T-shore Education

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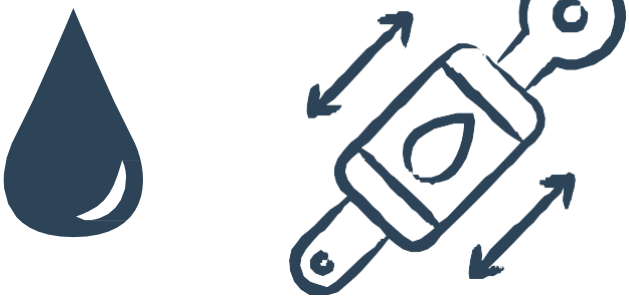
Module and Scenario Overview



Module:
Hydraulic Pitch Systems
Learning scenario:
Inspection of a Hydraulic Pitch Hub

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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 hydraulic pitch hub plays a vital role in the regulation of blade angles to optimise energy production and ensure the safe operation of a wind turbine. By adjusting the pitch of the blades in response to wind conditions, the system helps maximise efficiency and prevent overspeed situations. A failure in the pitch hub can lead to loss of control over the turbine rotor, increased wear, or even critical shutdowns.

This module will culminate in a Hydraulic Pitch Hub Inspection Scenario based on a real-world assessment carried out under operational conditions. The scenario focuses on a proactive inspection of the hydraulic pitch system. The goal is to identify potential issues to ensure the system operates within safe and efficient parameters.

1.1 Theory

Hydraulics in general:

Explain the objectives, scope and expected outcomes of the education module. Provide some background information on the theory and applications of hydraulic systems in general. Define the key terms and concepts related to the topic: pumps, oil reservoirs, oil filters, pipes and fittings, valves and sliders, cylinders and hydraulic motors, regulators

Hydraulics in wind turbine:

Explain the objectives, scope and expected outcomes of the education module. Provide some background information on the theory and applications of hydraulic systems in a Wind turbine. Discussion of the fundamentals.

Define the key terms and concepts related to the topic: fluid power, hydraulic power unit, manifolds, valves, flow restriction, cylinders, accumulators, rotor brake, yaw brake, maintenance on braking systems, pumps, motors, basic hydraulic circuit.

1.2 Practical

In the practical part, participants, under the instructor's guidance and following the provided documentation, perform practical training in hydraulics using simulation and doing exercises on hydraulic stations (e.g. Festo, Bosch Rexroth, …).

1.3 Evaluation

Throughout the entire module, the participant is evaluated by the instructor. The final evaluation is based on a reports review and discussion with conclusions.

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 hydraulics, pitch hubs in a wind turbine.

Skills: manual skills and experience enabling the demonstration of hydraulics using simulations, hydraulic stations, nacelle, pitch hubs.

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

3 Participant pre-qualification

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

Knowledge: The hydraulics section of the module starts from the basics. No prior knowledge is required. After the general basics of hydraulics, we focus on hydraulics in the wind turbine.
Skills: basic use of tools
Ability: safe work evaluation of situation

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

Name	Q/A	Type	Category	Where to use
PC with projector screen	1	Real-life equipment	Theoretical part equipment	Theoretical part
E-learning on hydraulics		Digital material	Theoretical part material	Theoretical part
Digital manuals		Digital material	Theoretical part material	Theoretical part
Digital manual: exercises		Digital material	Practical part material	Practical part
Risk assessment example	1	Printed document	Theoretical part material	Theoretical part
Risk assessment template	6	Printed document	Theoretical part material	Theoretical part
Equipment checklist example	1	Printed document	Practical part material	Preparation for practical exercises part
Equipment checklist template	6	Printed document	Practical part material	Preparation for practical exercises part

Learning scenario manual	6	Festo Manual (digital or printed document)	Practical part material	Practical part
Digital manual: exercises	6	Digital material	Practical part material	Practical part
Inspection report	6	Printed document	Practical part material	Practical part
Simulation tool (e.g. FluidSim)	1	Real-life equipment	Training infrastructure	Practical part
Nacelle	1	Real-life equipment	Training infrastructure	Practical part
Hydraulic pitch hub	1	Real-life equipment	Training infrastructure	Practical part
Didactic hydraulic workstations	3	Real-life equipment	Training infrastructure	Practical part
Safety gloves (resistant to hydraulic fluids)	6	Real-life equipment	Safety equipment	Practical part
Safety goggles	6	Real-life equipment	Safety equipment	Practical part
Suitable working clothing	6	Real-life equipment	Safety equipment	Practical part
Lockout device	6	Real-life equipment	Safety equipment	Practical part
padlock	6	Real-life equipment	Safety equipment	Practical part
tag	6	Real-life equipment	Safety equipment	Practical part
1/4” wrench	1	Real-life equipment	Safety equipment	Practical part
Paper towels	-	Real-life equipment	Component	Practical part

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
4 hours	Theory
4 hours	Practice in practical training (include evaluation)
Total: 8 hours	

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	Classroom lessons with e-learning support
Practical part	Practical skill training and scenario participation in practical training

Note Learning methods depends on accessibility of infrastructure and equipment.

7 Main learning outcomes for the module

Main learning outcome	Competency	No.
Demonstrates a good understanding of hydraulics and its function.	Hydraulics	3.1 Understand the basic principles of fluid mechanics and hydraulics
Can prepare and carry out preventive maintenance, taking into account situational elements or the maintenance history	Hydraulics	3.2 Maintain and repair hydraulic systems in wind turbines
Has knowledge of hydraulic operations in wind turbines.	Hydraulics	3.3 Understand hydraulic systems for wind energy applications
Can plan and conduct safe work in accordance with HSE requirements and correct use of PPE	Hydraulics Health, Safety, and Environment	3.4 Understand safety protocols related to hydraulic systems 4.2 Implement safety procedures and protocols for wind energy work environments
can read hydraulic diagrams and work instructions	Hydraulics	3.5 Understand and interpret Mechanical, electrical and hydraulic diagrams or schematics
Has knowledge about hazardous environment, can plan risk assessment and execute work in accordance with risk assessment	Health, Safety, and Environment	4.6 Perform risk assessments and have the proper safety mindset / risk awareness
Can 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. 5.2 Interpret and apply industry-standard hand signals for crane operations and equipment movement.
Can supply written and verbal report	Teamwork & communication	5.3 Document technical information accurately, including maintenance records and reports, using 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 training 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 participants must:

- Learn theory part
- Ask questions related to learning materials and module
- Conduct feedback questionnaire

Learning outcomes:

Detailed learning outcome	Main learning outcome
can name the types of pumps, motors and cylinders	Demonstrates a good understanding of hydraulics and its function.
can explain the operation of proportional hydraulic components	Demonstrates a good understanding of hydraulics and its function.
can build a hydraulic system in a wind turbine (simulation)	can read hydraulic diagrams and work instructions

8.2 Risk Assessment

The part of the training focused on risk assessment and its planning involves the instructor guiding training participants 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 Hydraulic pitch risk assessment (template and filled example)

- Conduct risk assessment exercise with training participants
- Answer questions and give feedback

Each course participants must:

- Ask questions related to learning materials
- Conduct risk assessment exercise

Learning outcomes:

Detailed learning outcome	Main learning outcome
Participants can identify and list specific hazards associated with executing the planned learning scenario.	Has knowledge about hazardous environment, can plan risk assessment and execute work in accordance with risk assessment
Participants can create a corresponding risk assessment addressing the hazards identified in the planned learning scenario.	Has knowledge about hazardous environment, can plan risk assessment and execute work in accordance with risk assessment

9 Practical part - introduction

9.1 General Introduction

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

Instructor must provide constructive feedback to participants on relevant practice activities. It includes feedback concerning the correctness 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 during performing of exercises.

At all the time during training participant can ask questions and expect feedback from the instructor.

9.2 Practical training introduction

Before start of practical exercises:

Participants may be divided into more groups.

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 glasses
- Safety gloves (resistant to hydraulic fluids)

The participants must be instructed about the followings:

- All the equipment to be used and their correct use.
- The instructor must be informed immediately if anyone feels ill, in pain, or exhausted about any condition that may affect health and safety.
- If anybody feels uncomfortable during 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 dressing

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 practical training zones.
- check if each participant has corrected PPE and wear it correctly.

Each course participants must:

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

Learning outcomes:

Detailed learning outcome	Main learning outcome
Participants can select the appropriate PPE based on the hazard analysis related to planning activities	Can plan and conduct safe work in accordance with general HSE requirements

Participants can wear correctly PPE equipment for planning activities	Can plan and conduct safe work in accordance with general HSE requirements

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 to handle according to the equipment characteristics and potential hazards and risks.
- Correct positioning under manual tasks

Each course participants must:

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

Learning outcomes:

Detailed learning outcome	Main learning outcome
Participants understand the rules for proper manual handling techniques.	Can plan and conduct safe work in accordance with general HSE requirements
Participants can perform practical tasks in compliance with manual handling requirements.	Can plan and conduct safe work in accordance with general HSE requirements

10.3 Equipment check

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 require quarantine. It also emphasises proper storage conditions and procedures.

Instructor must:

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

Each course participants 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 check of equipment and accessories.
- Practice the ability to identify accessories requiring quarantine.
- Practice the completion of equipment checklist

Learning outcomes:

Detailed learning outcome	Main learning outcome
Participants understand the importance of correct equipment storage	Can plan and conduct safe work in accordance with general HSE requirements
Participants can perform equipment inspection	Can plan and conduct safe work in accordance with general HSE requirements
Participants can correctly fill out equipment checklist	Can supply written and verbal report

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 hydraulic brake pad scenario:

- Simulation
- Practical trainings

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

11.1 Simulation

Trainees are asked to work out simulations using software (FluidSim) and explain them orally. During the oral explanation, the teacher tests understanding in more depth, by presenting analogous scenarios: what if ... (e.g. .... were to shut down).

Following simulation exercises are expected:

- basic hydraulic diagrams
- electro-hydraulics

- pressure controls and safety devices
- speed control
- accumulators

Instructor must:

- Present and explain the correct usage of simulation tool, including creating circuit diagrams, fault detection and avoidance, understanding the development of solutions and observing effects through real-time simulations.
- Observe participants' use of the simulation tool, assess their technique, and provide constructive feedback on their actions.

Each course participants must:

- Demonstrate the skills and ability to correctly use the simulation tool
- Know how to read hydraulic diagrams and work instructions
- Know the different types of pumps, motors, cilinders

Learning outcomes:

Detailed learning outcome	Main learning outcome
can build a hydraulic system in a wind turbine	Demonstrates a good understanding of hydraulics and its function.
can name the types of pumps, motors and cylinders	Demonstrates a good understanding of hydraulics and its function.
can interpret hydraulic diagrams and work instructions	can read hydraulic diagrams and work instructions

11.2 Practical training

Remind the training participants to follow the HSE regulations and wear appropriate protective equipment.

Provide them with the necessary tools and materials for this test.

Of the designed simulations, one task is also asked to be carried out in practice, implementing the circuits. The teacher determines this assignment.

The practical exercise is performed on hydraulic stations (e.g. Festo, Bosch Rexroth, …)

Instructor must:

- Present and explain the correct usage of the didactic hydraulic workstations, including how to safely operate the workstation, adjust settings, and ensure proper handling.

- • Observe participants' use of the workstation, assess their technique, and provide constructive feedback on their actions.

Each course participants must:

- Demonstrate the skills and ability to correctly use the workstation during practical exercises, ensuring safe and efficient operation.

Learning outcomes:

Detailed learning outcome	Main learning outcome
can build a hydraulic system in a wind turbine (simulation)	Has knowledge of hydraulic operations in wind turbines.
Performs preparatory work	Demonstrates a good understanding of hydraulics and its function.
Can check the operation of the equipment, the instrument data (pressure, flow, temperature, …) and the critical wearing points, lubrication points	Demonstrates a good understanding of hydraulics and its function.
Can replace and adjust hydraulic parts	Can prepare and carry out preventive maintenance, taking into account situational elements or the maintenance history
Can check and replace control valves	Can prepare and carry out preventive maintenance, taking into account situational elements or the maintenance history
Organises the storage of materials and tools	Can plan and conduct safe work in accordance with HSE requirements and correct use of PPE
Can carry out hydraulic circuits	can read hydraulic diagrams and work instructions
Can connect hydraulic pipes and hoses	can read hydraulic diagrams and work instructions
Works in a team environment	Can recognise the importance of, and demonstrate, proper teamwork and communication
Can complete follow-up documents	Can supply written and verbal report

12 Learning scenario

12.1 Scenario Introduction

The most common task regarding hydraulic system of a pitch hub is to check oil tank level, quality and possible leaks.
The evaluation is a visual inspection of the pitch hub, including:

- checking oil tank level and quality
- checking possible leaks

- analyzing pressure
- and performing a hand pump test.

12.2 Visual inspection of the brake system

Exercise description

The training participant compares the measurement with the standards and write an inspection report.

Training participants complete the assignments in pairs.

If the w practical training area 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.

Instructor must:

- Explain and discuss the steps 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 **visual inspection checklist**.
- Review and discuss the results of the participants reports with them.

Each course participants must:

- Familiarise yourself thoroughly with the exercise manual and clarify any unclear points.
- Perform each step from the manual.
- Complete the visual inspection checklist.

Learning outcomes:

Detailed learning outcome	Main learning outcome
The participants can check the oil tank level, assess oil quality, and identify possible leaks.	Has knowledge of hydraulic operations in wind turbines.
The participants can analyse system behaviour using a hydraulic schematic.	Has knowledge of hydraulic operations in wind turbines.
The participants can analyse pressure behaviour within the hydraulic circuit.	Has knowledge of hydraulic operations in wind turbines.
The participants can test the function and performance of a hand pump.	Has knowledge of hydraulic operations in wind turbines.

The participants are able to collaborate effectively to successfully complete the task.	Can recognise the importance of, and demonstrate, proper teamwork and communication
The participants can fill out check documentation in correct and reflective way	Can supply written and verbal report

12.3 Exercise 4 – 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 of them
- Review with participants their filled-out documentation
- Discuss final report outcome

Each course participants 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 your assessment skills.

Learning outcomes:

Detailed learning outcome	Main learning outcome
The participants can fill out check documentation in correct and reflective way	Can supply written and verbal report
The participants can reflect on inspection outcomes and recommend the next step actions	Can supply written and verbal report

13 Completion of training practical part

13.1 Safe dismounting and tools storage

This exercise involves safely cleaning up the practical training area 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 unmount tools & accessories and return them to the storage.

Each course participants must:

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

Learning outcomes:

Detailed learning outcome	Main learning outcome
Participants understand the importance of correct equipment storage	Can plan and conduct safe work in accordance with general HSE requirements
Participants can perform equipment inspection	Can plan and conduct safe work in accordance with general HSE requirements

14 Learning module & scenario evaluation

Module part	Exercise name	Evaluation method
Theory	learning theory	Classroom based training and LMS system moodle verification that participant completed e-learning
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 check	Instructor evaluation based on the **equipment check** report completed by the participant.
Practical skill training	Simulation	Instructor evaluation based on the practical skills demonstrated by the participant.
Practical skill training	Practical training	Instructor evaluation based on both practical demonstrated by the participant.
Learning scenario	Inspection of a hydraulic pitch hub	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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