>9.6<br>9.7 | Examples of electrical completion<br>Risks and hazards associated with handling and working with cables<br>Different types of cables<br>Simple installation diagrams<br>Cutting and crimping of cables<br>Marking, routing and termination of all cable types  |           |
| TOTAL                             |  |  |  | 420 min.  |
| 10                                | Principles of hydraulic completion                       | 10.1<br>10.2<br>10.3                   | Introduction to hydraulic completion<br>Examples of hydraulic completion<br>Risks and hazards associated with hydraulic completion   |           |
| TOTAL                             |  |  |  | 40 min.   |
| 11                                | Principles of operation with external generators         | 11.1<br>11.2<br>11.3<br>11.4<br>11.5   | Principles of yaw, rotor and blades operation with external generator<br>Risks and hazards associated with the operation of auxiliary systems with an external generator<br>Preconditions for the operation of a lift with an external generator<br>Preconditions for the operation of an internal crane with an external generator<br>Use of external generators for other auxiliary uses |           |
| TOTAL                             |  |  |  | 50 min.   |
| 12                                | Introduction to handover to the commissioning            | 12.1<br>12.2                           | Handover to commissioning<br>Risks and hazards associated with handing over to the commissioning   |           |
| TOTAL                             |  |  |  | 30 min.   |
| 13                                | Summary and Theoretical test                             | 13.1                                   | Summary<br>Theoretical test  |           |
| TOTAL                             |  |  |  | 50 min.   |
| 14                                | Evaluation   | 14.1                                   | Evaluation   |           |
| TOTAL                             |  |  |  | 15 min.   |
| GRAND TOTAL                       |  |  |  | 1060 min. |
| (If done after other BTT modules) |  |  |  | 1035 min. |

Table 12-5 – GWO BTT Installation module timetable



## 12.6 Learning outcomes of the BTT Installation Module

The learning outcomes specified for the BTT Installation Modules are:

### Lesson 1 - INTRODUCTION

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

**Note:** If this module is delivered and combined with other BTT modules to the same Delegates, the redundant introductory elements shall not be repeated.

#### ELEMENT 1.1 - SAFETY INSTRUCTIONS AND EMERGENCY PROCEDURES

Instructors shall:

- 1.1.1 Explain the safety instructions according to internal procedures
- 1.1.2 Explain the emergency exits and emergency procedures in the localities the Delegates can be expected to be located during the course.

#### ELEMENT 1.2 - FACILITIES

Instructors shall:

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

#### ELEMENT 1.3 - INTRODUCTION

Instructors shall:

- 1.3.1 Give a short presentation of himself including his background as an instructor.

Delegates shall:

- 1.3.2 Give a short introduction, including job function expectation for the course.

Instructors shall:

- 1.3.3 Explain the programme of the BTT, including breaks and meal times.

#### ELEMENT 1.4 - AIM AND OBJECTIVES

Instructors shall:

- 1.4.1 Explain the aims and objectives of this BTT Training.



## ELEMENT 1.5 - ON-GOING ASSESSMENTS

Instructors shall:

- 1.5.1 Explain the reasons for the on-going assessment
- 1.5.2 Explain the GWO Control Measures and their use.

## ELEMENT 1.6 - MOTIVATION

Instructors shall:

- 1.6.1 Explain the importance of personal involvement in the course.

## Lesson 2 - INTRODUCTION TO INSTALLATION

55 min.

The aim of this lesson is to give the Delegates an overview of the installation activities of a wind farm and the needed awareness, knowledge and understanding in order to handle installation hazards in an installation environment.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Identify the main installation activities (L1 – Knowledge).
- 2) Explain the importance of installation safety (L2 – Knowledge).
- 3) Identify safety signs (L2 – Knowledge).
- 4) Explain the required PPE for working with installation (L2 – Knowledge).
- 5) Explain the importance of proper isolation when working with Installation (L2 – Knowledge).

## ELEMENT 2.1 - INSTALLATION OVERVIEW

Instructors shall:

- 2.1.1 Explain 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)

## ELEMENT 2.2 - WHY INSTALLATION SAFETY

Instructors 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, i.e. electricity, dropped objects, crushing damage, sharp items, toxic materials and/or that are substances used in the workplace
  - b. Tools/equipment malfunctioning due to poor control and/or handling during installation.
- 2.2.2 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 to major cuts and/or crushing damage
  - d. Entrapment.
- 2.2.3 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.

Delegates shall:

- 2.2.4 Engage in discussions about safe working procedures, identifying the necessary PPE and the appropriate tools.



## ELEMENT 2.3 - SAFETY SIGNS

Instructors 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

Delegates shall:

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

## ELEMENT 2.4 - ELEMENT 2.4 TYPES OF PPE

Instructors shall:

- 2.4.1 Show examples of and explain the usage and the inspection of PPE suitable when in an installation environment.

## ELEMENT 2.5 - ELEMENT 2.5 THE IMPORTANCE OF APPROPRIATE ISOLATION

Instructors shall:

- 2.5.1 Explain the importance of using appropriate isolation techniques when in an installation environment.

Delegates shall:

- 2.5.2 Engage in discussions about roles and responsibilities regarding the isolation techniques
- 2.5.3 Engage in discussions about 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 Delegates an understanding of the checklist system through the complete installation process.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the checklist system throughout the complete installation process (L2 – Knowledge).



- 2) Explain the importance of good housekeeping when working on the installation environment (L2 – Knowledge).

### ELEMENT 3.1 - CHECKLISTS, WORK INSTRUCTIONS, ETC.

Instructors shall:

- 3.1.1 Explain the purpose of checklist, work instructions, etc. (show an example of a checklist, work instructions, etc.)
- 3.1.2 Explain the importance of working according to the approved working practices (checklist, work instructions, etc.)
- 3.1.3 Explain the importance of completing a task properly before starting the next task
- 3.1.4 Explain the importance of performing toolbox talks every day to discuss the specifics about the works to be performed during that day.

Delegates shall:

- 3.1.5 Engage in discussions about the importance of completing a task properly before starting the next task.

### ELEMENT 3.2 - HOUSEKEEPING

Instructors shall:

- 3.2.1 Explain the importance of having everything clean and tidy and its impact on safety and quality.

Delegates shall:

- 3.2.2 Engage in discussions about the consequences of poor housekeeping
- 3.2.3 Engage in discussions about the importance of personal commitment.

## Lesson 4 - INSTALLATION ENVIRONMENTS

45 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the characteristics of installation environments including site induction, various key working areas, safety behaviour and personnel roles (L2 – Knowledge).



## ELEMENT 4.1 - INSTALLATION ENVIRONMENTS

Instructors 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 (i.e. Site Manager, Site Supervisors, Team Leaders, Installation Crew, Admin staff, crane operator, Health & Safety, third parties...)
- 4.1.5 Explain what is a Site Induction and relate it to the previous point
- 4.1.6 Explain the differences with an off-shore site (examples of areas, environment, safety rules...).

Delegates shall:

- 4.1.7 Engage in discussions about on site organization; typical roles and responsibilities, communication and the interaction between them
- 4.1.8 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 Delegates the knowledge about the principles, standards of handling and storing goods and components onsite or within a storage area before and after installation.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the risks and hazards associated with handling and storing goods and components (L2 – Knowledge).
- 2) Demonstrate how to receive/inspect goods and components (L3 – Skill).
- 3) Explain how to unload and store goods and components (L1 – Knowledge).
- 4) Explain how to maintain tools and equipment during installation (L2 – Knowledge).
- 5) Explain how to prepare for returning goods and components (L2 – Knowledge).



## ELEMENT 5.1 - RISKS AND HAZARDS ASSOCIATED WITH HANDLING AND STORING

Instructors shall:

- 5.1.1 Describe examples of risks and hazards associated with handling and storing.

Delegates shall:

- 5.1.2 Engage in discussions about the risks and hazards associated with handling and storing.

## ELEMENT 5.2 - RECEPTION / INSPECTION

Instructors 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 get notified (Damage Report could be done by 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 The importance of notifying a supervisor and tag "out of service" (or "do not use" or similar) if something is broken while being used.

Instructors shall:

- 5.2.4 Demonstrate how to perform inspections in accordance to work instructions, checklists, etc.

Delegates shall:

- 5.2.5 Practice and demonstrate the ability to perform an inspection and document it on a checklist (focus is in the use of checklist, not in the inspection itself).





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

Instructors 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 on-site
- 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 of 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.

Delegates shall:

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

## ELEMENT 5.4 - TOOLS AND EQUIPMENT

Instructors 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 usually can be found in the tool container and should be cross referenced to make sure that all tools delivered on site are returned.

## ELEMENT 5.5 - RETURN GOODS AND COMPONENTS

Instructors shall:

- 5.5.1 Explain what needs to be returned:
  - a. Transport frames
  - b. Goods
- 5.5.2 Explain 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 defect tools are labelled



Delegates shall:

- 5.5.3 Engage in discussions about how they would like to receive the transport frames and goods themselves

Instructors shall:

- 5.5.4 Show an example of and describe the return goods report

Delegates shall:

- 5.5.5 Practice and demonstrate the ability to fill in a return goods report

## Lesson 6 - LIFTING OPERATIONS

100 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain different types of lifting (L2 – Knowledge).
- 2) Explain the risks and hazards associated with lifting operations (L2 – Knowledge).
- 3) Explain the roles and responsibilities when lifting (L2 – Knowledge).

### ELEMENT 6.1 - TYPES OF LIFTING

Instructors 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).

Delegates shall:

- 6.1.9 Discuss examples of the three different types of lifts in relation to the components (blades, nacelle, tower sections, hub, drive train and generator)
- 6.1.10 Discuss 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

Instructors shall:

- 6.2.1 Explain 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 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 damages to the equipment
- 6.2.6 Explain how to control movement of loads when lifting by means of tag lines.

Delegates shall:

- 6.2.7 Engage in discussions about the consequences of procedural errors in lifting operations and damages to the equipment

## ELEMENT 6.3 - ROLES AND RESPONSIBILITIES

Instructors 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)

Delegates shall:

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

## Lesson 7 - MAIN COMPONENTS PREPARATION, PRE-ASSEMBLY AND ASSEMBLY

50 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain the preparation of the different types of main components, Tower-sections – Hub – Blades – Nacelle - Generator – Drive Train (L2 – Knowledge).
- 2) Explain risks and hazards associated with main component preparation, pre-assembly and assembly (L2 – Knowledge).
- 3) Explain issues when assembling the main components i.e. tower-tower alignment, yaw alignment etc. (L2 – Knowledge).

### ELEMENT 7.1 - PREPARATION, PRE-ASSEMBLY AND ASSEMBLY

Instructors shall:

- 7.1.1 Give examples of and explain the difference between:
- a. Preparation. i.e. gathering tools, mounting stud bolts on blades, install spinner shells on hub, removing transport frames or equipment, cleaning flanges etc.
  - b. Pre-assembly. Assembly of components together before being mounted in the turbine. i.e. mounting of cooler top on top of nacelle, mounting of hub in the nacelle, mounting of blades into the hub
  - c. Assembly. i.e. assembly of main components into the turbine itself (tower sections, nacelle, hub, rotor, etc.)
- 7.1.2 Explain why preparation is performed before pre-installation and installation
- 7.1.3 Explain the importance of cleaning the main components before they are installed
- 7.1.4 Explain why it is important to repair damages on components before installation
- 7.1.5 Show examples of and explain cleaning.



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

Delegates shall:

- 7.1.7 Engage in discussions about different tasks for preparation, pre-installation and installation of WTG at onshore and offshore sites.

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

Instructors shall:

- 7.2.1 7.1.1 Explain the risks and hazards associated with:
- a. Main components preparation
  - b. Pre-assembly of components
  - c. Assembly of components
  - d. Cleaning.

- 7.2.2 Show pictures from installation sites with the relevant risks and hazards

Delegates shall:

- 7.2.3 Engage in discussions about how the risks in the previous pictures can be mitigated

## ELEMENT 7.3 - CHALLENGES WHEN ASSEMBLING MAIN COMPONENTS

Instructors shall:

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

Delegates shall:

- 7.3.2 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 Delegates the basic knowledge of the mechanical completion.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Describe the mechanical completion principles, application and the reason behind mechanical completion (L1 – Knowledge).
- 2) Demonstrate how to document on a checklist the mechanical completion of a partly complete WTG (L3 – Skill).
- 3) Explain risks and hazards associated with mechanical completion (L2 – Knowledge).

### ELEMENT 8.1 - INTRODUCTION TO MECHANICAL COMPLETION

Instructors shall:

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

### ELEMENT 8.2 - EXAMPLES OF MECHANICAL COMPLETION

Instructors 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.

Delegates shall:

- 8.2.2 Practice and demonstrate the ability to document on a checklist the mechanical completion of a partly complete WTG (aids to be used: images, video, 3D or VR)
- 8.2.3 Explain 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

Instructors shall:

- 8.3.1 Explain the risks and hazards associated with mechanical completion
- 8.3.2 Describe examples of different risks and hazards associated with mechanical completion (i.e. platforms not mounted yet).



Delegates shall:

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

## Lesson 9 - PRINCIPLES OF ELECTRICAL COMPLETION INCLUDING CABLE WORK

420 min.

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

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Describe electrical completion principles and application (L1 – Knowledge).
- 2) Explain examples of tasks related to electrical completion (L2 – Knowledge).
- 3) Explain the risks and hazards associated with electrical completion (L2 – Knowledge).
- 4) Identify and explain the purpose of different types of cables, i.e. small signal, main power (LV&HV) and fiber optic cables (L2 – Knowledge).
- 5) Demonstrate how to follow simple installation diagrams to install cables (L3 – Skill).
- 6) Demonstrate how to perform cutting and crimping of small signal and main power LV cables (L3 – Skill).
- 7) Demonstrate how to perform marking, routing and termination of all cable types (L3 – Skill).

### ELEMENT 9.1 - INTRODUCTION TO ELECTRICAL COMPLETION

Instructors shall:

- 9.1.1 Explain the electrical tasks to be completed in the turbine after the main components are installed.



## ELEMENT 9.2 - EXAMPLES OF ELECTRICAL COMPLETION

Instructors 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. Install ventilators
  - c. Install safety systems (aviation lights)
  - d. Install tower section cables
  - e. Routing of cables
  - f. Termination of cables.

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

Instructors shall:

- 9.3.1 Explain the risks and hazards associated with electrical completion
- 9.3.2 Explain that incorrect use of cutting and crimping tools could cause personal injury
- 9.3.3 Explain the risks associated with the installation of cables inside tower and hoisting / lowering cables
- 9.3.4 Explain that incorrect use of cutting and crimping tools could lead to damage to the insulation or poor connection resulting in serious damage such as fire.

Delegates shall:

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

## ELEMENT 9.4 - DIFFERENT TYPES OF CABLES

Instructors shall:

- 9.4.1 Show examples of and explain different types and purposes of cables:





- a. Small signal cables; shielded and unshielded, rubber, PVC, cable glands
- b. Main power (HV&LV) cables; copper, aluminium, rubber and PVC insulation types
- c. Fibre optic cables; glass core, plastic core.

Delegates shall:

- 9.4.2 Explain the application of the different cable types in the WTG.

## ELEMENT 9.5 - SIMPLE INSTALLATION DIAGRAMS

Instructors 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.

Delegates shall:

- 9.5.2 Practice and demonstrate the ability to read 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 OF CABLES

Instructors shall:

- 9.6.1 Explain 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
- Copper and aluminium (special attention to correct cable die-set)
  - Rubber and PVC insulation types
  - Install heat/cold shrink tube on top of cable and cable lug after cable lug is crimped.

Delegates shall:

- 9.6.4 Practice and demonstrate the ability to cut and crimp small signal cables:
- Shielded and unshielded
  - Rubber and PVC insulation types
  - Install heat/cold shrink tube on top of cable and cable lug after cable lug is crimped.
- 9.6.5 Practice and demonstrate the ability to cut and crimp main power (LV) cables:
- Copper and aluminium (special attention to the correct cable die-set)
  - Rubber and PVC insulation types.

## ELEMENT 9.7 - MARKING, ROUTING AND TERMINATION OF ALL CABLE TYPES

Instructors shall:

- 9.7.1 Show examples of and explain different types of marking and their purposes for all cable types:
- Cable and conductor
  - Cabinet (diagram).
- 9.7.2 Show examples of and explain important factors when routing all cable types (inform delegates to refer to work instructions for the specifics):
- Bending radius (why a minimum is important)
  - Not twisted
  - Distance between cables types and groups
  - Fastening of cables; fixed vs flexible
  - Cable protection tubes or edge protection
  - Cable glands.
- 9.7.3 Show examples of and explain important factors when handling fibre optic cables:
- Handle with care due to fragility (lower it individually, do not combine with other cables when handling)
  - Excess cable should not be cut out, but coiled



- c. How to bend (coil bending radius) in accordance to 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).

Delegates shall:

9.7.6 Engage in discussions about typical faults during termination:

- a. Insulation in terminal & loose cores
- b. Not correct torque – generates heat
- c. Poor crimping – all kinds of scenarios.

9.7.7 Practice and demonstrate the ability to mount markings in accordance with an electrical diagram:

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

9.7.8 Practice and demonstrate the ability to route all cable types applying these factors:

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

9.7.9 Practice and demonstrate the ability to route fibre optics cables

9.7.10 Practice and demonstrate the ability to correctly terminate signal cables:

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

9.7.11 Practice and demonstrate the ability to correctly terminate 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 Delegates the basic knowledge of the hydraulic completion.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Describe hydraulic completion principles and application (L1 – Knowledge).
- 2) Explain examples of topics during pre-assembly and installation while doing hydraulic completion (L2 – Knowledge).
- 3) Explain the risks and hazards associated with hydraulic completion (L2 – Knowledge).

### ELEMENT 10.1 - INTRODUCTION TO HYDRAULIC COMPLETION

Instructors shall:

- 10.1.1 Explain that there are hydraulic tasks to be completed in the turbine after the main components are installed.

### ELEMENT 10.2 - EXAMPLES OF HYDRAULIC COMPLETION

Instructors 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).

Instructor shall:

- 10.2.2 Explain the importance of following the work instructions (avoid leaks and breakdowns)
- 10.2.3 Explain the importance of cleanliness (most of the breakdowns are due to contamination).



Delegates shall:

- 10.2.4 Engage in discussions about the importance of following the work instructions (avoid leaks and breakdowns)
- 10.2.5 Engage in discussions about the importance of cleanliness (most of breakdowns due to contamination).

### ELEMENT 10.3 - RISKS AND HAZARDS ASSOCIATED WITH HYDRAULIC COMPLETION

Instructors shall:

- 10.3.1 Explain the risks and hazards associated with hydraulic completion
- 10.3.2 Explain how to react in case of hydraulic incident (hydraulic injures)
- 10.3.3 Explain the importance of reporting and cleaning any oil spillage.
- 10.3.4 Show examples of and describe different risks and hazards associated with the hydraulic completion (including possibility of pressure in accumulators).

Delegates shall:

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

## Lesson 11 - PRINCIPLES OF OPERATION WITH EXTERNAL GENERATOR

50 min.

The aim of this lesson is to give the Delegates an understanding on the principles of operating external generators during installation.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Demonstrate how to supply an electrical installation using auxiliary power instead of the main power supply (L3 – Skill).
- 2) Explain risks and hazards associated with operation of auxiliary systems with an external generator (L2 – Knowledge).
- 3) Recognize preconditions for the operation of a lift with an external generator (L1 – Knowledge).
- 4) Recognize preconditions for the operation of an internal crane with an external generator (L1 – Knowledge).



- 5) Recognize the basic principles of using external generators for auxiliary systems (L1 – Knowledge).

#### ELEMENT 11.1 - PRINCIPLES OF YAW, ROTOR AND BLADES OPERATION WITHOUT GRID-POWER

Instructors 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.).

Delegates shall:

- 11.1.3 Practice and demonstrate the ability to, based on a work instruction, connect 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 OPERATION OF AUXILIARY SYSTEMS WITH EXTERNAL GENERATOR

Instructors shall:

- 11.2.1 Explain the risks and hazards associated with the operation of auxiliary systems without grid-power.
- 11.2.2 Show examples of and describe different risks and hazards associated with the operation of auxiliary systems without grid-power.

Delegates shall:

- 11.2.3 Engage in discussions about the risks and hazards associated with the operation of auxiliary systems without grid-power
- 11.2.4 Engage in discussions about the importance of appropriate isolation/locking techniques (e.g. Lock Out Tag Out)
- 11.2.5 Engage in discussions about the correct PPE.

#### ELEMENT 11.3 - PRECONDITIONS FOR OPERATION OF LIFT WITH EXTERNAL GENERATOR

Instructors 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.

Delegates shall:

- 11.3.3 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 CRANE WITH EXTERNAL GENERATOR

Instructors 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 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.

Delegates shall:

- 11.4.6 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

Instructors 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 Explain the importance of ground connections and GFCIs/RCDs
- 11.5.3 Explain the need of 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 Delegates the basic knowledge of the handover to commissioning.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Explain handover/completion of the checklist (L2 – Knowledge).
- 2) Explain about possible risks and hazards we can pass on when handing over to commissioning (L2 – Knowledge).

### ELEMENT 12.1 - HANDOVER TO COMMISSIONING

Instructors 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

Instructors shall:

- 12.2.1 Explain the risks and hazards associated with the handover to commissioning that may lead to injury to any personnel involved
- 12.2.2 Explain the risks associated with handover to commissioning in terms of cost, project timeline and potential damage to components.
- 12.2.3 Show examples of and describe the risks and hazards that may lead to injury to personnel (i.e. incorrectly applied isolation procedures or forgotten tools)
- 12.2.4 Show examples of and describe the risks associated with 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.

Delegates shall:

- 12.2.5 Engage in discussions about the risks and hazards to personnel involved in handover to commissioning as a consequence of tasks completed partially, incorrectly or their status incorrectly reported
- 12.2.6 Engage in discussions about the consequences to 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 Delegates.

To successfully complete this BTT Module, Delegates shall be able to:

- 1) Recall the objectives that have been covered within this module
- 2) Pass the theoretical test.

### ELEMENT 13.1 - SUMMARY

Instructors shall:

- 13.1.1 Summarise the BTT Installation Module referring to the objectives

### ELEMENT 13.2 - THEORETICAL TEST

Instructors shall:

- 13.2.1 Introduce the test to the delegates explaining the rules to be followed during the test
- 13.2.2 Conduct the test with the delegates

Delegates shall:

- 13.2.3 Conduct the test (20 questions / 30 min)

Instructors shall:

- 13.2.4 Check the test results and give feedback to the Delegates about the test result
- 13.2.5 In case of a Delegate failing, conduct an interview with the Delegate according to "Delegates Performance Assessment" section.

## Lesson 14 - EVALUATION

15 min.

The aim of this is lesson to give the Delegates the opportunity to conduct an open-minded review of the training and the instructor in both oral and written.



## ELEMENT 14.1 - EVALUATION

Delegates shall:

- 14.1.1 Conduct a written/online evaluation

Instructors shall:

- 14.1.2 Give necessary feedback on the written evaluation



## ANNEX 1 - DELEGATE PERFORMANCE ASSESSMENT FORM

|  |                      |   |                                |            |                           |                          |                          |                          |                          |
|--|----------------------|---|--------------------------------|------------|---------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Delegate full name as in passport        |                      |   |                                |            |                           |                          |                          |                          |                          |
| Delegate WINDA ID                        |                      |   |                                |            |                           |                          |                          |                          |                          |
| Course module                            |                      | Mechanical                              | <input type="checkbox"/>       | Electrical | <input type="checkbox"/>  | Hydraulic                | <input type="checkbox"/> | Installation             | <input type="checkbox"/> |
|  |                      | Date of completion                      |                                |            |                           |                          |                          |                          |                          |
|  |                      | <b>Violation of Assessment Measures</b> | <b>0-2 passed<br/>3 failed</b> |            | <b>Instructor Remarks</b> |                          |                          |                          |                          |
| Instructions                             |                      |   |                                |            |                           |                          |                          |                          |                          |
| Instructionsn Followed                   |                      |   |                                |            |                           |                          |                          |                          |                          |
| Safety                                   |                      |   |                                |            |                           |                          |                          |                          |                          |
| Awareness of ... Safety                  | Individual           |   |                                |            |                           |                          |                          |                          |                          |
|  | Group                |   |                                |            |                           |                          |                          |                          |                          |
| PPE                                      | Selection            |   |                                |            |                           |                          |                          |                          |                          |
|  | Inspection           |   |                                |            |                           |                          |                          |                          |                          |
|  | Correct use          |   |                                |            |                           |                          |                          |                          |                          |
| Tools                                    |                      |   |                                |            |                           |                          |                          |                          |                          |
| Tools                                    | Selection            |   |                                |            |                           |                          |                          |                          |                          |
|  | Inspection           |   |                                |            |                           |                          |                          |                          |                          |
|  | Correct and Safe Use |   |                                |            |                           |                          |                          |                          |                          |
| Attitude                                 |                      |   |                                |            |                           |                          |                          |                          |                          |
| Control                                  |                      |   |                                |            |                           |                          |                          |                          |                          |
| Participation                            |                      |   |                                |            |                           |                          |                          |                          |                          |
| Applies knowledge                        |                      |   |                                |            |                           |                          |                          |                          |                          |
| Quality                                  |                      |   |                                |            |                           |                          |                          |                          |                          |
| Demonstrates understanding of subject    |                      |   |                                |            | Yes:                      | <input type="checkbox"/> | No:                      | <input type="checkbox"/> |                          |
| Total Marks:<br>(0-13 Pass / 14-39 Fail) |                      |   |                                |            | PASS:                     | <input type="checkbox"/> | FAIL:                    | <input type="checkbox"/> |                          |
| Instructor Name<br>(in CAPITAL letters)  |                      |   |                                |            | Instructor Signature      |                          |                          |                          |                          |



## 1. CONTROL MEASURE INSTRUCTIONS

The purpose of this form is for the instructor to document the delegate's performance while doing the practical exercise.

This Control Measures Form must be used by the instructor during practices for each one of the delegates and for each one of the modules contained within this Standard, so they have to be prepared before the training starts with 1 copy per delegate and per module being delivered.

The Control Measure Form is divided into 4 categories:

1. Instructions
2. Safety
3. Tools
4. Attitude

And each category has its own sub-categories (see template above).

Explanations about Attitude sub-categories:

|                   |   |
|-------------------|---|
| Control           | Establishes and maintains control of the exercise scenario at all times     |
| Participation     | Fully participates in the exercise scenario                                 |
| Applies Knowledge | Applies subject knowledge correctly in given scenario                       |
| Quality           | Performs the task with the Quality level required by the instructions given |

For every time a delegate is doing something wrong, he/she should get notified by the instructor, explained why what he/she was doing was wrong and then this should be recorded in at least one of the sub-categories above.

At the end of each module the instructor will go through each one of them and will evaluate whether the delegates pass the practices or not and keep the document for future reference. If for any of the sub-categories the delegates get 3 violations, he/she will not pass the module.

If in total, a delegate gets more than 13 violations he/she will not pass the module. It is also possible for the instructor to fail a delegate even if the number of violations did not exceed the previous mentioned, if he/she has the feeling that the delegate was not able to demonstrate having reached the objective defined for the practice. That will be recorded using the filed "Demonstrates understanding of subject".



## ANNEX 2 - MEDICAL SELF-ASSESSMENT FORM

Your personal health is your own responsibility. Your Training Provider shall not be held responsible for any illness whatsoever during or after the training.

I hereby confirm that I have read and understood the listed risks and potentially life-threatening medical conditions and that I am physically and medically fit to participate in GWO Training.

I hereby confirm that there is no factor that will inhibit or affect my participation in GWO Training. I agree to follow all instructions from the appointed Instructor for the duration of the GWO Training. Should there be any doubt regarding my medical fitness, the training provider will stop the training and seek a physician's advice.

|                     |  |
|---------------------|--|
| Name as in passport |  |
| Delegate WINDA ID   |  |
| Course module       |  |
| Signature and date  |  |

### The following conditions could pose a risk, when you participate in GWO training

- Asthma or other respiratory disorders
- Epilepsy, blackouts or other fits
- Angina or other heart complaints
- Vertigo or inner ear problems (difficulty with balance)
- Claustrophobia/Acrophobia (fear of enclosed area/height)
- Blood pressure disorder
- Diabetes
- Pacemaker or implanted defibrillator
- Arthritis, osteoarthritis or other muscular/ skeletal disorders affecting mobility
- Known allergies (E.g. bee, wasps or spider stings / bites)
- Recent surgery
- Any other medical condition or medication dependency that could affect climbing or physical impact of climbing



## ANNEX 3 - EQUIPMENT LIST

The equipment required for training must be available and must fulfil national legal requirements where applicable. The tools, materials and equipment are needed for the execution of the course are listed in the following pages.

Any equipment used during this GWO training module shall meet or exceed the minimum requirements of the national standards listed in table A3-1 to A3-4. When working in a country where there is no applicable national standard then the equipment shall meet or exceed the minimum requirements of the European standards.

Each delegate 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 delegate shall be provided with PPE appropriate to the task they are performing.

**Note:** All equipment shall be maintained and where appropriate, inspected and tested in accordance with current national Standards/legislation and manufacturers' recommendations.

**Note:** There is no need to calibrate the tools as long as this is not compromising safety and the tools are maintained. In this case the tools must be tagged "NO CALIBRATION. ONLY FOR TRAINING" or similar, so that the user knows that the tools are only allowed to be used for training purposes.



## 1. BTT MECHANICAL MODULE

The following equipment is required during the entire duration of this BTT Mechanical Training to meet the needs of the BTT Mechanical Module:

- 1) PPE suitable for mechanical work (mechanical gloves, safety goggles, safety shoes or boots and working clothing)
- 2) Spanners
- 3) Torque wrenches
- 4) Sockets
- 5) Screwdrivers
- 6) Hexagon (Allen) keys
- 7) Feeler gauges
- 8) Dial gauge
- 9) Vernier Calliper
- 10) Dial Test Indicators
- 11) Brake disc
- 12) Brake pad
- 13) Mock up for bolt torque including various sets of bolts
- 14) A simple cooling circuit (or part of it)
- 15) A simple lubrication system (or part of it)

Any equipment used during this GWO training module shall meet or exceed the minimum requirements of the national standards in the country where the training is taking place. When working in a country where there is no applicable national standard then the equipment shall meet or exceed the minimum requirements of the European standards.



## 2. BTT ELECTRICAL MODULE

The following equipment is required during the entire duration of this BTT Electrical Training to meet the needs of the BTT Electrical Module.

- 1) PPE suitable for electrical work (Insulating gloves, goggles, safety shoes or boots and suitable clothing)
- 2) LOTO equipment
- 3) Measuring devices
- 4) Multimeter
- 5) Two Pole voltage detector

There must be a panel with standard DIN rail for mounting an electrical circuit and the following components:

- 1) Power supply or transformer and a bridge rectifier
- 2) Electrical protection
- 3) Appropriate electrical wires
- 4) Different value resistances
- 5) Lamps
- 6) Switches
- 7) Capacitors
- 8) Diodes
- 9) Terminals for rail
- 10) Push buttons (NO and NC)
- 11) Contactors
- 12) Relays
- 13) Emergency stop button
- 14) PT 100 sensor

Any equipment used during this GWO training module shall meet or exceed the minimum requirements of the national standards in the country where the training is taking place. When working in a country where there is no applicable national standard then the equipment shall meet or exceed the minimum requirements of the European standards.





### 3. BTT HYDRAULIC MODULE

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

- 1) PPE suitable for hydraulic work (Gloves, safety goggles, safety shoes or boots and suitable clothing or overalls)
- 2) LOTO equipment
- 3) Filling kit for nitrogen
- 4) Nitrogen bottle
- 5) Pressure gauge/manometer

There must be a rig with pre-built electrical control of a hydraulic circuit that contains the following components:

- 1) Tank with level indicator
- 2) Pump with electrical motor
- 3) Directional valve
- 4) Needle valve
- 5) Pressure relief valve
- 6) Non-return valve
- 7) Pressure switch
- 8) Actuator
- 9) Accumulator
- 10) Test points
- 11) Oil
- 12) Filters

Any equipment used during this GWO training module shall meet or exceed the minimum requirements of the national standards in the country where the training is taking place. When working in a country where there is no applicable national standard then the equipment shall meet or exceed the minimum requirements of the European standards.



## 4. BTT INSTALLATION MODULE

The following equipment is required during the entire duration of this training to meet the needs of the BTT Installation Module:

- 1) 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)
- 2) Spanners
- 3) Torque wrenches
- 4) Sockets
- 5) Screwdrivers
- 6) Cable ties
- 7) Heat shrinks / cold shrinks
- 8) Hexagon (Allen) keys
- 9) Tool set for cutting, stripping and crimping small cables (smaller than 6mm<sup>2</sup>) – 1 set for 2 delegates
- 10) Tool set for cutting and stripping main cables (massive & core conductors, bigger than 35mm<sup>2</sup>) – 1 set for 2 delegates
- 11) Tool set for crimping wires bigger than 35mm<sup>2</sup> (electric or electro-hydraulic) – 1 set for 4 delegates
- 12) Log Out Tag Out kit (this kit should not be required if not needed considering the setup available for the practices)
- 13) Mock-up for cable work including:
  - a. Electrical cabinets with standard DIN rails for mounting terminals (clamp, screw type)
  - b. Clamp, screw type terminals
  - c. Cable glands
  - d. Cable trays
  - e. Bus bars (copper) with holes to connect cables with cable lugs

Any equipment used during this GWO training module shall meet or exceed the minimum requirements of the national standards in the country where the training is taking place. When working in a country where there is no applicable national standard then the equipment shall meet or exceed the minimum requirements of the European standards.