

***Standardised
Blade
Inspection***

Blade Care Consulting



1 *Blade construction*

2 *Composite materials*

3 *Inspection and categorization*

4 *Training and certification of techs.*

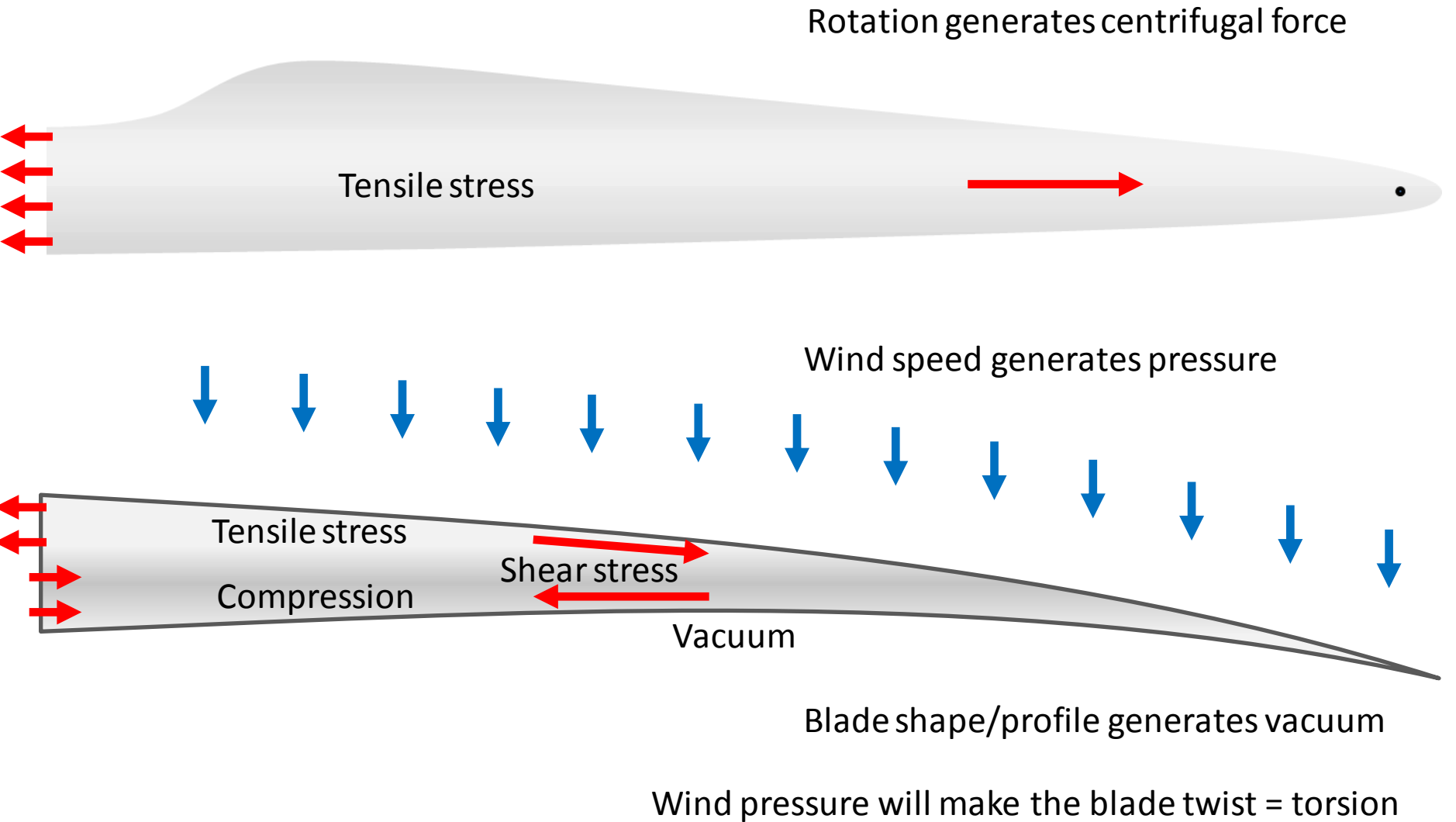




The blade have to:

- Transfer the energy from wind into rotation of the main shaft
- Capture as much energy from the wind as possible
- Minimise the loads and vibrations on the turbine
- Operate in - 40° C to + 40° C
- Operate for 20-25 years with only basic maintenance
- Be as light as possible to reduce materials throughout the WTG

Some sites with high wind shear, for each ten metre increase in height, the wind speed can increase by 20%





- Strength
- Flexibility-stiffness
- Weak spots



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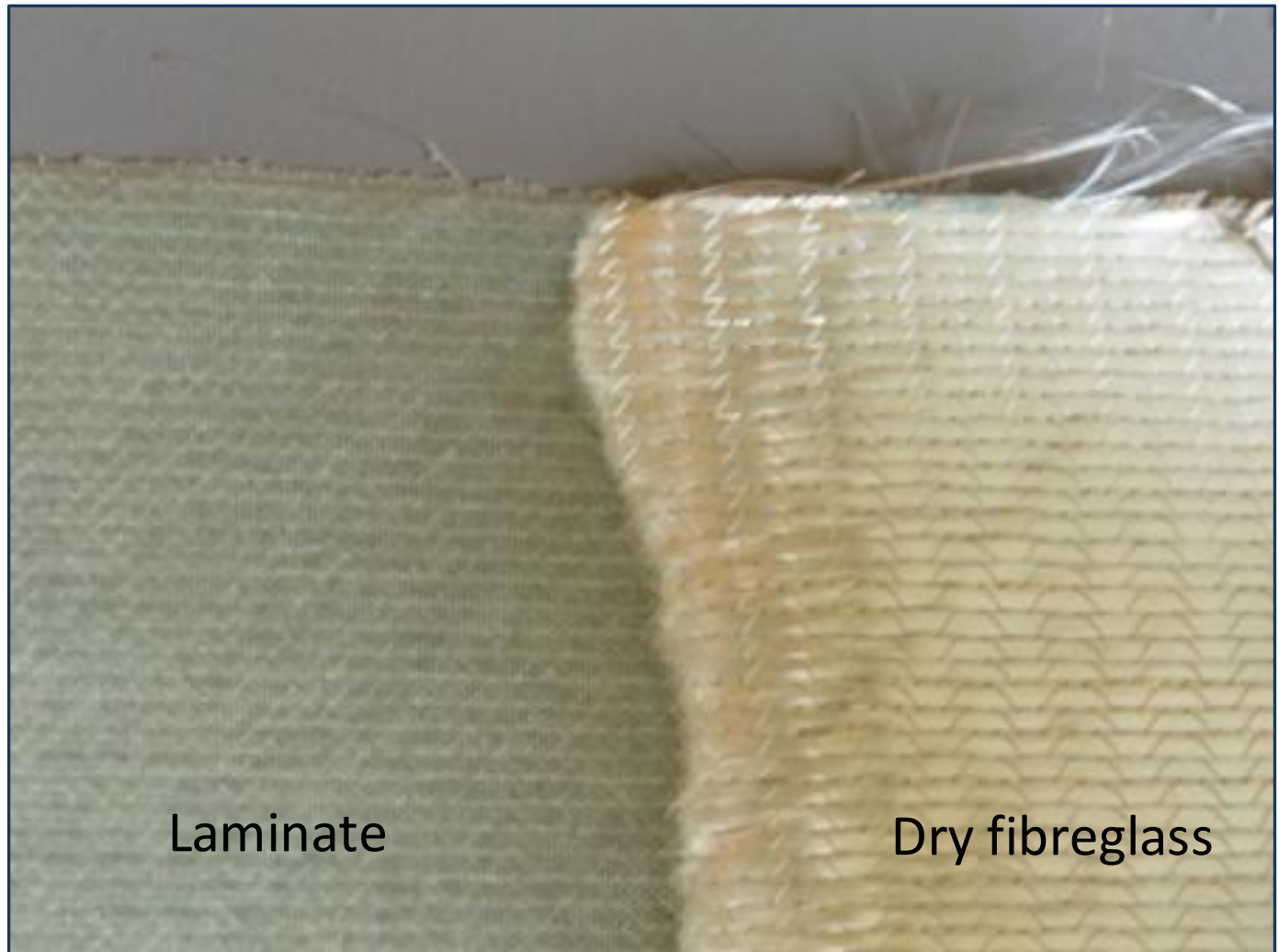
4 *Training and certification of techs.*



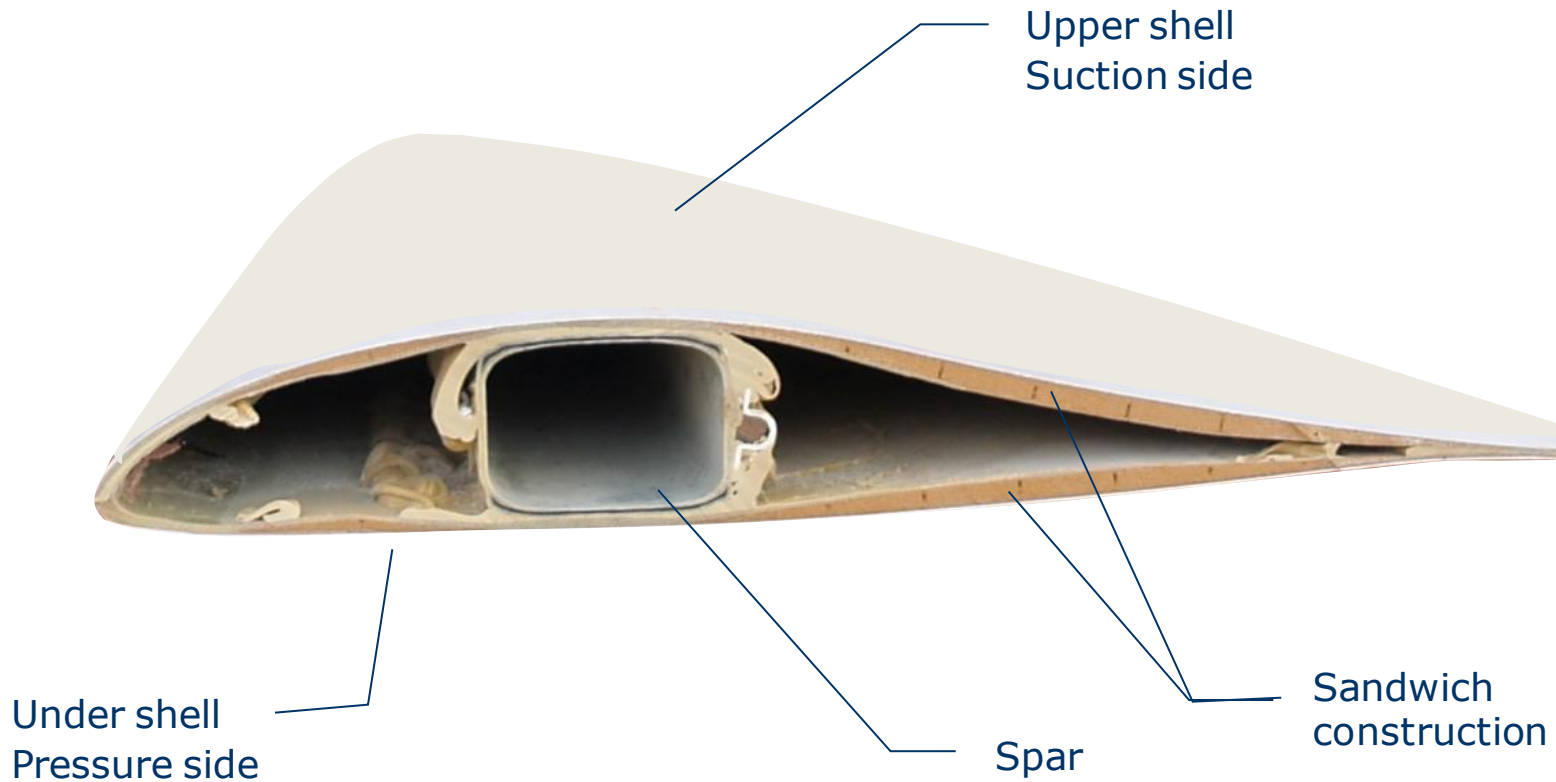


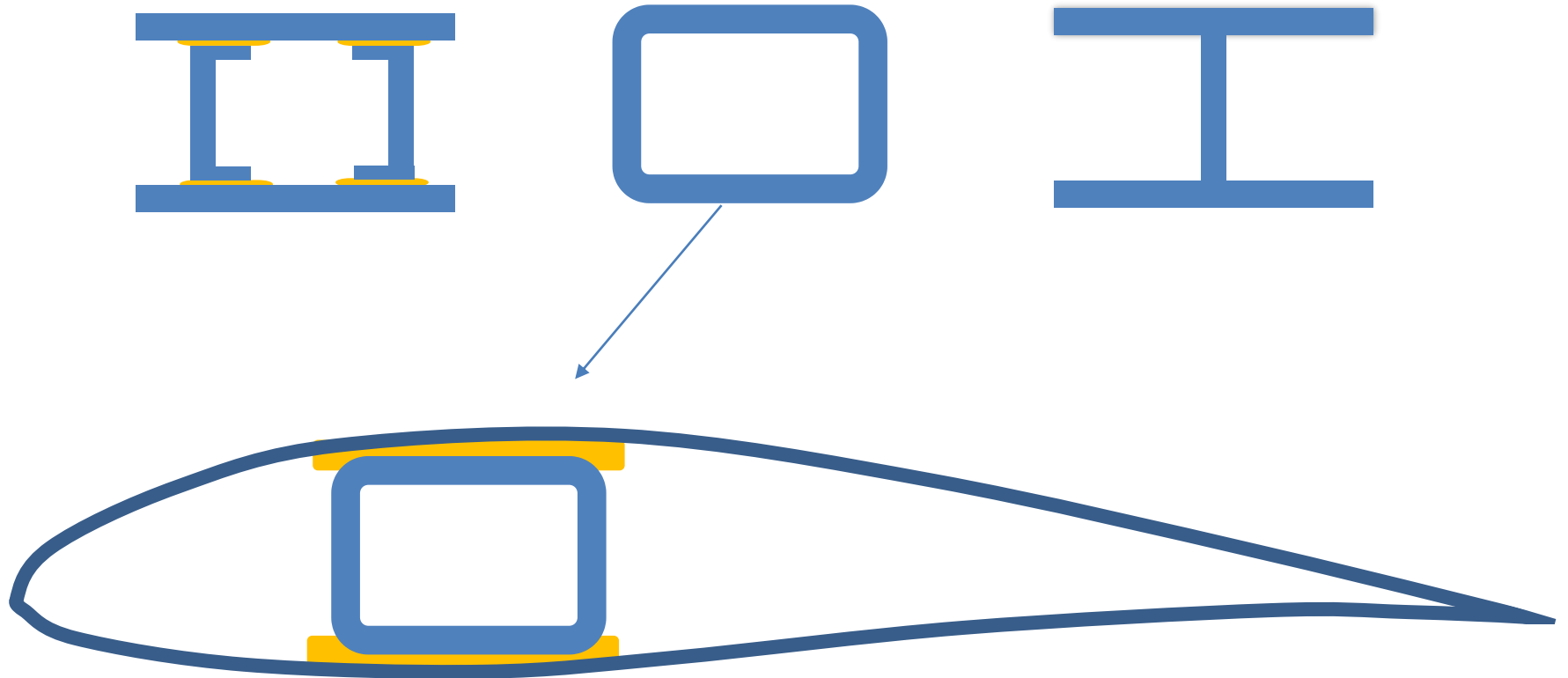
Composite material

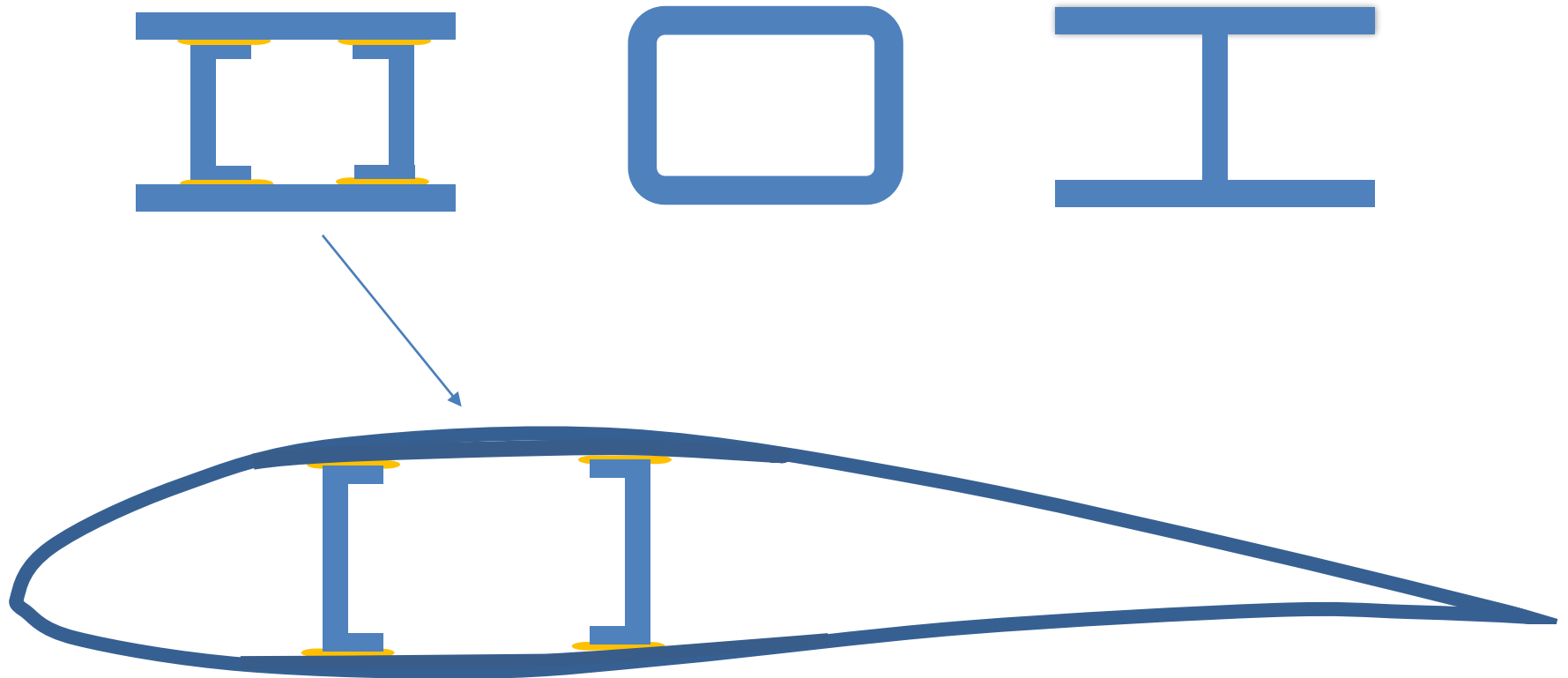
**Laminate from
Epoxy and
fibreglass**

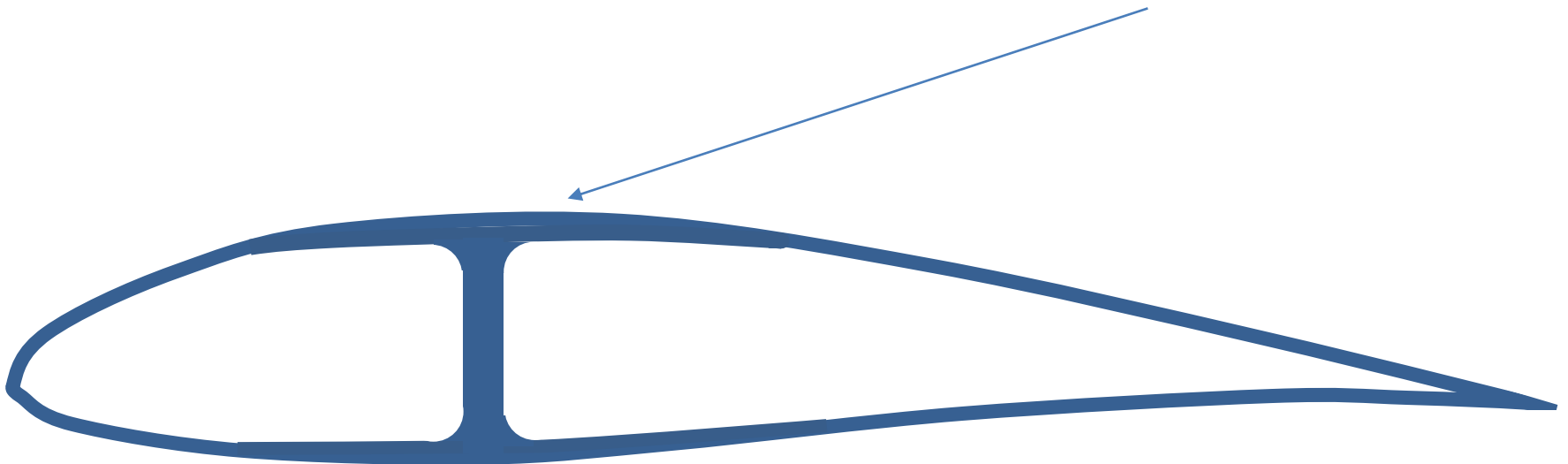
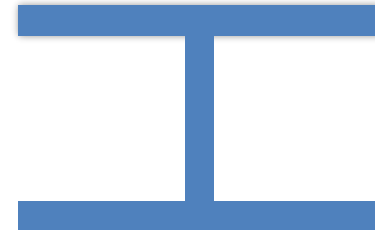
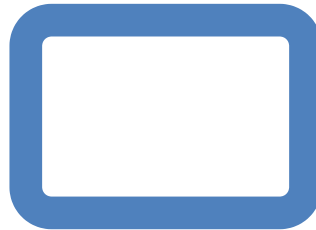
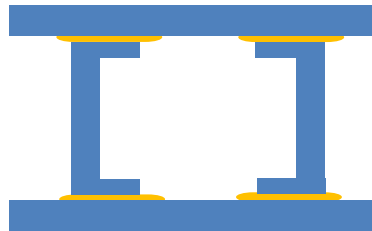


Blade profile











Older LM profile



Aero Laminar (AL-blade)
NECMicon



Siemens integral blade

Vestas with spar - bonded

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Why?

Inspection methods are different!

- Blade manufacturers have own documentation, procedures
- Uniform methods
- Requirement of trained inspectors
- Better communication
- More detailed documentation
- Same type of Inspection Report



Doc. no:	0100-0001 V03	Doc. Type:	Blade Service Standard	Page:	2 of 20
Created:	2012-11-29	Description:	Generic Inspection of Blades	Language:	GB
Reviewed:	2015-02-07	Blade type:	All types in service	Issued by:	OS

1. Purpose

The purpose of this document is to provide general guidelines to monitor, inspect and document the operating conditions for all types of WTG blades.

Inspection data will be analysed and collected in a blade status report, to create an overview on action to be taken and planning for service repair.

The blade status report shall enable one to keep the blade in operation and plan service in favourable time of year regarding wind speed, temperature and humidity.

*Content of**Service Work Instruction**Generic Inspection of Blades*

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GVI

General Visual Inspection. From ground level

CVI

Close Visual inspection, use of hands, tape measures, photo cards, off rope or crane.

DVI

Detailed Visual Inspection.

Use of tools to further inspection of damage

To document WTG blades operational status, all defects and damages must be categorized into five levels.

This information will be used for planning service, operational risk assessment and repair to take place.

Category	Description	Status
1	Cosmetic, no further action	Operation PMR
2	Cosmetic, but laminate and lifetime will be affected over time. Repair when convenient.	Operation PMR
3	Damage, not serious, but risk for damage to increase. Repair must be done in the next planned inspection.	Operation PMR PMO ORA
4	Serious damage, but not an immediate risk for the blade structure. Repair must be planned as soon as possible. Damage must be inspected regularly until repair is done.	Operation ORA PMO
5	Very serious damage, risk for losing blade parts or whole blade.	Stop CMO

Color code

Description

Cosmetic defects on blade surface.

Blade surface does not meet the standard of a new blade.

Criteria for placement in category 1:

- No access to laminate below surface coating
- No risk for the defect to expand
- No or minor effect on blade performance

Findings must be registered in Blade report.

Example

Status

Turbine ready for operation

No immediate action to be taken

Preventive Maintenance Routine (PMR)

Colour code

Description

Defects in blade surface layer

Gel coat, filler or paint layer is broken/missing and allows access to the laminate.

Defects on Vortex generators, stall strips, Dino tails and LE tape.

Criteria for placement in category 2:

- No immediate loss of laminate strength
- No or minor risk for water ingress in laminate
- No or minor effect on blade performance

[Example](#)**Status**

Turbine ready for operation

No action to be taken

Preventive Maintenance Routine (PMR)

Preventive Maintenance Order (PMO)

Colour code

Description

Defect and damage in first layer/layers of laminate.

Small bond failure

Small crack in laminate

Criteria for placement in category 3:

- Risk for laminate to loose strength
- Risk for water ingress into laminate
- Only risk for slow development of damage

[Example](#)**Status**

Turbine ready for peration

Action to be taken:

Operational Risk Assessment (ORA) to be conducted and
Preventive Maintenance Order (PMO) raised

Color code

Description

Serious damage, on structural parts of blade.

Criteria for placement in category 4:

- no immediate risk of the blade structure collapsing.
- no risk of loose blade parts.
- blade not out of balance.

[Example](#)**Status**

Turbine must remain stopped

Action to be taken:

Operational Risk Assessment (ORA) to be conducted and Corrective Maintenance Order (CMO) raised, before restarting turbine.

Colour code**Description**

Very serious damage on blade structure.

Criteria for placement in category 5:

- Risk of losing parts of the blade
- Risk of the entire blade breaking down.
- Seriously out of balance

[Example](#)**Status**

Turbine must remain stopped.

Action to be taken:

Corrective Maintenance Order (CMO) completed prior to further operation

Language: GB

Blade Inspection Report

No. XX

Summary

Wind farm		Inspection date	
Turbine type		Turbine status after inspection	
Turbine No.		Technician name	

Blade A - Blade no. 12345678

Category 1	Category 2	Category 3	Category 4	Category 5
0	1	1	1	0

Notes:

- Cat. 2
- Cat. 3
- Cat. 4

Action: Cat 2 Preventive maintenance routine
 Cat 3 Operational risk assessment
 Preventive maintenance order within 3 months
 Cat 4 Operational risk assessment
 Corrective maintenance order within 1 month
 Inspection of damage – weekly, until documented CMO.

Ex. BIR-pdf

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Training of blade service technicians

Renewables GB producing:

Blade Repair and Inspection training program BRAI

Documented qualifications

3 levels of training standard

- Awareness and Basic
- Intermediate
- Advanced

For all types of blades out of warranty

Accepted by GB operators and insurance companies



Awareness

Awareness of all 5 fault categories and the inspection and repair elements associated with each

Basic

Inspection:	Visual, non-intrusive	(Fault categories 1-2)
Repair:	Cosmetic - gel and paint	(Fault categories 1-2)

Intermediate

Inspection:	Including intrusive	(Fault category 3)
Repair:	1 st layer of laminate	(Fault category 3)

Advanced

Inspection:	Introduction to non-visual	(Fault categories 4-5)
Repair:	2 nd layer + and Structural	(Fault categories 4-5)

Doc. no: 0030-0001 V00	Doc. Type: Course Outline	Page: 1 of 5
Created: 2012-11-29	Description: Inspection of Blades Level 1	Language: GB
Reviewed: 2012-03-20	Blade type: All types in service	Issued by: OS

Attendant profile

Attendant profile: WTG Service technicians, Site Managers, Wind farm owners / technicians

Course duration

3 days, 21 lessons

Pre-requisites for participation

None

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Course outcome

To qualify participant to perform blade service inspection on all types of WTG blades, according to Global Blade Service Standard.

Objectives

After the training the participant will be able to:

- Carry out General Visual Inspection, from ground level.
- Carry out Close Visual inspection, use of hands, tape measures, photo cards, off rope or crane.
- Carry out Detailed Visual Inspection. Use of tools to further inspection of damage by sanding away damaged paint/gelcoat, and visually inspect laminate, and bonded joints.
- Recognize different types of defects and damages.
- Assess and categorize defects and damages.
- Carry out minor cosmetic repair of surface coatings.
- Use correct terms for blade communication.
- Fill in blade status report.
- Describe the general construction of WTG blades.
- Describe health risk involved when handling polyester, epoxy and isocyanates.

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***Thank you
for your attention!***

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