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## 1. Purpose

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

Inspection data will be analysed and collected in a blade status report, to create 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 planning service in favourable time of year regarding wind speed, temperature and humidity.

## 2. Requirement for Service Technician

Service technicians must hold a valid Global Blade Service - Certificate level 1

## 3. Access to Blades

To access turbine and operate WTG for inspection, Service Technician must follow regulations and instructions provided by the WTG manufacturer.

## 4. Health and Safety

Technicians performing work involving:

- Hoist, lifting equipment, platform or rope access
- Chemicals like epoxies, isocyanates or organic solvents
- Tools for sanding, cutting or drilling
- Electrical equipment

must follow laws and executive orders for safety at work in the country and region where action takes place.

Please read the related SDS in the local language and use the correct PPE's.

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## 5. Terms and abbreviations

#### Exterior of blade



## Blade profile



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#### Abbreviations

SWI	Service Work Instruction
LPF	Lost Production Factor
SDS	Safety Data Sheet
PPE	Personnel Protective Equipment
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
PMR	Preventive Maintenance Routine
PMO	Preventive Maintenance Order
CMO	Corrective Maintenance Order
ORA	Operational Risk Assessment
BIR	Blade Inspection Report
BRR	Blade Repair Report

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# 6. Equipment and Tools

## GVI from ground/distance

Description	Item number	Quantity
Camera DSLR high resolution		1
Tele lens 300mm.		1
Tripod		1
Laptop		1

### CVI

Description	Item number	Quantity
Hand lamp		1
Tape measure 2M.		1
Laser distance measuring instrument 0-200m		1
Photo card		2
Dry marker pen		2
Compact camera		1
Hammer for tap testing		1
Milli Ohm Meter Megger BT51		1

### DVI

Description	Item number	Quantity
Endoscope 6mm. with light and USB connector		1
Angle grinder 125 mm. Electrical or battery		1
Semi-Flexible Rubber backing disc for angel grinder 125 mm.		1
Mixing gun for Araldite 2021		1

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#### 7. Consumables

For cosmetic repairs

Description	Item number	Quantity
Sanding disc125mm P60		20
Sanding disc125mm P80		20
Sanding disc125mm P120		20
Sanding disc 125mm P220		20
Masking tape 50mm		2
Flash tape (silicon) 50 mm.		2
Araldite 2021- including mixer		2
Gelcoat and hardener relevant for actual blade type		1 kg.
Awlgrip spot fast filler Base	A1706	1
Awlgrip spot fast filler Converter (hardener)	A1704	1
Paint (surface coating) relevant for actual blade type		1 kg.
Brush 20 mm		5
Mixing cup plastic 0,5 ltr.		5
Stirring stick wood		5
Filler knife metal 50 mm.		2
Filler knife plastic 100 mm.		10
Acetone		1 I.
Paper roll of dispensable towels for cleaning		1
Disposable syringe 20 ml.		5
Disposable syringe 50 ml.		5

## Personnel protective equipment

Description	Item number	Quantity	
Protective glasses		1	
White cover suit		2	
Dust mask		20	
Chemical gloves		10	
Protective gloves (for sanding)		2	
Ear protection plugs			

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## 8. GVI from distance/ground

Weather conditions recommended for inspection:

- Low wind, (wind will cause the blade to move decreasing photo quality).
- Good visibility, (fog, rain or snow will decrease photo quality).

#### Inspection procedure

- 1. If the turbine is in operation, listen carefully for unexpected/different sounds from the 3 blades and take notes.
- 2. Stop the turbine and turn rotor into position. Blade B pointing vertically up.

#### Note!

<u>Onshore turbines</u>. To achieve better light on actual inspected blade surface, place photo equipment at best position and inspect the blades individually in any position at best choice.

- 3. Place photo equipment on WTG boat landing, avoiding direct sunlight into the lens.
- 4. Carefully investigate the surface from blade A pressure side, starting at hub and ending at blade tip. Observing any deviations from normal surface, focus and take a picture. Check for photo quality and move on.
- 5. Take notes for photos on every blade side :
  - Blade number
  - Vacuum or pressure side
  - Approximately radius
  - Photo file number starting and ending for actual blade surface.
  - Comments
- 6. Turn camera and inspect blade C vacuum side following same procedure as blade A.
- 7. Turn rotor 120° and inspect blade C pressure side.
- 8. Inspect blade B vacuum side.
- 9. Turn rotor 120° and inspect blade B pressure side
- 10. Inspect blade A vacuum side.

If damage is found, camera can be moved or blade can be pitched to get a better photo angle to the damage.

## 9. CVI from basket or rope

Safety regulations and weather conditions for working from basket or rope must be followed regarding:

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- Approval of equipment and operator
- Wind speed (Turbine specific but recommend the wind speed is below 6 m/s)
- Risk of lightning

Turbine must be stopped and locked in accordance to WTG recommendations.

#### Inspection procedure

- 1. Measure out distance from blade tip to hub, using a laser distance measurer to determine the right radius for eventual damages.
- 2. Lower cable from hub connected to lightning down conductor cable.
- 3. Measure and take note of the resistance from all lightning receptor bolts on both sides of blade.
- 4. Inspect the blade tip and move upwards.

**Note!** Inspection from rope will start from root and finish at blade tip.

- 5. Measure out radius and distance from TE or LE for every defect or damage.
- If possible, delamination is suspected, perform a tap-test around the damage and if delamination is detected, mark it with a pen and take photo.
  For large damages measure out size.
- 7. Take photo including the photo card, filled out with the blade information.
- 8. Note picture file no. start and end for the total blade.
- 9. Finding damages under surface coating proceed to: DVI.

## 10. DVI of damage

To inspect the laminate under a damaged surface coating, proceed with the following steps:

- 1. Sand (grind) away the gel coat, paint or filler to inspect the laminate.
- 2. If damaged laminate is found grind away the damaged part. Take care not to remove undamaged laminate.
- 3. Take photo
- If core material is damaged it must be removed to inspect the inner shell laminate. If possible, inspect the inner shell laminate from inside the blade. Internal inspection.
- 5. Mark up for repair.
- 6. Take a photo
- 7. Carry out the repair or temporary repair to avoid moisture or water to enter the laminate.
- 8. Take a photo

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## 11. Categorization

To document WTG blades operational status, all defects or 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 ORA PMO
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

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#### Examples

## 11.1 Category 1

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.

No immediate action to be taken. PMR 24 monthly





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## 11.2 Category 2

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

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 CM Site/project Demo 123456 WTG no. A Blade no. R 8000 to 8500 Distance from HUB X Position TE Pressure Suction Blade Care Consulting Company Cat. 2-1 Coating flaking off, small area Cat. 2-2 Incorrect mix of epoxy gelcoat

No immediate action to be taken. PMO 12 monthly

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# 11.3 Category 3

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

Action to be taken: ORA to be conducted and PMO raised





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## 11.4 Category 4

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.

#### Action to be taken: ORA to be conducted and CMO raised





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# 11.5 Category 5

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

Turbine must remain stopped.

Action to be taken: CMO completed prior to further operation





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## 12. Documentation

All relevant observations and collected data from the individual blade like:

- blade data
- inspection data
- detected defects and damages
- exact location of damages
- notes on observations for every single damage
- measurement data
- photos

are to be gathered in a Blade Inspection Report. Doc. BIR-0100-1020

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## 13. History of document

Version	Description of change	Date	Approved
number.		2 0.10	
- 02	GVI		
	CVI		
	DVI		
	PMR		
	PMO		
	СМО		
	ORA updated	2013-11	OS
	8.		
	Note!		
	Onshore turbines. To achieve better light on actual		
	inspected blade surface, place photo equipment at best		
	position and inspect the blades individually in any		
	position at best choice.	2015-02-07	OS
	8.		
	Place photo equipment on WTG boat landing	2015-02-7	OS
-03	9.		
	Note! Inspection from rope will start from root and finish		
	at blade tip.		
	For large damages measure out size.	2015-02-07	OS
-04	MSDS changed to SDS	2019-01-08	OS