BLADE INSPECTION REPORT

BT1 Wind Farm
Turbine No.239262
Local Turbine ID WTG18

BUREAU VERITAS 1828

POWER
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1. INTRODUCTION

On May 15, 2024, Bureau Veritas Vietnam conducted a comprehensive drone-based inspection of the rotor blade on turbine **No. 239262** at the BT1 Wind Farm.

This report aims to present the detailed results of the inspection activities carried out on wind turbine **No. 239262**. It includes an assessment of any detected damage, proposed repair solutions, and relevant recommendations.

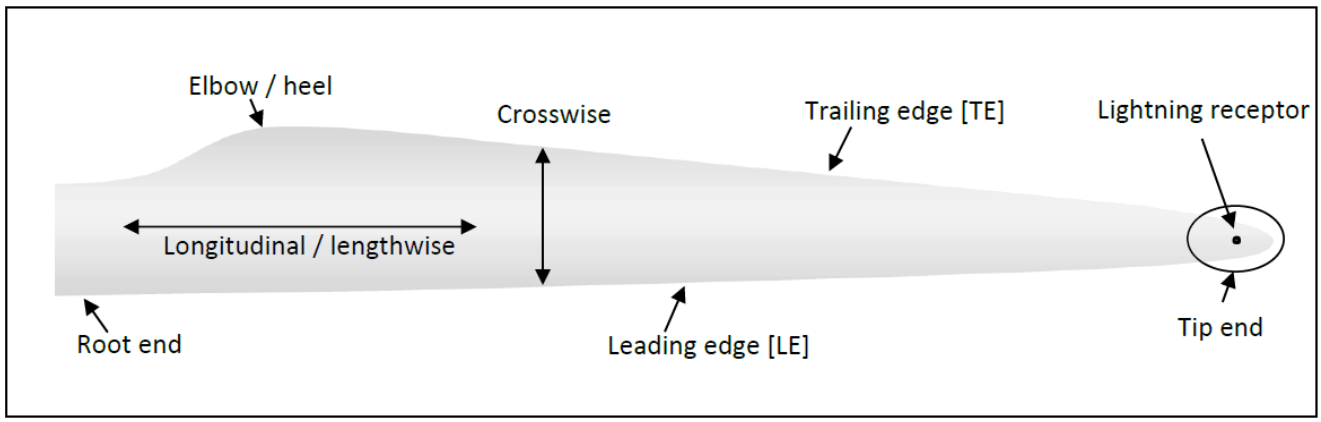
1.1. Site information:

Site Location **Address**	**BT1 Wind Farm** **Quảng Ninh District, Quang Binh Province, Vietnam**
Wind Turbine Type	V150
Blade length	73.7 m
Hub height	145 m
Wind Turbine Number	**239262**
Wind Turbine Local ID	WTG18
Blade Rotor	**29101070WHYE255933 (Blade A)** **29101070WHYE255934 (Blade B)** **29101070WHYE255935 (Blade C)**
Inspection Date (DD/MM/YYYY)	20/05/2024
Report Creator	

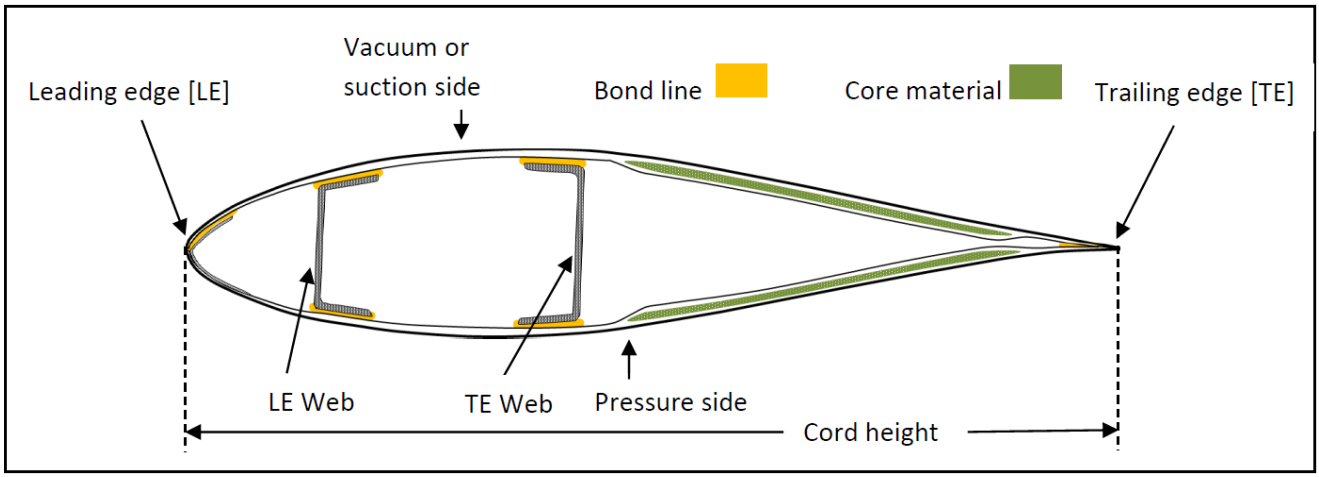
1.2. Site Map:

2. NAMING AND DEFINITIONS

2.1. Exterior of blade



2.2. Blade profile



2.3. Blade elements definitions:

Name	Description
Shell	The function is to give an aerodynamic profile.
SS	Suction side - also known as Leeward. SS shell is upper side during production. This side faces towards the tower.
PS	Pressure side - also known as Windward. PS shell is under side during pro-duction. This side is facing the wind.
LE	The leading edge of the blade, i.e. the “nose” that is heading into the wind during operation.
TE	The trailing edge of the blade is the thin edge where the airflow leaves the blade during operation.
PPT	Pre-Preg Technology. This term is used for blades where the main structure is the spar
Spar	This is the main structural component of PPT blades. It is positioned between the shells and resists loads and forces.
SST	Structural Shell Technology. This term is used for blades where the main structure is in the shells.
Web	It is positioned between the shells and must transfer loads and forces.
Bond Line	Line of adhesive bonding two parts together.
Flap Wise	The flap wise load is the motion of the blade caused by the wind. These loads are normal to the WW and LW shell surfaces of the blade
Edge Wise	The edge wise loads are caused by a combination of the rotation of the rotor and the mass of the blade itself, in the direction from LE to TE or vice versa.
Receptor	Metallic lightning receptor disc on the blade surface
SMT	Solid Metal Tip is a part of lightning protection.
Copper cap	May be installed at the tip on blades without SMT to improve lightning protection
Copper strip	May be installed at the tip on PPT blades to improve lightning protection
AAOs	Aerodynamic Add-Ons, optional parts attached to the blade surface to im-prove aerodynamic performance
GF	Gurney Flap is an Add-On used for production increase.
TVG	Tip Vortex Generator is an Add-On for noise reduction
RVG	Root Vortex Generator is an Add-On used for production increase.
STE	Serrated Trailing Edge is an Add-On for noise reduction
Stall Strip	Add-On used for stall control on stall-regulated turbines
LEP	Leading Edge Protection, either coating, tape or shells. May be applied to

3. OVERVIEW

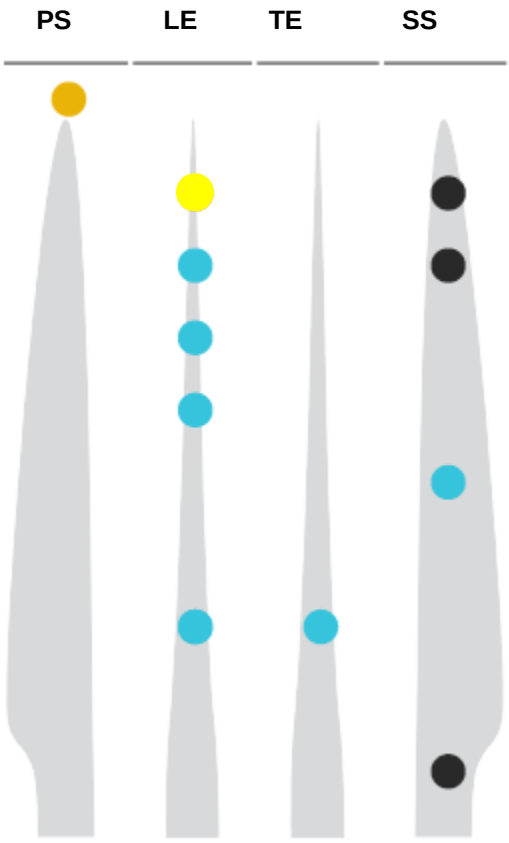
The blades were inspected according to the relevant work instructions, and any detected damage was classified in accordance with the Condition Monitoring guidelines for Vestas blades. Based on these guidelines, the detected damages are categorized as follows:

3.1. Category Definition

Category	Finding Description	Recommended Action	Turbine status
● 1	**Cosmetic**	No action necessary Monitor at next inspection	**Continue Operation**
● 2	**Minor** No impact on functional integrity of the blade	Repair only if other damages are to be repaired	**Continue Operation**
● 3	**Functional** Minor impact to the functional integrity of the blade	Repair must be done within a time frame	**Continue Operation**
● 4	**Serious** Impact on the functional or structural integrity of the blade, but not threatening safe operation	Repair required within a short time frame	**Continue Operation**
● 5	**Critical** Structural integrity of the blade is severely compromised, may lead to catastrophic failure	Immediate intervention required WTG to remain in pause until approved to return to operation	**Stop Operation** Safety is not ensured

3.2. Blade A_ID: 29101070WHYE255933

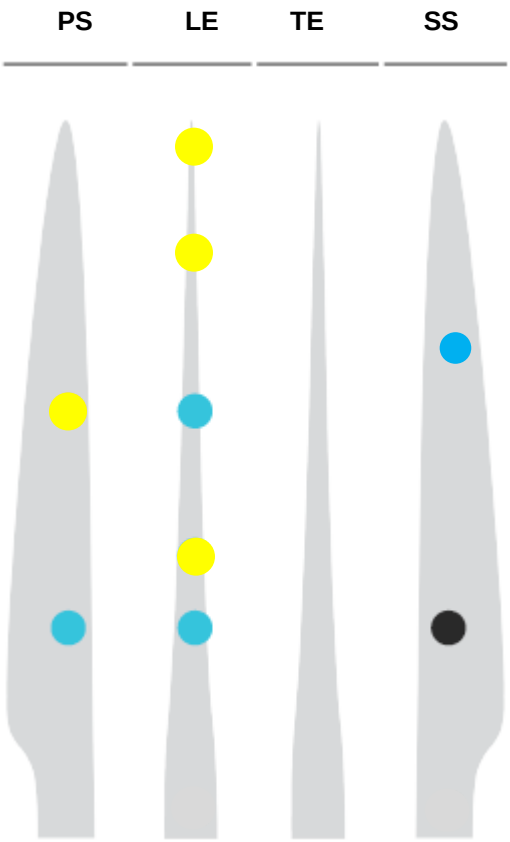
BLADE A Faults Map



No.	Issue Type	Distance from Hub	Blade Edge	Category	Recommendation
1	Erosion	73 m	Leading Edge	4	Repair required within a short time frame
2	Erosion	70 m	Leading Edge	3	Repair must be done within a time frame
3	Erosion	66 m	Leading Edge	3	Repair must be done within a time frame
4	Damage	71 m	Pressure Side	3	Repair must be done within a time frame
5	Erosion	57 m	Leading Edge	2	Repair only if other damages are to be repaired
6	Erosion	49 m	Leading Edge	2	Repair only if other damages are to be repaired
7	Erosion	26 m	Leading Edge	2	Repair only if other damages are to be repaired
8	Erosion	22 m	Leading Edge	2	Repair only if other damages are to be repaired
9	Damage	27 m	Trailing Edge	2	Repair only if other damages are to be repaired
10	Contamination	60 m	Suction Side	1	No Action
11	Damage	10 m	Suction Side	1	No Action

3.3. Blade B_ ID: 29101070WHYE255934

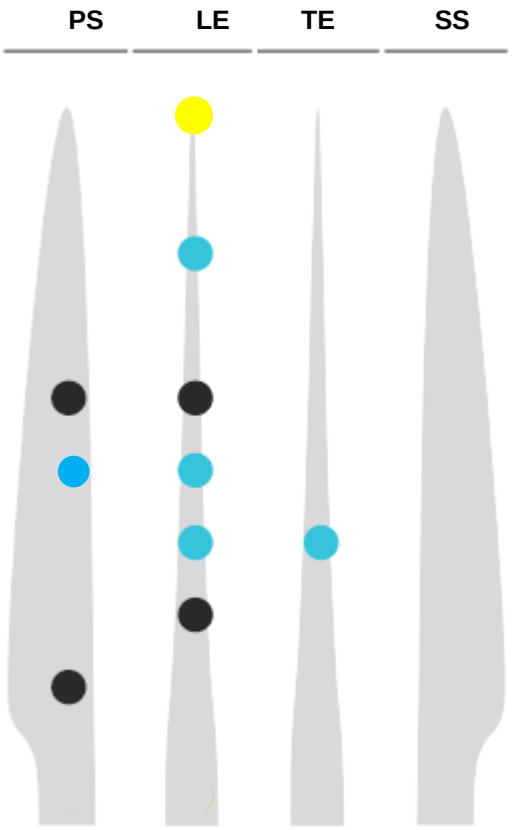
BLADE B Faults Map



No.	Issue Type	Distance from Hub	Blade Edge	Category	Recommendation
1	Erosion	**70 m**	Leading Edge	**3**	Repair must be done within a time frame
2	Erosion	**34 m**	Leading Edge	**3**	Repair must be done within a time frame
3	Erosion	**49 m**	Pressure Side	**3**	Repair must be done within a time frame
4	Erosion	**65 m**	Leading Edge	**3**	Repair must be done within a time frame
5	Erosion	**50 m**	Leading Edge	**2**	Repair only if other damages are to be repaired
6	Chip	**53 m**	Suction Side	**2**	Repair only if other damages are to be repaired
7	Damage	**21 m**	Pressure Side	**2**	Repair only if other damages are to be repaired
8	Chip	**24 m**	Leading Edge	**2**	Repair only if other damages are to be repaired
9	Damage	**23 m**	Suction Side	**1**	No action

3.4. Blade C_ID: 29101070WHYE255935

BLADE C Faults Map

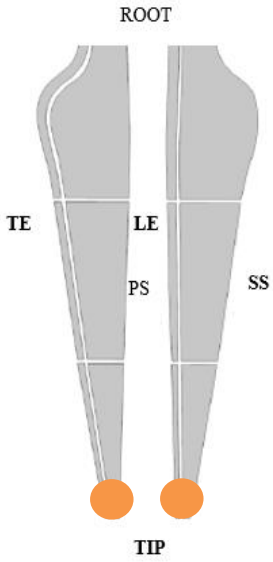


No.	Issue Type	Distance from Hub	Blade Edge	Category	Recommendation
1	Erosion	70 m	Leading Edge	3	Repair must be done within a time frame
2	Erosion	41 m	Leading Edge	2	Repair only if other damages are to be repaired
3	Erosion	30 m	Leading Edge	2	Repair only if other damages are to be repaired
4	Erosion	41 m	Pressure Side	2	Repair only if other damages are to be repaired
5	Chip	28 m	Trailing Edge	2	Repair only if other damages are to be repaired
6	Erosion	58 m	Leading Edge	2	No action. Monitor at next inspection
7	Contamination	46 m	Leading Edge	1	No action
8	Erosion	21 m	Leading Edge	1	No action
9	Contamination	43 m	Pressure Side	1	No action
10	Coating Damage	16 m	Pressure Side	1	No action

4. DETAILED INSPECTION RESULTS

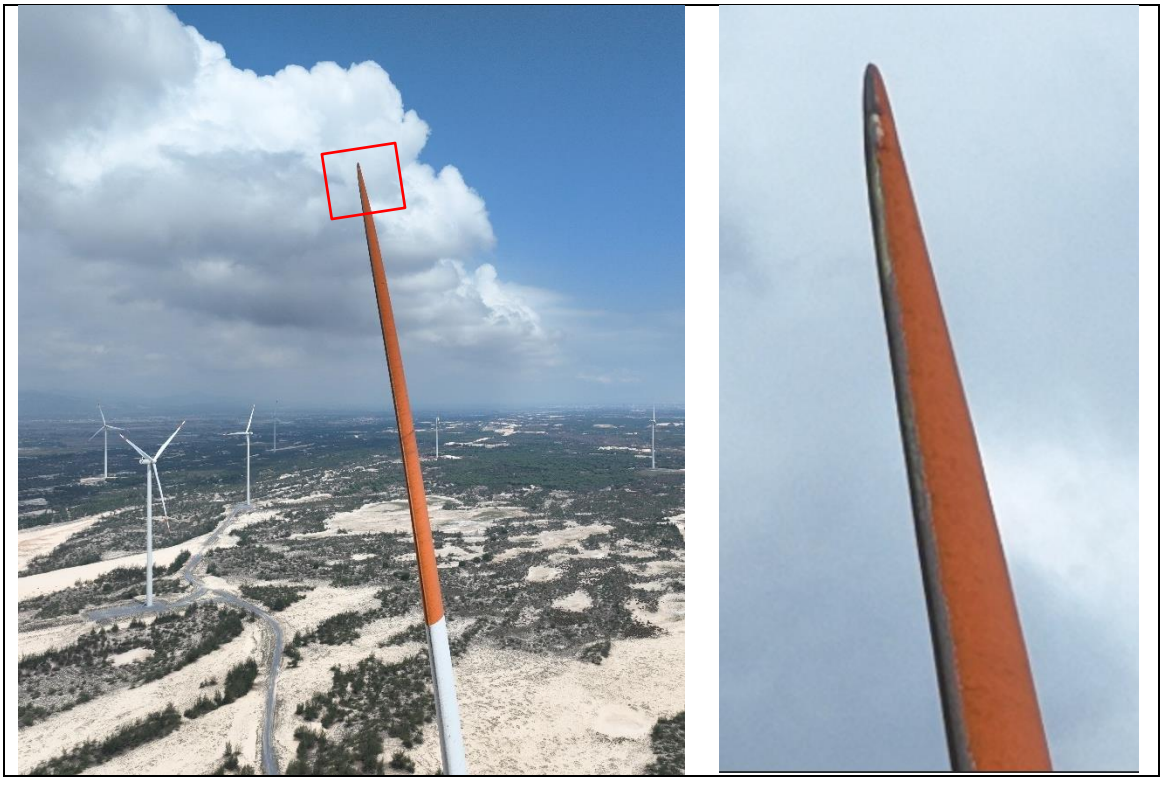
4.1. Blade A_ID: 29101070WHYE255933

Damage 1 of 11 on blade 29101070WHYE255933

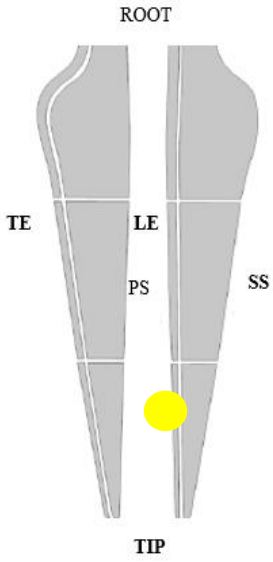


Blade Edge	Leading Edge
Distance from Hub	73 m
Damage Type	Erosion
Damage Subtype	Tip Erosion
Root Cause	
Damage Severity	4
Recommendation.	Repair required within a short time frame.
Comment	The blade tip is damaged due to erosion.

Images of Damage 1 of 11 on blade 29101070WHYE255933

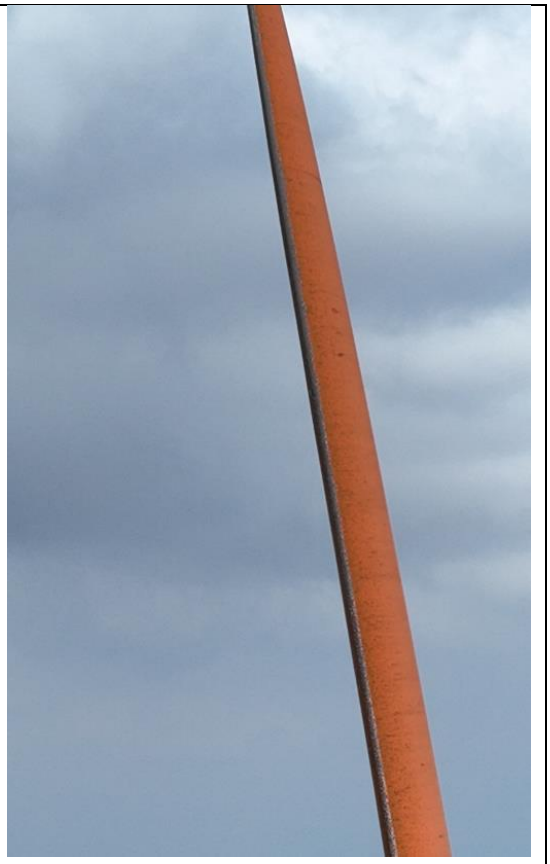


Damage 2 of 11 on blade 29101070WHYE255933

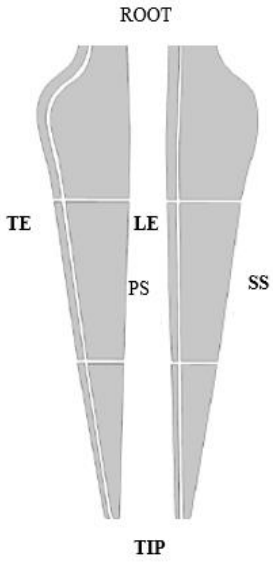


Blade Edge	Leading Edge
Distance from Hub	66 m
Damage Type	Erosion
Damage Subtype	LE erosion
Root Cause	
Damage Severity	3
Recommendation.	Repair must be done within a time frame.
Comment	The leading edge (LE) side is damaged due to erosion.

Images of Damage 2 of 11 on blade 29101070WHYE255933



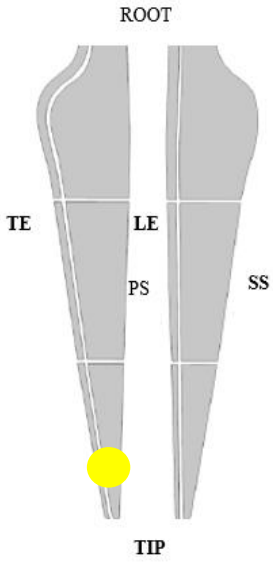
Damage 3 of 11 on blade 29101070WHYE255933



Blade Edge	Leading Edge
Distance from Hub	65 m
Damage Type	Erosion
Damage Subtype	LE erosion
Root Cause	
Damage Severity	3
Recommendation.	Repair must be done within a time frame.
Comment	The leading edge (LE) side is damaged due to erosion.

Images of Damage 3 of 11 on blade 29101070WHYE255933

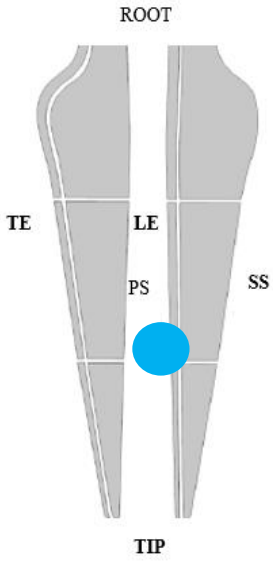
Damage 4 of 11 on blade 29101070WHYE255933



Blade Edge	Pressure Side
Distance from Hub	71 m
Damage Type	Damage
Damage Subtype	Lightning receptor damage
Root Cause	
Damage Severity	3
Recommendation.	Repair must be done within a time frame.
Comment	Leak around lightning receptors om the PS side.

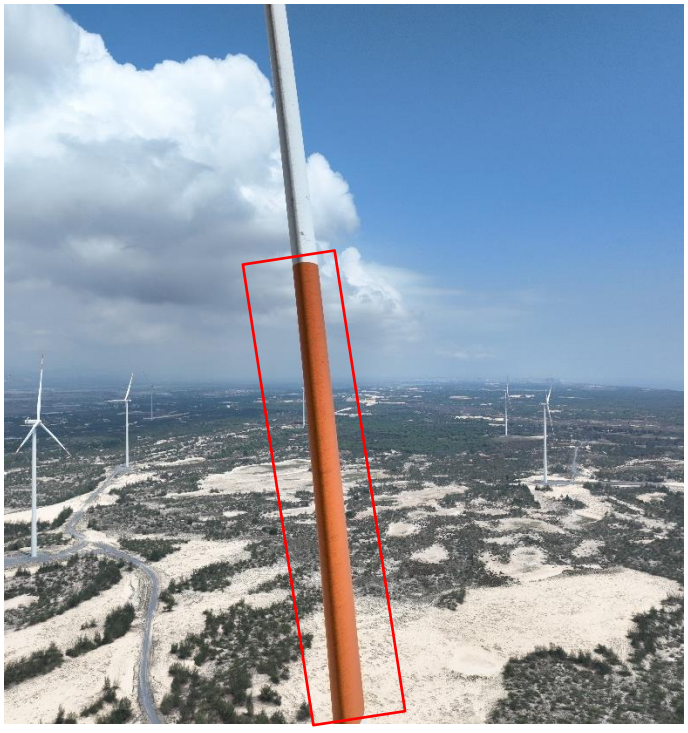
Images of Damage 4 of 11 on blade 29101070WHYE255933

Damage 5 of 11 on blade 29101070WHYE255933

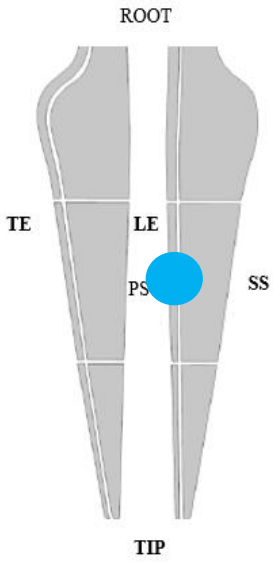


Blade Edge	Leading Edge
Distance from Hub	57 m
Damage Type	Erosion
Damage Subtype	LE erosion
Root Cause	
Damage Severity	2
Recommendation.	Repair only if other damages are to be repaired.
Comment	The leading edge (LE) side is damaged due to erosion.

Images of Damage 5 of 11 on blade 29101070WHYE255933



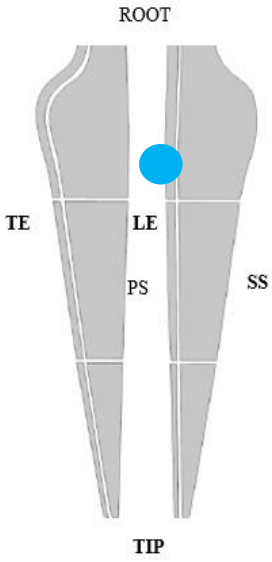
Damage 6 of 11 on blade 29101070WHYE255933



Blade Edge	Leading Edge
Distance from Hub	49 m
Damage Type	Erosion
Damage Subtype	LE erosion
Root Cause	
Damage Severity	2
Recommendation.	Repair only if other damages are to be repaired.
Comment	The leading edge (LE) side is damaged due to erosion.

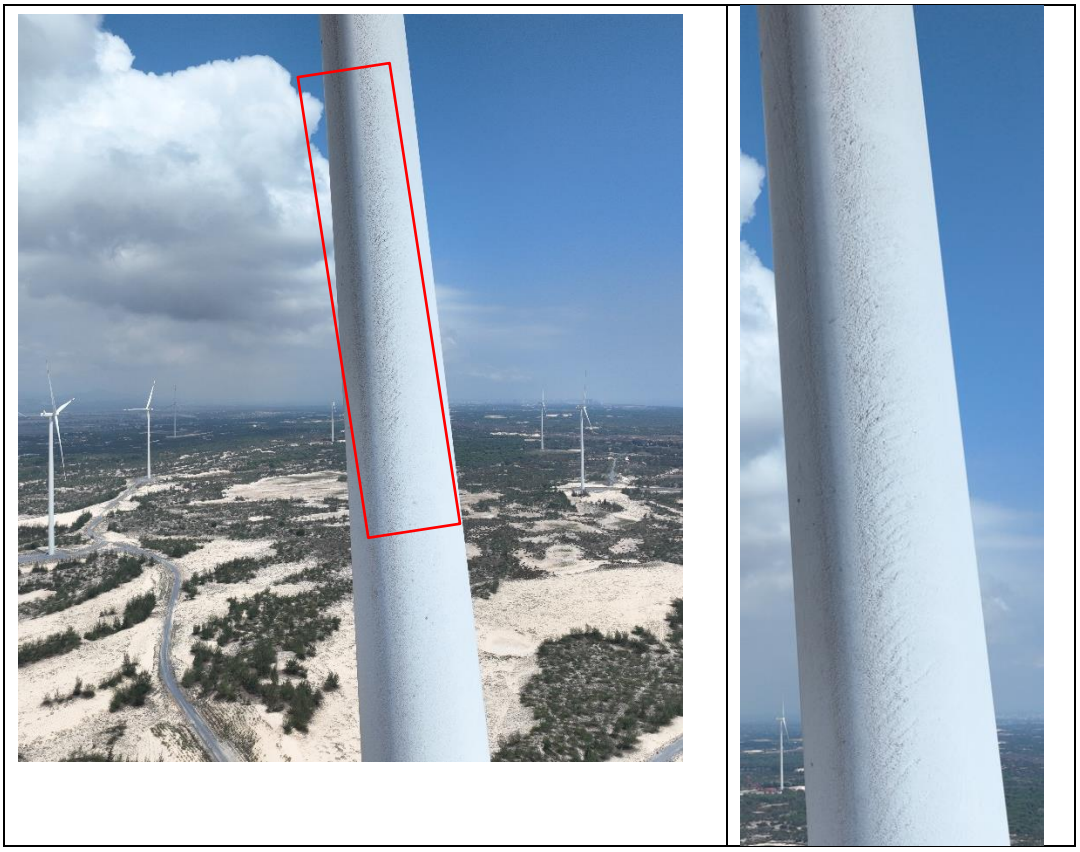
Images of Damage 6 of 11 on blade 29101070WHYE255933

Damage 7 of 11 on blade 29101070WHYE255933

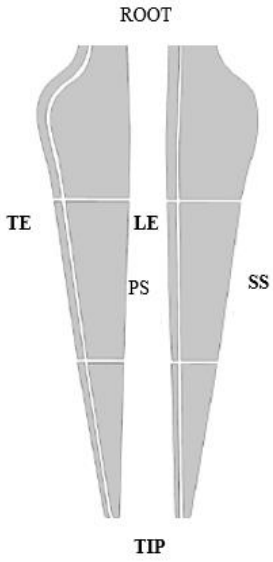


Blade Edge	Leading Edge
Distance from Hub	26 m
Damage Type	Erosion
Damage Subtype	Coating damage
Root Cause	
Damage Severity	2
Recommendation.	Repair must be done within a time frame.
Comment	The leading edge (LE) side is damaged due to erosion.

Images of Damage 7 of 11 on blade 29101070WHYE255933

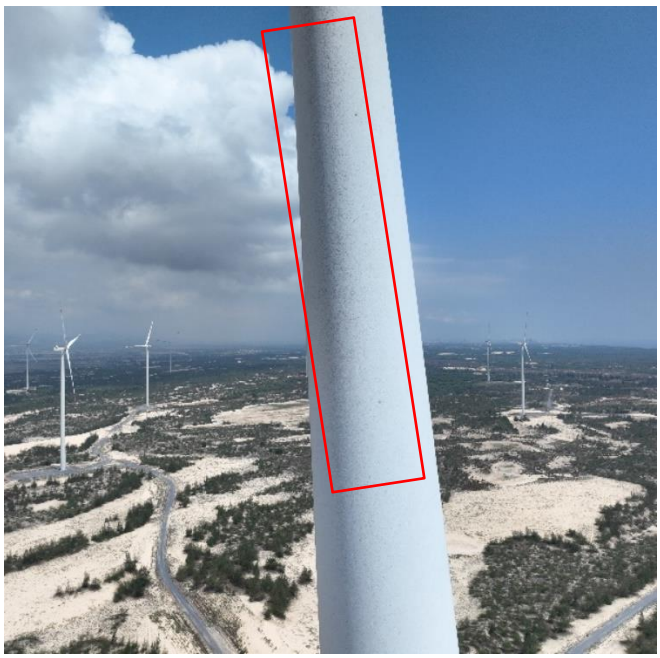


Damage 8 of 11 on blade 29101070WHYE255933

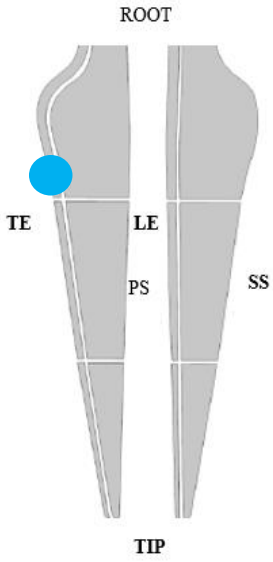


Blade Edge	Leading Edge
Distance from Hub	22 m
Damage Type	Erosion
Damage Subtype	Coating damage
Root Cause	
Damage Severity	2
Recommendation.	No action. Monitor at next inspection
Comment	The leading edge (LE) side is damaged due to minor erosion.

Images of Damage 8 of 11 on blade 29101070WHYE255933

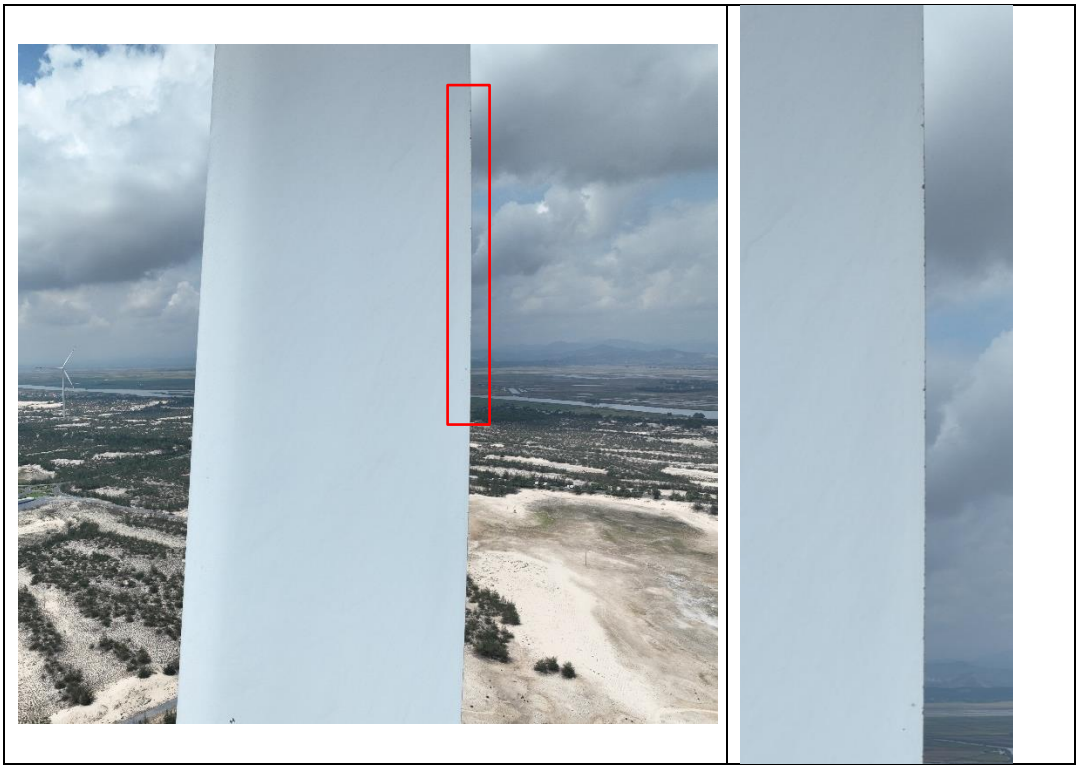


Damage 9 of 11 on blade 29101070WHYE255933

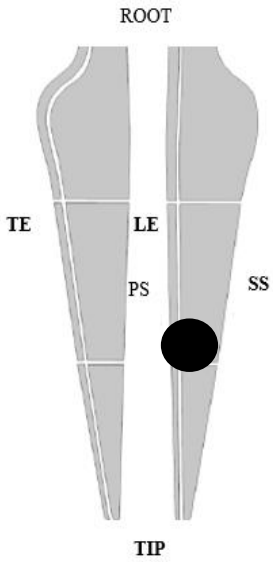


Blade Edge	Trailing Edge
Distance from Hub	27 m
Damage Type	Damage
Damage Subtype	Chip
Root Cause	
Damage Severity	2
Recommendation.	No action. Monitor at next inspection.
Comment	Minor chips are occurring along the TE side.

Images of Damage 9 of 11 on blade 29101070WHYE255933



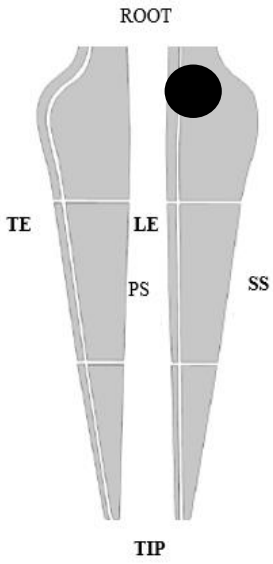
Damage 10 of 11 on blade 29101070WHYE255933



Blade Edge	Suction Side
Distance from Hub	60 m
Damage Type	Damage
Damage Subtype	Contamination (Dirt/Grease/Oil)
Root Cause	
Damage Severity	1
Recommendation.	No action.
Comment	Contamination (Grease) on the suction side (SS)

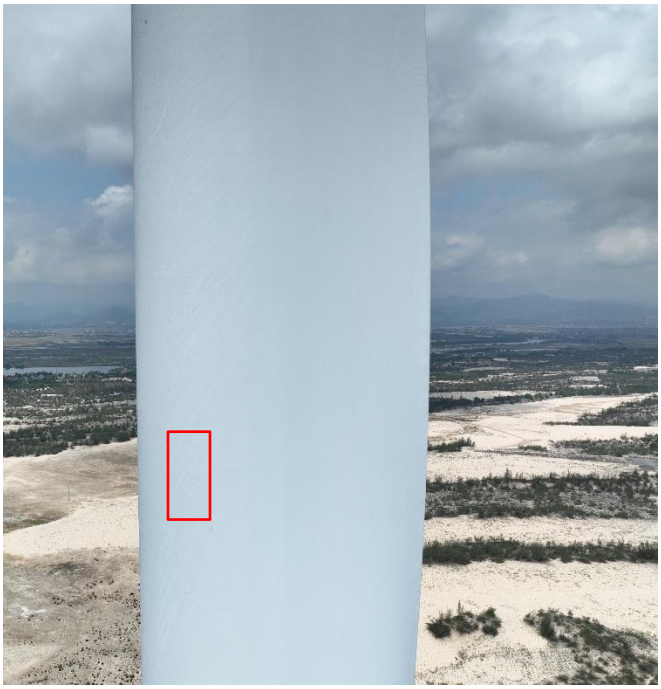
Images of Damage 10 of 11 on blade 29101070WHYE255933

Damage 10 of 11 on blade 29101070WHYE255933



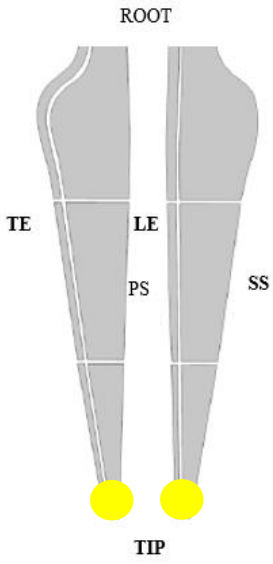
Blade Edge	Suction Side
Distance from Hub	10 m
Damage Type	Damage
Damage Subtype	Scratches
Root Cause	
Damage Severity	1
Recommendation.	No action.
Comment	Minor scratches on the surface

Images of Damage 11 of 11 on blade 29101070WHYE255933



4.2. Blade B_ ID: 29101070WHYE255934

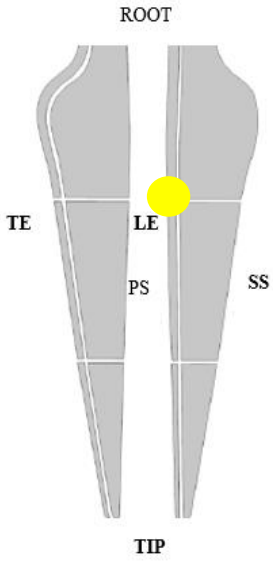
Damage 1 of 10 on blade 29101070WHYE255934



Blade Edge	Leading Edge
Distance from Hub	73 m
Damage Type	Erosion
Damage Subtype	Tip section erosion.
Root Cause	
Damage Severity	3
Recommendation.	Repair must be done within a time frame.
Comment	Paint starting to wear off on the tip of the LE side.

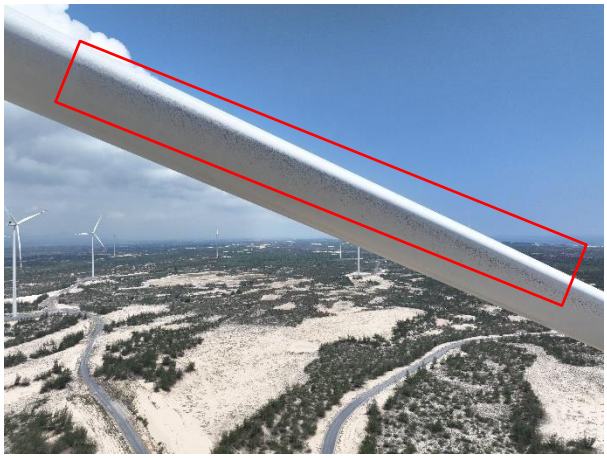
Images of Damage 1 of 10 on blade 29101070WHYE255933

Damage 2 of 10 on blade 29101070WHYE255934

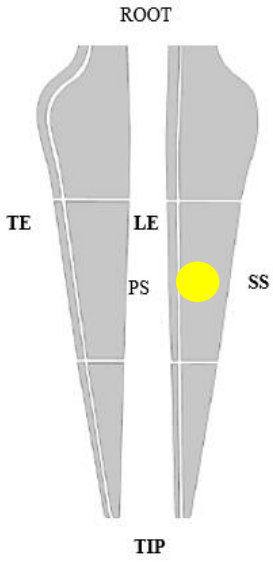


Blade Edge	Leading Edge
Distance from Hub	34 m
Damage Type	Erosion
Damage Subtype	LE erosion
Root Cause	
Damage Severity	3
Recommendation.	Repair must be done within a time frame.
Comment	Erosion occurring on the leading edge (LE) of surfaces.

Images of Damage 2 of 10 on blade 29101070WHYE255933

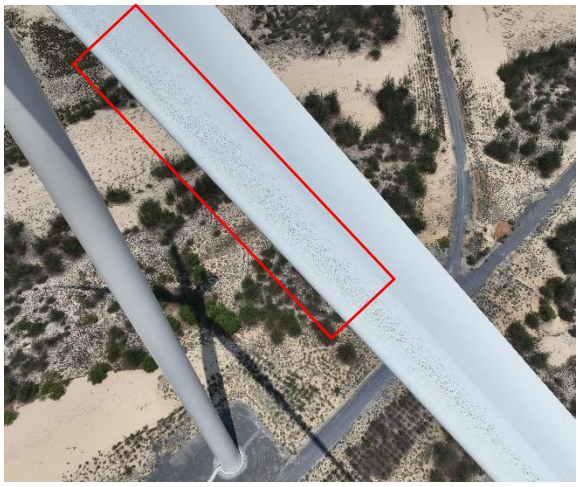


Damage 3 of 10 on blade 29101070WHYE255934

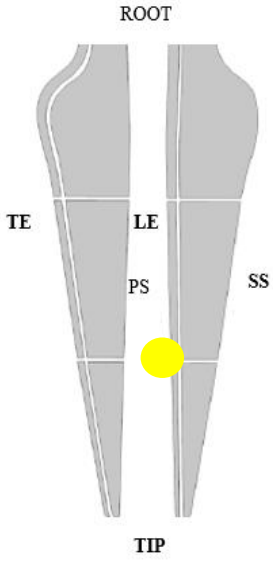


Blade Edge	Pressure Side
Distance from Hub	49 m
Damage Type	Erosion
Damage Subtype	PS erosion
Root Cause	
Damage Severity	3
Recommendation.	Repair must be done within a time frame.
Comment	Erosion occurring on the PS side near the leading edge (LE) of surfaces.

Images of Damage 3 of 10 on blade 29101070WHYE255933



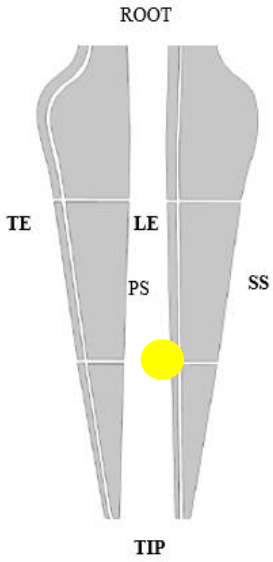
Damage 4 of 10 on blade 29101070WHYE255934



Blade Edge	Suction Side
Distance from Hub	65 m
Damage Type	Erosion
Damage Subtype	SS erosion.
Root Cause	
Damage Severity	3
Recommendation.	Repair must be done within a time frame.
Comment	Erosion occurring on the leading edge (LE) of surfaces.

Images of Damage 4 of 10 on blade 29101070WHYE255933

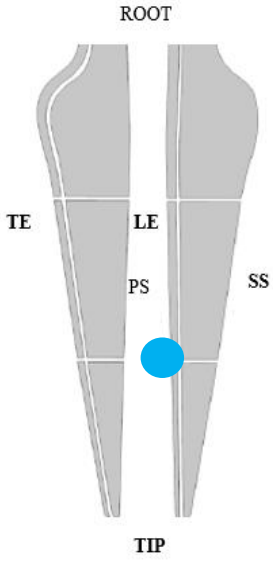
Damage 4 of 9 on blade 29101070WHYE255934



Blade Edge	Suction Side
Distance from Hub	65 m
Damage Type	Erosion
Damage Subtype	SS erosion
Root Cause	
Damage Severity	3
Recommendation.	Repair must be done within a time frame.
Comment	Erosion occurring on the leading edge (LE) of surfaces.

Images of Damage 4 of 9 on blade 29101070WHYE255933

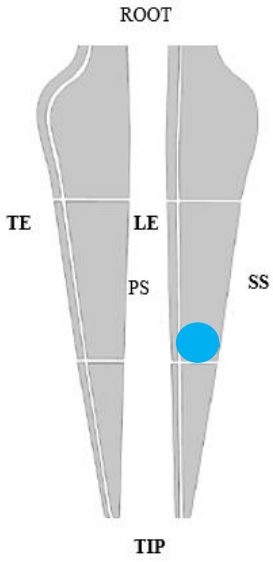
Damage 5 of 9 on blade 29101070WHYE255934



Blade Edge	Suction Side
Distance from Hub	50 m
Damage Type	Erosion.
Damage Subtype	SS Erosion.
Root Cause	
Damage Severity	2
Recommendation.	No action. Monitor at next inspection
Comment	Erosion occurring on the leading edge (LE) of surfaces.

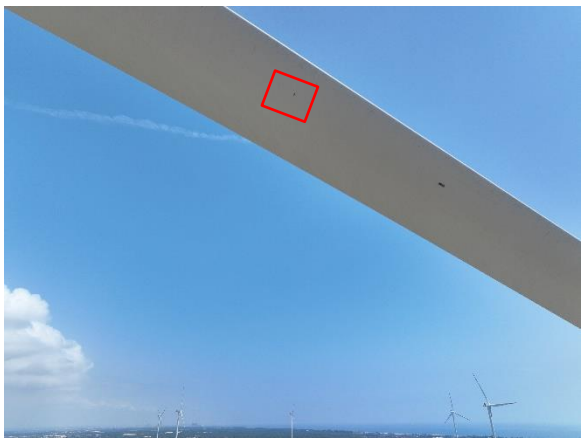
Images of Damage 5 of 9 on blade 29101070WHYE255933

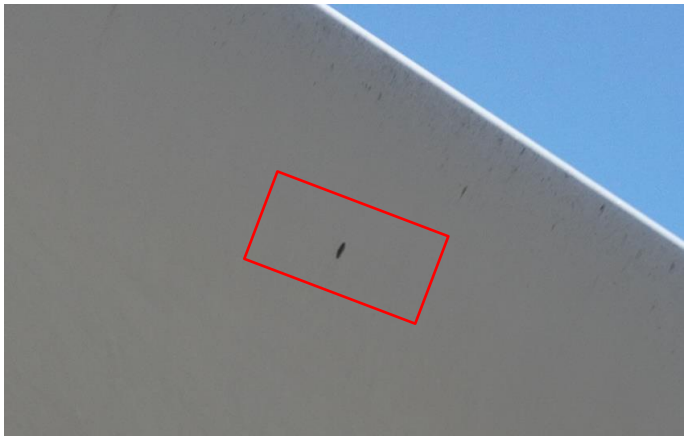
Damage 6 of 9 on blade 29101070WHYE255934



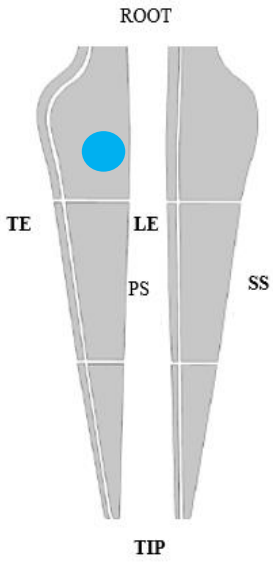
Blade Edge	Suction Side
Distance from Hub	53 m
Damage Type	Coating damage
Damage Subtype	Chip
Root Cause	
Damage Severity	2
Recommendation.	Repair only if other damages are to be repaired.
Comment	A minor chip on the SS surface

Images of Damage 6 of 9 on blade 29101070WHYE255933





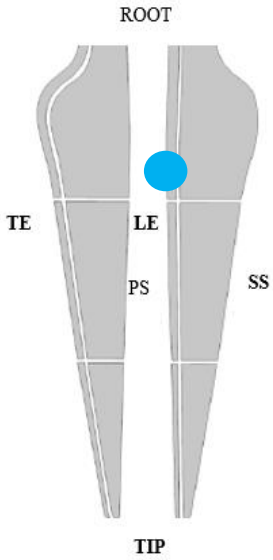
Damage 7 of 9 on blade 29101070WHYE255934



Blade Edge	Pressure Side
Distance from Hub	21 m
Damage Type	Coating damage
Damage Subtype	Scratches.
Root Cause	
Damage Severity	2
Recommendation.	Repair only if other damages are to be repaired.
Comment	Scratches on the pressure side surfaces.

Images of Damage 7 of 9 on blade 29101070WHYE255933

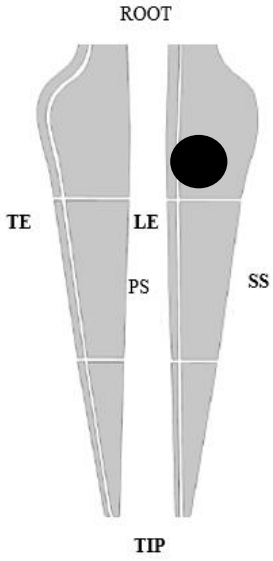
Damage 8 of 9 on blade 29101070WHYE255934



Blade Edge	Leading edge
Distance from Hub	24 m
Damage Type	Coating damage
Damage Subtype	Chip
Root Cause	
Damage Severity	2
Recommendation.	Repair only if other damages are to be repaired.
Comment	Coating surface chipped on the LE side.

Images of Damage 8 of 9 on blade 29101070WHYE255933

Damage 9 of 9 on blade 29101070WHYE255934

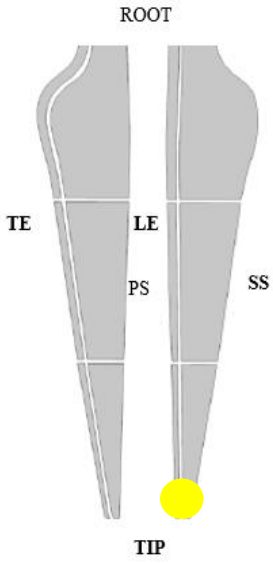


Blade Edge	Suction Side
Distance from Hub	23 m
Damage Type	Erosion
Damage Subtype	SS Erosion.
Root Cause	
Damage Severity	1
Recommendation.	No action.
Comment	Minor erosion occurring on the Suction Side of surfaces.

Images of Damage 9 of 9 on blade 29101070WHYE255933

4.3. Blade C_ID: 29101070WHYE255935

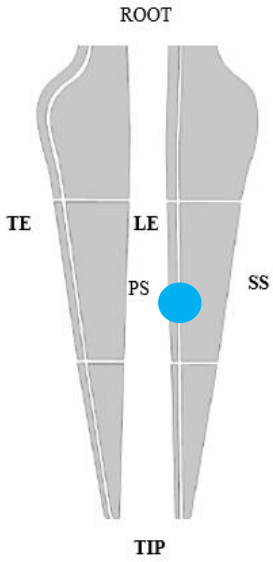
Damage 1 of 10 on blade 29101070WHYE255935



Blade Edge	Leading Edge
Distance from Hub	73 m
Damage Type	Erosion
Damage Subtype	Tip section damage.
Root Cause	
Damage Severity	3
Recommendation.	Repair must be done within a time frame.
Comment	Erosion occurring on the LE surfaces at the Tip section.

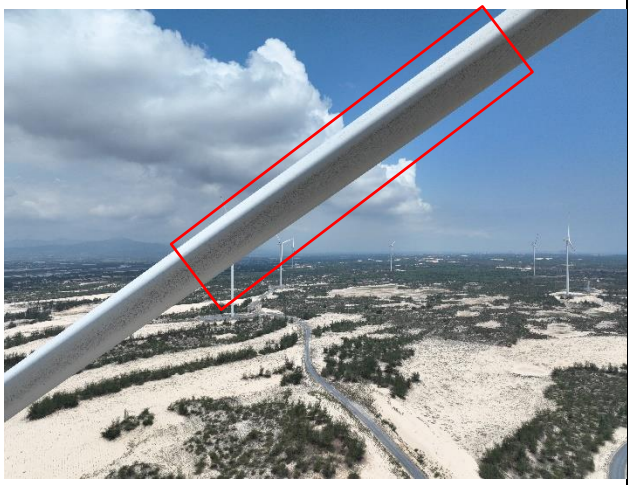
Images of Damage 1 of 10 on blade 29101070WHYE255933

Damage 2 of 10 on blade 29101070WHYE255935

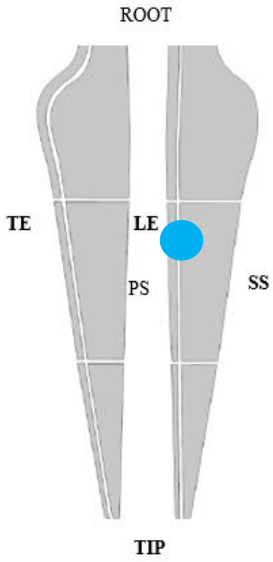


Blade Edge	Leading Edge
Distance from Hub	41 m
Damage Type	Erosion
Damage Subtype	LE Erosion
Root Cause	
Damage Severity	2
Recommendation.	Repair only if other damages are to be repaired.
Comment	Erosion occurring on the LE surfaces

Images of Damage 2 of 10 on blade 29101070WHYE255933



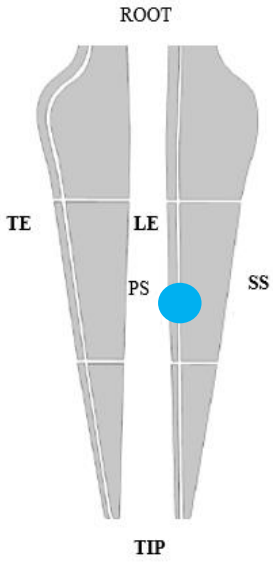
Damage 3 of 10 on blade 29101070WHYE255935



Blade Edge	Leading Edge
Distance from Hub	30 m
Damage Type	Erosion
Damage Subtype	LE Erosion
Root Cause	
Damage Severity	2
Recommendation.	Repair only if other damages are to be repaired.
Comment	Erosion occurring on the leading edge (LE) of surfaces.

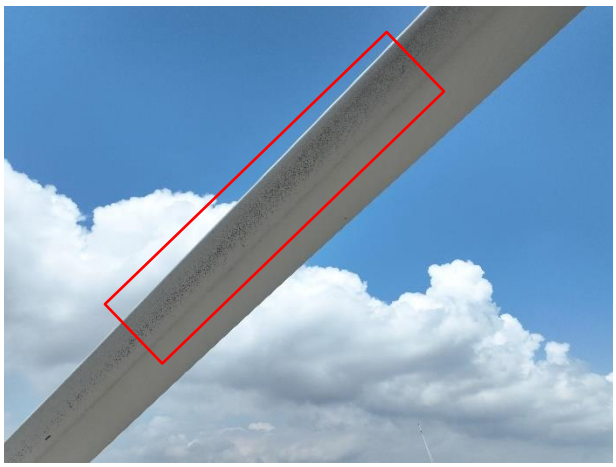
Images of Damage 3 of 10 on blade 29101070WHYE255933

Damage 4 of 10 on blade 29101070WHYE255935

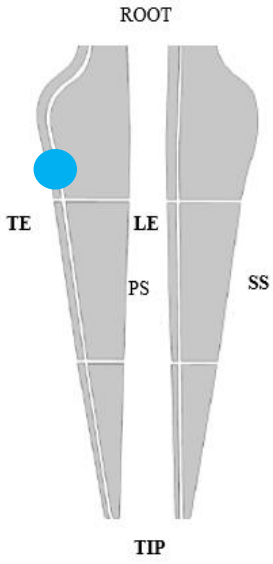


Blade Edge	Pressure Side
Distance from Hub	41 m
Damage Type	Erosion
Damage Subtype	PS Erosion.
Root Cause	
Damage Severity	2
Recommendation.	Repair only if other damages are to be repaired.
Comment	Erosion occurring on the PS side near the leading edge (LE) of surfaces.

Images of Damage 4 of 10 on blade 29101070WHYE255933

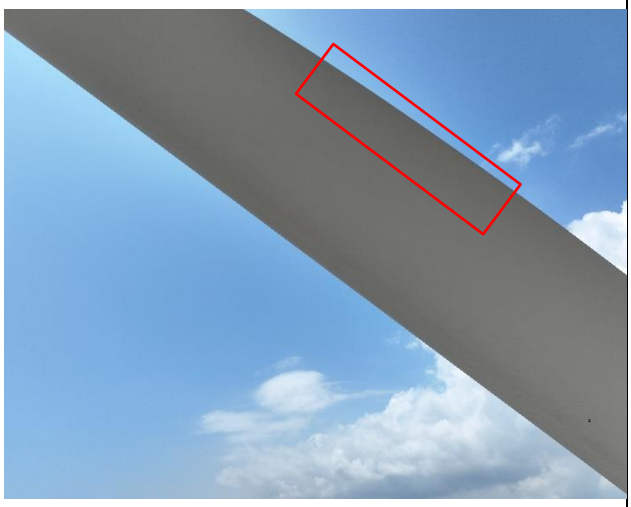


Damage 5 of 10 on blade 29101070WHYE255935

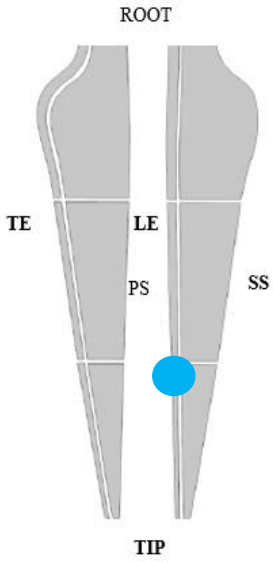


Blade Edge	Trailing Edge
Distance from Hub	28 m
Damage Type	Coating damage
Damage Subtype	Chip
Root Cause	
Damage Severity	2
Recommendation.	No action. Monitor at next inspection
Comment	Minor chip occurring on the TE surfaces.

Images of Damage 5 of 10 on blade 29101070WHYE255933



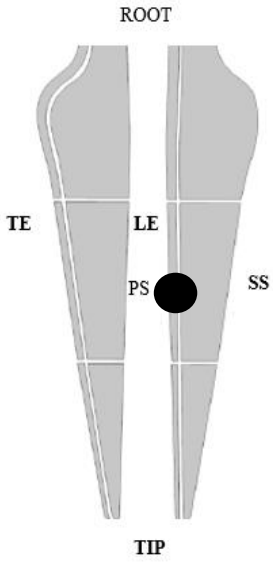
Damage 6 of 10 on blade 29101070WHYE255935



Blade Edge	Leading Edge
Distance from Hub	58 m
Damage Type	Erosion
Damage Subtype	LE Erosion
Root Cause	
Damage Severity	2
Recommendation.	No action. Monitor at next inspection
Comment	Minor erosion occurring on the leading edge (LE) of surfaces.

Images of Damage 6 of 10 on blade 29101070WHYE255933

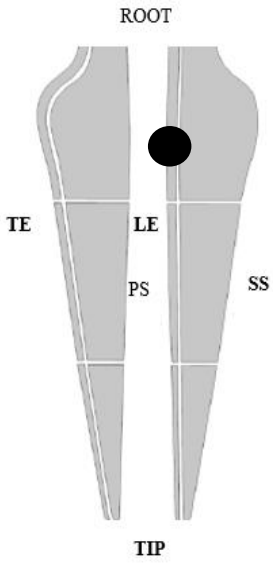
Damage 7 of 10 on blade 29101070WHYE255935



Blade Edge	Leading Edge
Distance from Hub	46 m
Damage Type	Coating Damage
Damage Subtype	Contamination (Dirt/grease/oil)
Root Cause	
Damage Severity	1
Recommendation.	No action.
Comment	Contamination (Dirt/grease) on the leading edge (LE) of surfaces.

Images of Damage 7 of 10 on blade 29101070WHYE255933

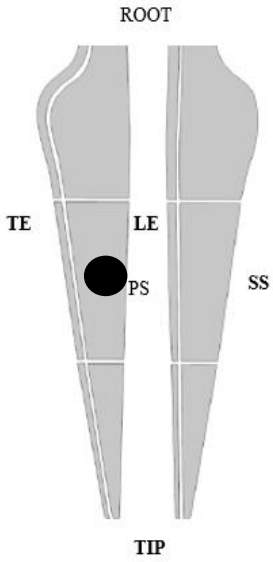
Damage 8 of 10 on blade 29101070WHYE255935



Blade Edge	Leading Edge
Distance from Hub	21 m
Damage Type	Erosion
Damage Subtype	LE Erosion
Root Cause	
Damage Severity	1
Recommendation.	No action. Monitor at next inspection
Comment	Minor erosion occurring on the leading edge (LE) of surfaces.

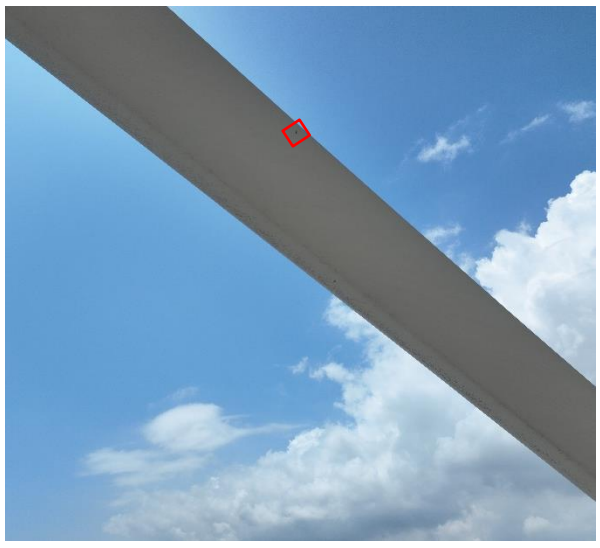
Images of Damage 8 of 10 on blade 29101070WHYE255933

Damage 9 of 10 on blade 29101070WHYE255935

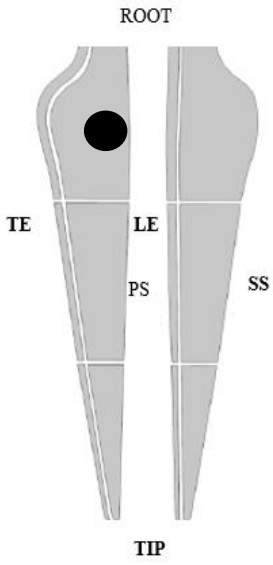


Blade Edge	Pressure Side
Distance from Hub	43 m
Damage Type	Coating Damage
Damage Subtype	Contamination (Dirt/grease/oil)
Root Cause	
Damage Severity	1
Recommendation.	No action. Monitor at next inspection
Comment	Contamination (Dirt/grease) on the PS of surfaces.

Images of Damage 9 of 10 on blade 29101070WHYE255933



Damage 10 of 10 on blade 29101070WHYE255935



Blade Edge	Pressure Side
Distance from Hub	16 m
Damage Type	Coating Damage
Damage Subtype	Scratches
Root Cause	
Damage Severity	1
Recommendation.	No action. Monitor at next inspection
Comment	Minor scratches on the PS surfaces

Images of Damage 9 of 10 on blade 29101070WHYE255933