



Wind Farm Location:

Site Manager:

Turbine ID#: T123

Manufacturer/Model:

Turbine Defect Summary (all blades)

Defect Category	# of Defects Identified
5 (Major Structural)	0
4 (Moderate Structural)	6
3 (Minor Structural)	0
2 (Major Cosmetic)	0
1 (Minor Cosmetic)	0



Summary for Blade #T123-1

Reading guide: This page summarizes and categorizes the defects found by blade.

Category	Quantity	Sub-Category of Defect
5 (Major Structural)	0	Edge split / Crack greater than 1 meter
	0	Lightning strike (severe)
	0	Delamination damage (severe)
	0	Buckle (severe)
4 (Moderate Structural)	0	Edge split / Crack less than 1 meter
	0	Lightning strike (moderate)
	6	Delamination damage (moderate)
	0	Buckle (moderate)
3 (Minor Structural)	0	Edge erosion
	0	Lightning strike (minor)
	0	Laminate damage (minor)
	0	Missing/damaged hardware, clogged drain tip
2 (Major Cosmetic)	0	Paint gouge, scuff, chip, crack, peeling
	0	Edge erosion, moderate
1 (Minor Cosmetic)	0	Contamination/incorrect paint color
	0	Insect accumulation



Wind Farm Location:
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Blade #T123-1 Category 4-Delimitation Damage (moderate)

Reading guide: The following pages provide detailed pictures of each defect. It is organized by blade, then by defect category. Location of defect is outlined in red on the diagram provided.
Please refer to the [HUVR login portal](#) for the full high definition picture.





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Blade #T123-1 Category 4-Delimitation Damage (moderate)

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Blade Identification Guide

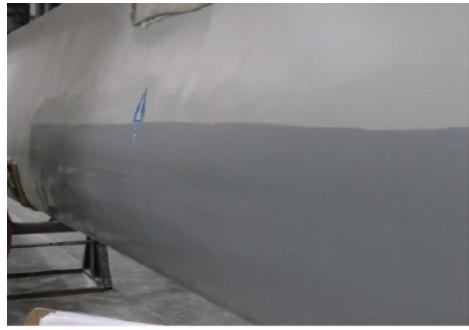
Level 1 Defect - Minor Cosmetic

- Compare identified defects to common defects in identification guide
- If identified defect does not match any common defects, estimate severity or contact blade repair company
- Reference Defect Severity Guide to determine risk assessment

Contamination



Incorrect Paint Color



Insect Accumulation



Contamination includes from dirt, mold, bugs, oil, or any other substance that attaches to the blade surface, resulting in decreased aerodynamic efficiency.

Incorrect paint color does not affect blade performance but is not appealing aesthetically.

Accumulation of bugs along the leading edge will result in performance losses over time. Rain showers will clean the leading edge and remove bug debris. Bug debris should be removed during regular scheduled blade cleaning exercises.

Blade Identification Guide

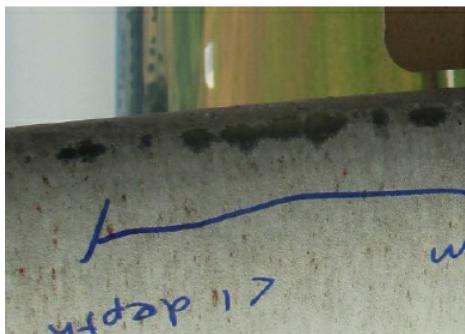
Level 2 Defect - Major Cosmetic

- Compare identified defects to common defects in identification guide
- If identified defect does not match any common defects, estimate severity or contact blade repair company
- Reference Defect Severity Guide to determine risk assessment

Paint Gouge



Leading Edge Erosion



Insect Accumulation



Paint gouges typically occur from transportation and handling but may also result from inclement weather. A paint gouge will appear with sharp edges and may expose underlying laminate.

Leading edge erosion can affect the performance of a turbine. LE erosion will be more prevalent from mid-span to the tip of the blade and appear in a random orientation with no symmetry.

Paint scuffs can be difficult to identify under certain lighting and viewing angles. Inspect closely to ensure that this type of damage is not overlooked. Paint scuffs generally do not expose underlying laminate.

Paint Chip



Paint chips are commonly found near the leading edge and are usually attributed to impacts from ice or other objects. Paint chips are identified by their jagged appearance and exposed laminate.

Paint Crack



Paint cracks may be singular or identified in groupings. Paint cracks can run spanwise or chordwise and are generally confined to the paint and filler layers only.

Peeling Paint



Peeling paint is usually caused by improper subsurface preparation during the manufacturing process or from a previous repair. Peeling paint may expose the underlying filler layer or in some cases bare laminate.

Blade Identification Guide

Level 3 Defect - Minor Structural

- Compare identified defects to common defects in identification guide
- If identified defect does not match any common defects, estimate severity or contact blade repair company
- Reference Defect Severity Guide to determine risk assessment

LE Erosion (Severe)



Severe leading edge erosion is identified by the presence of exposed laminate which may or may not be damaged. LE erosion of this magnitude effects power output and aerodynamic efficiency greatly.

Cracked Balance Chamber



All rotor blades come from the factory balanced within a set. Balance chambers located outboard of mid-span may develop cracks, allowing moisture to seep into the chamber and result in costly repairs.

Lightning Strike (Minor)



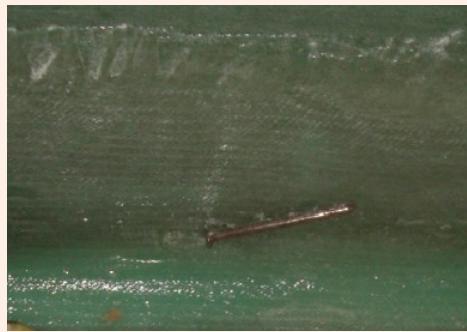
Minor lightning strikes generally hit the designated LPS receptor and do not create apparent laminate damage, however underlying laminate damage may be present. Minor strikes generally have minor charring.

Missing/Damaged Blade Accessory



During turbine operation, blade accessories may be subject to impacts or instances where the accessory becomes broken, damaged, or missing. Missing blade accessories may impact blade performance.

Foreign Object in Laminate



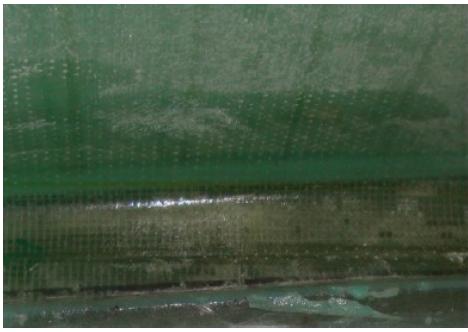
Foreign objects located within the laminate are inadvertently placed during the manufacturing process. Foreign objects do not necessarily need to be removed if no additional defect is identified or propagation is not occurring.

Fiber Rich Laminate



Fiber rich laminate has a white appearance and is an indication of laminate that was not fully wetted during manufacturing or repair. Fiber rich laminate differs from delaminate in that there is no separation between layers.

Air in Laminate



Air in laminate may be caused during the manufacturing process or during blade repair. Air in laminate must be larger than 25mm in diameter (size of quarter) to be considered a defect.

Laminate Contamination



Laminate contamination occurs when a substance is allowed to absorb into the laminate. The most common substances are water and/or oil. Laminate contamination will degrade laminate over time and cause an imbalance.

Root Ring Damage



Some rotor blades have a root ring at the root that covers the hardware used to mount the blade to the pitch bearing. The root ring must completely seal the internal hardware from the environment to prevent damage.

Blade Identification Guide

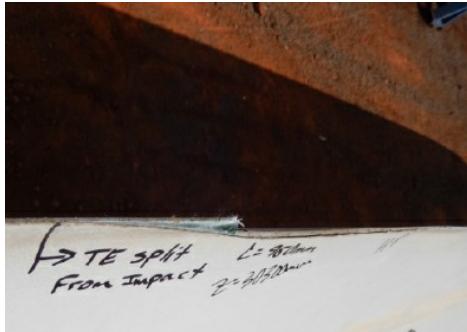
Level 4 Defect - Moderate Structural

- Compare identified defects to common defects in identification guide
- If identified defect does not match any common defects, estimate severity or contact blade repair company
- Reference Defect Severity Guide to determine risk assessment

LE Split ($\leq 1000\text{mm}$)

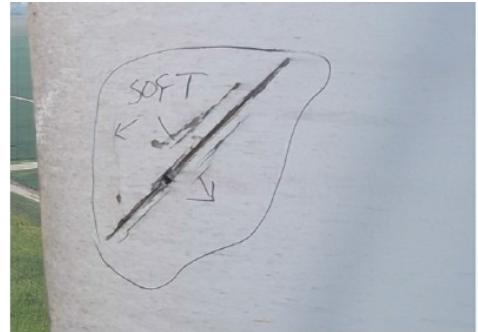
Leading edge splits are identified by a crack or separation of shells along the leading edge. The leading edge may open during operation, allowing the split to propagate. Level 4 LE splits must be 1000mm in length or less.

Cracked Balance Chamber



Trailing edge splits are identified by a crack or separation of shell along the trailing edge. The split may open during operation, allowing propagation. Level 4 TE splits must be 1000mm in length or less.

Lightning Strike (Minor)



Moderate lightning strike are identified by charring and string delamination (notice diagonal orientation). Moderate lightning strike damage will generally consist of inner skin, core, and outer skin damage.

Delamination (Moderate)



Moderate delamination may be identified internally or externally. External delamination are generally caused by lightning strikes or impact and appear white in color. Use of tap testing may confirm the presence of delamination.

Crushed Laminate (Moderate)



Crushed laminate generally occurs from impact during operation. Crushed laminate is identified by inward orientated damage and random delaminated fiberglass layers with a white appearance.

Clogged Drain Tip



A clogged drain tip occurs when debris from the blade interior is forced to the tip and becomes clogged over time. This allows condensation to accumulate resulting in imbalance and severe damage if a lightning strike occurs.

Chordwise Laminate Winkle



Chordwise laminate wrinkles are generally observed internally. A wave-like appearance in the laminate will indicate a chordwise wrinkle. Chordwise wrinkles should be repaired due to the risk of catastrophic failure.

Buckle (Moderate)



A moderate buckle has the appearance of a bubbled laminate. The buckle can be located anywhere along the blade shells but generally near the center of the shells. Buckles have the tendency to propagate rapidly.

Missing/Damaged Hardware



Missing or damaged hardware on a rotor blade may consist of LPS components, mounting hardware, or hardware used to secure the lightning protection system. The most common missing or damage blade hardware is the LPS receptor.

Blade Identification Guide

Level 5 Defect - Major Structural

- Compare identified defects to common defects in identification guide
- If identified defect does not match any common defects, estimate severity or contact blade repair company
- Reference Defect Severity Guide to determine risk assessment

LE Split ($\geq 1000\text{mm}$)

Leading edge splits are identified by a crack or separation of shells along the leading edge. The leading edge may open during operation, allowing the split to propagate. Level 5 LE splits may propagate rapidly to the point of complete failure.

TE Split ($\geq 1000\text{mm}$)

Trailing edge splits are identified by a crack or separation of shells along the trailing edge. The trailing edge may open during operation, allowing the split to propagate. Level 5 TE splits may propagate rapidly to the point of complete failure.

Lightning Strike (Severe)



Severe lightning strikes are evident by charring, obvious delamination, or extreme laminate damage. Severe lightning strikes may be an indication of a malfunctioning LPS system. Verify LPS integrity by use of continuity verification.

Delamination (Severe)



Severe delamination may be identified internally or externally. Severe delamination will have a bubble appearance or white laminate if exposed. Severe delamination has the tendency to propagate rapidly.

Laminate Crack



Laminate cracks are identified by a break in the fiberglass with possible adjacent delamination. Laminate cracks located near maximum chord will propagate extremely rapidly to the point of failure.

Laminate Puncture



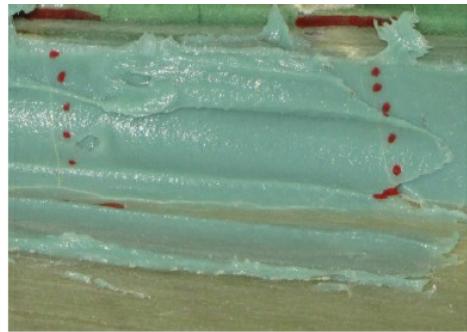
Laminate punctures generally occur during handling and transport but may occur from impact during operation. Laminate punctures identified by inward orientated damage or damage known to have been caused by an impact.

Dry Laminate



Dry laminate is considered a manufacturing or repair defect. Dry laminate appears white and will have a soft texture. Generally, the paint or gelcoat over dry laminate will bubble due to heat expansion difference.

Adhesive Cracks



Internal adhesive cracks can be orientation spanwise or chordwise and may or may not show complete separation. Adhesive cracks can propagate to the point of complete blade failure.

Buckle (Severe)



A severe buckle has the appearance of a bubbled laminate and may be several meters in length. Buckles are generally located near the center of the shells. Buckles have the tendency to propagate rapidly.