T-shore Education

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Module and Scenario Overview

Module:
Yaw Motor Systems
Learning scenario:
Yaw Motor Fault Diagnosis

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

Table of Contents

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1 Description of module

The yaw system is a critical component of horizontal axis wind turbines, responsible for orienting the nacelle and rotor to face the wind direction for optimal energy capture. This module will cover the theory and practical aspects of yaw motor operation, maintenance, and troubleshooting.

It is common that there are six yaw motors required in a wind turbine to rotate the nacelle, but there could be from 4 to 8 motors. It is critical that all motors work together to rotate the nacelle due to the mass. Therefore, all motor brakes need to release at the same time and the brake callipers on the yaw ring must also release at the correct time. These motors are 3-phase, asynchronous motors with a magnetic brake. These motors are direct speed and do not soft start.

Should the yaw system cease operation, it is required that a wind technician visits the nacelle to diagnose the fault. The SCADA system will provide an error similar to “yaw malfunction” for example. When attempting to diagnose the fault the wind technician should check the following upon arrival at the Nacelle:

Check for more details on the fault within the SCADA system. This should identify which motor(s) has failed.

At this point, the fuses should be checked at the panel to ensure that no fuse has failed.

Ensure that the motor is isolated by following the correct lockout tagout procedure.

If all fuses are functional, check the operation of the magnetic brake on each of the faulty motor(s). The magnetic brake failing on the motor is the most common fault with yaw motors.

If the brake has failed, then the dysfunctional yaw motor(s) must be replaced.

If the brake is functional, then the windings of the motor must be inspected.

If the windings are broken or insulation between the windings has failed, then the dysfunctional yaw motor(s) must be replaced.

Check the SCADA system to ensure that the fault has been resolved and that there are no other outstanding faults.

Update the report to state what error was identified and how it was resolved, clearly stating the resources required to repair the fault.

Examination included a discussion between examiner and participant about own work, for example a roleplay between site manager and wind technician about the inspection report.

1.1 Theory

The module consists of a theoretical part where the participants will learn about the components and function of the yaw system, including:

- Overview of yaw system, purpose and benefits
- Yaw bearings

- Yaw drives (3-phase motors, gearboxes, gear rims and pinions)
- Yaw brakes
- Yaw control systems

1.2 Practical

In the practical element, participants will follow the instructor's guidance and documentation. Participants will gain hands-on experience with conducting yaw motor inspections; testing motor windings, brakes, and rectifiers; performing maintenance tasks; and troubleshooting common yaw system issues.

The practical training will end in a “debrief”, in which the instructor facilitates a conversation allowing the participants to reflect on their performance during the practical. The participants will be given the opportunity to comment on what went well, what did not go well, and where improvements could be made. The debrief will also focus on the participant’s communication and teamwork skills.

1.3 Evaluation

Throughout the module, participants will be evaluated by the instructor through written tests on theoretical knowledge; practical demonstrations of skills; and a final assessment which will include a report with conclusions and recommendations.

2 Instructor pre-qualification

To conduct the learning module theory and practical training, instructors must meet the minimum requirements below:

Knowledge: specialised education or advanced knowledge in the field of 3-phase motor diagnostics.

Skills: practical experience with wind turbine yaw systems.

Ability: educational skills and ability to conduct classes as an instructor, a reflective approach to teaching, and demonstration of safe work practices.

3 Participant pre-qualification

To conduct the module (theory and practical training), participants must meet the minimum requirements below:

Knowledge: Basic knowledge of wind turbine construction and rotating machinery. Basic electrical knowledge.

Skills: skills in reading electrical diagrams and using multimeters, multifunction meters and torque wrench.

Ability: safe work evaluation of situation

4 Overview of theoretical content, scenario documents, training equipment and infrastructure

Name	Quantity	Type	Category	Where to use
PC with projector screen	1	Real-life equipment	Theoretical part equipment	Theoretical part
Yaw Motor E-Learning		Digital material	Theoretical part material	Theoretical part
Risk assessment template	6	Printed/Digital Document	Theoretical part material	Theoretical part
Equipment checklist	6	Printed/Digital Document	Practical part material	Preparation for practical part
Yaw Motor Learning Scenario manual	6	Printed/Digital Document	Practical part material	Practical part
Yaw motor inc. brake	3	Real-life equipment	Practical part material	Practical part
Multimeters and multifunction meter	3	Real-life equipment	Practical part material	Practical part
Safety equipment (PPE)	1 each	Real-life equipment	Safety equipment	Practical part

Table 1 Material and equipment required

Note The list is provided for a group of 6 participants. For smaller or larger groups, the list needs to be adjusted accordingly.

5 Timeframe

Time	Part
2 hours	Theory
6 hours	Practice in workshop/assessment
Total: 8 hours	

Table 2 Timeframe of learning module and scenario

Note Timeframe may vary depending on number of participants, level of initial knowledge, skill and ability of participants and need to meet learning objectives.

6 Learning methods

Part	Learning method
Theory part	E-learning modules, classroom lectures, group discussions
Practical part	Practical skills training and hands-on exercises in workshop

Table 3 Learning Methods

Note Learning methods depends on accessibility of infrastructure and equipment.

7 Module learning outcomes

By the end of this module, students will be able to:

Module learning outcome	Competency	No.
Describe the main components of the yaw system and yaw motor	Electrical Mechanical	1.1 Understand the basic concepts of electricity and magnetism 2.1 Understand and interpret mechanical, electrical and hydraulic systems, including diagrams or schematics
Explain the purpose and importance of the yaw system and its components.	Electrical Mechanical	1.1 Understand the basic concepts of electricity and magnetism 2.2 Understand fundamental concepts of mechanics, dynamics, and thermodynamics
Describe the diagnostic process for identifying yaw motor faults	Electrical	1.2 Diagnose and rectify faults in electrical systems
Perform inspections and tests on yaw motors, including brake, rectifier, windings, and cables, using multimeters and multifunction meter, as well as troubleshoot common yaw system faults.	Electrical	1.2 Diagnose and rectify faults in electrical systems
Demonstrate proper safety procedures for yaw system maintenance	Safety	1.5 Apply knowledge of electrical safety in the context of wind energy facilities 4.2 Implement safety procedures and protocols for wind energy work environments 4.6 Perform risk assessments and have the proper safety mindset / risk awareness
Recognise the importance of and demonstrate proper **teamwork** and **communication**	Teamwork & Communication	5.1 Communicate effectively using verbal skills, industry-specific terminology, and active listening
Demonstrate effective reporting post-task of procedures carried out, both written (on Tablet or computer) and verbal.	Teamwork & Communication	5.3 Document technical information accurately, including maintenance records and reports, using verbal communication as well as written and digital tools

8 Theory part

8.1 Learning theory

The part of the training dedicated to theory involves classroom-based teaching of theory or the assessment of knowledge for participants who have completed e-learning before commencing the learning scenario. This can be implemented as a hybrid of both methods.

Note Some modules / practical learning parts may require a back-and-forth between theory and practice.

Instructor must:

- Present introduction / opening presentation specific for site
- Inform about and explain feedback questionnaire.
- Present the theory material or verify if participants complete e-learning on their own
- Collect feedback after theory introduction.

Each course participant must:

- Complete e-learning module
- Ask questions related to learning materials and module
- Conduct feedback questionnaire

Learning outcomes:

Detailed learning outcome	Module learning outcome
List the yaw system components including yaw motor, transmission, gearbox, bearings and brakes.	Describe the main components of the yaw system and the yaw motor
Define the basic principles of yaw mechanism operation. Explain the role of the yaw mechanism in wind turbine orientation. Outline how yaw electrical motors function to orient the turbine perpendicular to wind direction.	Explain the purpose and importance of the yaw system and its components.
Describe the principles of electromagnetic induction as it relates to propulsion in a yaw motor Explain the steps involved to troubleshoot a yaw motor. Explain the safe work procedures specific to yaw system maintenance.	Describe the diagnostic process for identifying yaw motor faults
Demonstrate the proper communication techniques required to safely perform yaw motor maintenance. Summarise the key benefits of effective post-task reporting for both the individual and the team/organisation.	Recognise the importance of and demonstrate proper **teamwork** and **communication**

8.2 Risk Assessment

The part of the training focused on risk assessment and its planning involves the instructor guiding students through an exercise on planning a risk assessment for a specific learning scenario and location.

Instructor must:

- Explain what risk assessment is and how it is being created
- Show template of risk assessment and filled example
- Conduct risk assessment exercise with students
- Answer questions and give feedback

Each course participant must:

- Ask questions related to learning materials

- Conduct risk assessment exercise

Learning outcomes:

Detailed learning outcome	Module learning outcome
Identify and list specific hazards associated with executing the Yaw Motor learning scenario. Evaluate potential risks and identify mitigating measures to minimise risk. Develop a risk assessment addressing the hazards identified in the planned Yaw Motor learning scenario.	Demonstrate proper safety procedures for yaw system maintenance

9 Practical part

9.1 General introduction

This part of the document describes how the practical part of the module should be organised. This is a guideline which may need local adaptation. Modules may require that the participants undergo practical skill training before they carry out the learning scenario. This may include how to operate tools, equipment and how a component function. After the skill training, the students will test their skills and knowledge in a practical learning scenario. Both the practical skill training and the learning scenario can be adapted to be a practical examination.

The instructor must provide constructive feedback to participants on relevant practice activities, including feedback on the accuracy of the exercise performed by the training participant, suggestions for improving the execution of the exercise by the training participant, and general remarks about participant safety at a given moment while performing of exercises.

At all times during training, participants can ask questions and expect feedback from the instructor.

9.2 Workshop introduction

Before start of practical exercises:

Participants may be divided into groups. Max ratio: 6 participants per instructor for practical session.

All participants and instructors shall use appropriate PPE in accordance with local laws and regulations.

The minimum requirement is:

- Overalls/work clothes – long sleeves
- Safety shoes
- Safety helmet

- Safety glasses
- Gloves with ANSI cut resistant level A1

The participants must be instructed about the following:

- All the equipment to be used and their correct use.
- The instructor must be informed immediately if anyone feels ill, in pain, tired or about any condition that may affect health and safety.
- If anybody feels uncomfortable during the training, e.g. uncomfortable working position, dizziness, etc., the instructor must be notified immediately.
- If anyone gets injured or causes harm to others, the instructor must be notified immediately.

Exclusion zones must be set up and maintained around the practical training area.

10 Preparation for practical exercises

10.1 HSE brief & PPE

The HSE brief includes information specific to the components and equipment used during the practical portion. It also involves verifying all safety aspects related to the practical exercises and ensuring that participants use PPE correctly.

Instructor must:

- Present and explain the hazards and risks in workshop zones.
- Check if each participant has the correct PPE and is wearing it correctly.

Each course participant must:

- Demonstrate the ability during practical exercises to keep themselves out of hazard and risk in the training workshop during scenario exercises.
- Inspect PPE before use and wear correct PPE equipment for training.

Learning outcomes:

Detailed learning outcome	Module learning outcome
Identify the appropriate PPE based on the hazard analysis related to planning activities Wear correct PPE equipment for planning activities	Demonstrate proper safety procedures for yaw system maintenance

10.2 Manual handling

Manual handling is a part of the training dedicated to preparing participants for physical tasks such as lifting heavy objects, bending, or assuming unnatural positions during exercises.

Instructor must:

- Facilitate warming up exercise, and manual handling exercises with group and discussions on how to handle equipment manually according to the equipment characteristics and potential hazards and risks.
- Correct positioning under manual tasks

Each course participant must:

- Warm up, and practice correct manual lifting techniques. Focus on correct work positioning.

Learning outcomes:

Detailed learning outcome	Module learning outcome
Demonstrate a proper warm-up prior to lifting heavy objects. Perform correct lifting techniques with a focus on correct work positioning.	Demonstrate proper safety procedures for yaw system maintenance

10.3 Equipment checks

This part of the training focuses on presenting the verification and inspection process for equipment needed during the practical part, as well as identifying when equipment requires quarantine. It also emphasises proper storage conditions and procedures.

Instructor must:

- Show where the yaw motor accessories, tools, and equipment are stored. Explain how to store them correctly and describe potential consequences of failing to do so.
- Explain the different indicators that must be checked during pre-use and post-use checks.
- Explain the reasons for quarantining accessories and equipment.
- Explain how to fill **equipment checklist**

Each course participant must:

- Practice the ability to correctly store accessories and tools – executing also during later practical exercises.
- Practice how to conduct pre-use and post-use equipment and accessories checks.
- Practice the ability to identify accessories requiring quarantine.
- Practice the completion of equipment checklist.

Learning outcomes:

Detailed learning outcome	Module learning outcome
Demonstrate proper procedure to store accessories and tools during after use.	Demonstrate proper safety procedures for yaw system maintenance
Conduct equipment inspection Complete equipment checklist	Demonstrate effective reporting post-task of procedures carried out, both written (on Tablet or computer) and verbal.

11 Practical skill training

Practical skill training is highly dependent on participants' pre-qualifications. Based on an assessment of participants' skills, the instructor should determine the amount of skill training required to allow participants to engage in exercises from the learning scenario. In cases where participants possess varying skill levels identified through a gap analysis; skill training should be planned according to the lowest skill level identified. This approach ensures learning opportunities for less experienced participants, while for more advanced participants, it serves as a review and practice of their skills.

Examples of skill training exercises related to the yaw motor scenario:

Testing motor windings at the control cabinet including:

- Continuity (multimeter)
- Balance (all three phases have the same resistance) (multimeter)
- Insulation resistance test (multifunction meter):
    a) Between windings and motor casing (ground).
    b) Between each phase.

Testing motor windings at the motor terminal block for the same as above to eliminate possible cable damage between control cabinet and the motor.

Testing the yaw motor brake including:

- Visually inspect yaw brake for physical damage.
- Test solenoid coil resistance against manufactures declared range.
- Test coil for shorts to ground.
- Test brake torque using torque wrench (13NM normally, this may vary depending on the motor).

Testing rectifier (in motor terminal block) including:

- Testing all four diodes with a multimeter with a diode testing function.
- Test for voltage drop (around 0.7V) in positive direction and “out of range” drop in the negative direction.

Implement practical skill training on equipment that can simulate the environment.

11.1 Use of mechanical tools

Skill exercise description

The mechanical testing required to establish the condition of a yaw motor are limited to simple tools to open the terminal block and isolate the windings. Also, the braking capacity of the motor brake can be tested to ensure that the brake will hold while the yaw system is idle. The tools required to conduct these tests are simple screwdrivers, ratchet and sockets along with a torque wrench.

Instructor must:

- Demonstrate and explain the use of a torque wrench to test the operational status of the yaw motor brake.
- Demonstrate and explain the correct procedure to open the terminal block and isolate the windings for testing using screwdrivers, sockets and a ratchet.

Each course participants must:

- Demonstrate the use of a torque wrench to test the operational status of the yaw motor brake.
- Demonstrate the correct procedure to open the terminal block and isolate the windings for testing using screwdrivers, sockets and a ratchet.

Learning outcomes:

Detailed learning outcome	Module learning outcome
Demonstrate the correct use of a torque wrench to test the operational status of the yaw motor brake. Demonstrate the correct procedure to open the terminal block and isolate the windings for testing using screwdrivers, sockets and a ratchet.	Perform inspections and tests on yaw motors, including brake, rectifier, windings, and cables, using multimeters and multifunction meter, as well as troubleshoot common yaw system faults.

11.2 Use of Meters

Skill exercise description

The multimeter and the multifunction meter are essential tools in testing the condition of a yaw motor and diagnosing faults. The multimeter is used to test for breaks in the windings which could be a cause of imbalance that could lead to heat, fire and yaw system failure. Similarly, the imbalance in a yaw motor may also occur from differing resistances in the three phases. This can also be observed using a multimeter.

A common source of failure in the yaw system is the yaw motor brake. To assess the condition of the yaw motor brake, it is prudent to test if the brake is receiving a voltage to open and allow the shaft to rotate. The yaw motor brake is commonly opened by a solenoid powered by a DC voltage from one of the phases of the yaw motor. As the yaw motor receives AC, this must be rectified to DC prior to power the solenoid. This is done using a simple bridge rectifier. This rectifier contains 4 diodes that can be tested using a multimeter. Furthermore, the solenoid can be tested using a multimeter and the results compared to the manufacturers declared resistance values.

Instructor must:

- Show and explain how to test for continuity with a multimeter.
- Demonstrate and explain the procedure to test the balance of a motor using a multimeter.
- Exhibit and explain how to test the diodes in a bridge rectifier using a multimeter.
- Demonstrate and explain how to test the voltage drop across a rectifier in both the positive and negative direction.
- Show and explain the procedure to test the motor brake solenoid and compare to manufacturers declared resistance values.
- Demonstrate and explain how to conduct an insulation resistance test using a multifunction meter.

Each course participants must:

- Show how to test for continuity with a multimeter.
- Demonstrate the procedure to test the balance of a motor using a multimeter.
- Exhibit how to test the diodes in a bridge rectifier using a multimeter.
- Demonstrate how to test the voltage drop across a rectifier in both the positive and negative direction.
- Demonstrate the procedure to test the motor brake solenoid and compare to manufacturers declared resistance values.

- Show how to conduct an insulation resistance test using a multifunction meter.

Learning outcomes:

Detailed learning outcome	Module learning outcome
Show how to test for continuity with a multimeter. Demonstrate the procedure to test the balance of a motor using a multimeter. Exhibit how to test the diodes in a bridge rectifier using a multimeter. Demonstrate how to test the voltage drop across a rectifier in both the positive and negative direction. Demonstrate the procedure to test the motor brake solenoid and compare to manufacturers declared resistance values. Show how conduct an insulation resistance test using a multifunction meter.	Perform inspections and tests on yaw motors, including brake, rectifier, windings, and cables, using multimeters and multifunction meter, as well as troubleshoot common yaw system faults.

12 Learning scenario

12.1 Scenario Introduction

Participants will learn to perform a proactive inspection and fault diagnosis, with required documentation, of a yaw motor like those found in the yaw system inside the nacelle.

Note: *If the workshop does not have realistic wind turbine components that supports all the practical steps described below: Implement practical skill training on equipment that can simulate the environment.*

Note: *Before starting practical exercises, please refer to Section 9.2 Workshop introduction.*

12.2 Exercise 1 – Yaw motor operation safety

Exercise description

On commencing the exercise, the instructor will explain the safety procedures required when working with yaw motors, including how to disconnect power from the yaw motor and control cabinet, as well as how to verify proper lockout/tagout procedures are followed. The exercise should also demonstrate how to the multimeter to resistance (ohms) mode. The exercise should also focus on accurate reporting of the conditions encountered developing the ability to conduct an objective assessment.

Instructor must:

- Explain and discuss the steps in Exercise 1 from the **learning scenario manual**, emphasising the details of each action while maintaining safety protocols.
- During the exercise, provide feedback and reflections to the participants, engaging them in discussions.
- Explain and demonstrate how to complete the **yaw motor equipment checklist**.
- Review and discuss the results of the participant reports with them.

Each course participant must:

- Familiarise themselves thoroughly with the learning scenario manual and clarify any unclear points.
- Perform each step from the manual.
- Complete the yaw motor operation safety checklist.

Learning outcomes:

Detailed learning outcome	Module learning outcome
Explain the safety procedures required for yaw system maintenance.	Knowledge of safety procedures required for yaw system maintenance.
Describe potential risks to safety during yaw system maintenance.	Knowledge of the risks involved in yaw system maintenance.
Demonstrate collaboration effectively to successfully complete the task.	Recognise the importance of, and demonstrate, proper teamwork and communication.
Complete inspection documentation in correct and reflective way.	Communicate clearly the procedures undertaken using written documentation and verbal reports.
Exhibit the correct lockout tagout procedure to isolate the yaw motor Complete the yaw motor operation safety checklist	Recognise the importance of and demonstrate proper **teamwork** and **communication**

12.3 Exercise 2 – Yaw motor windings assessment

Exercise description

The objective of this exercise is to assess the condition of yaw motor windings to identify potential faults that could lead to abnormal noise, stuck or inaccurate positioning of the turbine nacelle.

Instructor must:

- Explain and demonstrate how to perform a motor windings assessment at both the cabinet and the motor which include:
  - a) Continuity test
  - b) Insulation resistance test
    - Between windings (check for a short between each phase)
    - Between windings and motor casing (check for short between each winding and ground)
- Balance (all three phases have the same resistance) (multimeter)

Each course participant must:

- Practice the ability to conduct a motor windings assessment.
- Practice the ability to fill out a motor windings assessment inspection report.

Learning outcomes:

Detailed learning outcome	Module learning outcome
Conduct a continuity test, insulation resistance test and a resistance balance test Compare the results of the above tests to manufacturer specifications	Perform inspections and tests on yaw motors, including brake, rectifier, windings, and cables, using multimeters and multifunction meter, as well as troubleshoot common yaw system faults.
List results from the above tests in maintenance report	Demonstrate effective reporting post-task of procedures carried out, both written (on Tablet or computer) and verbal.

12.4 Exercise 3 - Yaw motor brake test

Exercise description

The objective of this exercise is to test the yaw brake system's ability to properly engage and release while assessing electrical functionality and brake contact

Instructor must:

- Explain and demonstrate how to test the condition of the yaw motor brake including:
  - a) Visually inspect yaw brake for physical damage.
  - b) Test solenoid coil resistance against manufactures declared range.
  - c) Test coil for shorts to ground.
  - d) Test brake torque using torque wrench (13NM normally, this may vary depending on the motor).
- Explain and demonstrate how to fill out the inspection report.

Each course participants must:

- Practice the skills testing yaw motor brake.
- Practice the ability to fill out *inspection report*.

Learning outcomes:

Detailed learning outcome	Main learning outcome
Demonstrate a visual inspection on a yaw motor brake for physical damage. Conduct a solenoid coil resistance test and short test and compare with manufacturers declared values. Demonstrate a brake torque test using a torque wrench set to the correct torque.	Perform inspections and tests on yaw motors, including brake, rectifier, windings, and cables, using multimeters and multifunction meter, as well as troubleshoot common yaw system faults.
List results from the above tests in maintenance report	Demonstrate effective reporting post-task of procedures carried out, both written (on Tablet or computer) and verbal.

12.5 Exercise 4 - Rectifier test

Exercise description

The objective of this exercise is to test the rectifier functionality to ensure proper AC to DC conversion for the yaw motor control system.

Instructor must:

- Explain the function of a halfwave bridge rectifier.
- *Explain and demonstrate how to conduct a rectifier test including:*
  a) Testing all four diodes with a multimeter with a diode testing function.
  b) Test for voltage drop (around 0.7V) in positive direction and “out of range” drop in the negative direction.

Each course participants must:

- Practice the skills of testing a rectifier.
- Practice the ability to fill out *inspection report*.

Learning objectives:

Detailed learning outcome	Module learning outcome
Describe the function of a half wave bridge rectifier Demonstrate the procedure to test diodes in a rectifier Determine the voltage drop across the 4 diodes in a rectifier in both the positive and negative direction	Perform inspections and tests on yaw motors, including brake, rectifier, windings, and cables, using multimeters and multifunction meter, as well as troubleshoot common yaw system faults.
List results from the above tests in maintenance report	Demonstrate effective reporting post-task of procedures carried out, both written (on Tablet or computer) and verbal.

12.6 Exercise 5 – Final reporting

The final exercise, Final Reporting, focuses on practicing reporting skills, including clear and accurate communication of content, as well as reflections on the previously performed exercises. In this part, the instructor evaluates how well the participants understood the tasks they carried out and whether they drew correct conclusions and reflections.

Instructor must:

- Discuss with participants each of the exercises and summarise results
- Review with participants their filled-out documentation
- Discuss final report outcome

Each course participant must:

- Engage in discussion about exercises.
- Finalise all required documentation and verify if all documentation is completed.
- Prepare final report section in **Inspection report** with next step service action proposition.
- Listen to feedback from the instructor and peers to improve their assessment skills.

Learning outcomes:

Detailed learning outcome	Module learning outcome
Evaluate each test as either pass or fail Recommend remedial action in the event of a test fail (motor replacement)	Demonstrate effective reporting post-task of procedures carried out, both written (on Tablet or computer) and verbal.
Justify the above decision based on the test results reported.	Recognise the importance of and demonstrate proper **teamwork** and **communication**

13 Completion of training practical part

13.1 Safe dismounting and tools storage

This exercise involves safely cleaning up the workshop after completing the practical sessions. It aims to demonstrate the correct sequence for safely dismantling equipment, returning it to the storage space, and preparing it for future use.

Instructor must:

- Inform participants how safely and in what order to unmount tools & accessories and return them to the storage.

Each course participant must:

- Safely unmount tools & accessories.
- Correctly return tools and accessories to the storage

Learning outcomes:

Detailed learning outcome	Module learning outcome
Carry out correct equipment storage Conduct equipment inspection	Demonstrate proper safety procedures for yaw system maintenance

14 Learning module & scenario evaluation

Module part	Exercise name	Evaluation method
E-Learning - Theory	The purpose of the yaw system	Automated quiz
E-Learning - Theory	The components of the yaw system	Automated quiz
E-Learning - Theory	3-Phase Yaw Motors	Automated quiz
E-Learning - Theory	Yaw Motor Maintenance	Automated quiz
Theory	Risk assessment	Instructor evaluation based on the **risk assessment** document created by the participant.
Preparation for practical exercises	HSE brief & PPE dressing	Instructor evaluation based on the participant's correct preparation procedure.
Preparation for practical exercises	Manual handling	Instructor evaluation based on the participant's demonstration of proper manual handling techniques.
Preparation for practical exercises	Equipment checks	Instructor evaluation based on the **equipment check** report completed by the participant.
Practical skill training	Use of mechanical tools	Instructor evaluation based on the practical skills demonstrated by the participant.
Practical skill training	Use of Meters	Instructor evaluation based on practical skills demonstrated by the participant.
Learning scenario	Yaw motor operation safety	Instructor evaluation based on the participant's practical skills demonstrated and the completed section of the **inspection report**.
Learning scenario	Yaw motor windings assessment	Instructor evaluation based on the participant's practical skills demonstrated and the completed section of the **inspection report**.
Learning scenario	Yaw motor brake test	Instructor evaluation based on the participant's practical skills demonstrated and the completed section of the **inspection report**.
Learning scenario	Rectifier Test	Instructor evaluation based on the participant's practical skills demonstrated and the completed section of the **inspection report**.
Learning scenario	Final reporting	Role-play exercise between a site manager and a wind technician regarding the

		inspection reporting. Instructor evaluation based on the participant's reflections, reporting quality, and the completed **inspection report** document.

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