

Leading Edge Wear and Erosion - Inspection and Protection Work Instructions

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Intended audience: Wind turbine blade technicians, rope access teams, O&M; supervisors
Scope: Field inspection of leading edge wear/erosion, temporary protection, and minor repair pathways on composite blades. Excludes spar/spar-cap structural repairs and major laminate reconstruction. For severe findings, escalate per Section 4.4.

Revision table

Version (date)	Change
1.0 (2025-11-02)	Initial release
1.2 (2026-01-05)	Updated severity thresholds and photo requirements
1.3 (2026-01-17)	Added tape edge sealing and post-work acceptance checks

1.0 TERMS AND DEFINITIONS

- 1.1 Leading edge:** The forward-most blade edge facing oncoming flow.
- 1.2 Erosion:** Material loss or surface roughening due to rain, particles, or contamination.
- 1.3 LEP:** Leading edge protection (tape or coating applied to reduce further wear).
- 1.4 Span position:** Location along blade length expressed as percent of span (0% at root, 100% at tip).
- 1.5 Repair class:** Categorization used to select action pathway (see Table 3.2).

2.0 SAFETY

2.1 General

- Follow site permit-to-work and rescue plan requirements.
- Verify turbine state and lockout/tagout before accessing blade surfaces.
- Use fall protection and tether tools to prevent dropped objects.

2.2 Stop Criteria (Do not operate if...)

- Do not return turbine to service if any of the following are observed:
- Exposed structural fibers over an area larger than 50 cm2.
 - Leading edge material is missing to a depth greater than 3 mm over a continuous length greater than 300 mm.
 - Any crack (through-coat or laminate) intersecting the leading edge with length greater than 100 mm (refer to Manual 2 for crack handling).
 - Loose or lifting protection tape longer than 200 mm that cannot be re-adhered and sealed (risk of peel propagation).

2.3 Chemical and Dust Controls

- Wear respirator suitable for composite dust during sanding.
- Use gloves and eye protection when handling solvents, primers, and adhesives.
- Keep ignition sources away from solvent vapors.

3.0 INSPECTION

3.1 Inspection Objective

Identify leading edge wear, measure severity, document location and extent, and determine if temporary protection or minor repair is appropriate.

3.2 Erosion Severity and Action Table

TABLE 3.2 (ASCII)

Class	Visual Indicators	Typical Depth	Action
E1	Dull finish, light roughness	<0.5 mm	Clean, monitor, record
E2	Local pitting, small coat loss patches	0.5-1.5 mm	Apply temporary protection
E3	Continuous wear band, exposed filler	1.5-3 mm	Minor repair + protection
E4	Exposed fibers, deep scalloping	>3 mm	Stop and escalate (Section 4.4)

3.3 Required Measurements and Reporting Fields

Turbine ID, blade ID, date/time, weather conditions

Turbine state (stopped, feathered, locked out)

Span position range (e.g., 20-60% span), side (pressure/suction), edge (leading)

Damage length (mm), max width (mm), estimated depth (mm)

Photo set: overview, close-up perpendicular, close-up angled, measurement scale visible

Notes on contamination (insects, salt, dust), tape condition (if present)

3.4 Inspection Method

Perform an overview scan from 0-100% span focusing on 20-60% span where wear is most common.

Identify and mark areas of roughness or coat loss.

Clean a small test area with approved cleaner to confirm if discoloration is surface contamination or material loss.

Measure and record damage dimensions using a flexible ruler and depth gauge (or comparative step gauge).

4.0 PROCEDURE

4.1 Procedure Overview

This procedure covers cleaning, preparation, application of temporary protection, and minor repair for erosion classes E1-E3. For E4, follow Section 4.4.

4.2 Materials and Tools

Approved surface cleaner (non-residue), lint-free wipes

Abrasives: 120, 180, 240 grit

Masking tape, measuring tools, marker pencil

LEP tape kit or field-applied protective film (as specified by site)

Edge sealant compatible with tape system

Filler/putty (non-structural) for shallow erosion pits

Primer (if required by tape system), mixing supplies

Roller/squeegee, heat gun (low setting), IR thermometer

4.3 Step-by-Step Procedure (E1-E3)

Verify lockout/tagout and turbine state. Record turbine state in the work log.

Confirm weather limits: do not apply tape if surface is wet or if steady wind prevents controlled work.

Mark the repair zone with masking tape boundaries. Include at least 30 mm margin beyond visible wear.

Clean the zone using approved cleaner and lint-free wipes. Repeat until wipe shows minimal residue.

Inspect the cleaned surface under angled light to identify pits and coat loss edges.

Measure and record length/width/depth and span position. Take the required photo set (Section 3.3).

For E2-E3: Feather sanding. Use 180 grit to remove loose coating and create a smooth taper at the boundary (no sharp steps).

Vacuum and wipe down. Confirm no dust remains. Allow solvents to flash off fully.

If pits exceed 1 mm depth (E3): Apply non-structural filler to pits only. Do not build a thick layer. Smooth to profile.

Allow filler cure per product instructions. Verify cure by fingernail test (no tack, no indentation).

Sand cured filler flush with surrounding surface (240 grit). Maintain original leading edge contour.

If required by tape system: Apply primer to the prepared zone. Allow to dry as specified.

Dry-fit LEP tape. Confirm alignment along leading edge and verify overlap margins.

Apply tape from center outward using a squeegee/roller to avoid trapped air. Use firm pressure.

Work tape edges with a roller. If temperature is low, gently warm the tape (low heat) to improve conformability.

Seal tape edges with compatible edge sealant. Apply a continuous bead along both tape edges.

Remove masking and check for lifted corners, wrinkles, or air pockets. Rework immediately if found.

Record completion photos: overview and two close-ups showing edge sealant continuity.

Document materials batch numbers, ambient temperature, and humidity estimate if available.

Release turbine only after acceptance checks (Section 5.3) are passed.

4.4 Escalation Procedure (E4 or Uncertain)

Stop work and notify supervisor.

Capture detailed photos with scale.

Tag the location and record span position to nearest 1%.

Do not apply tape over exposed fibers without explicit instruction.

Recommend follow-up with structural repair team.

5.0 CHECKLIST

5.1 Pre-Work Checklist

- Permit-to-work approved and rescue plan confirmed
- LOTO applied and verified
- Weather suitable for controlled handling of materials
- Tools tethered; drop zone established
- Correct tape system and edge sealant available
- PPE: respirator, gloves, eye protection

5.2 In-Process Checklist

- Cleaned surface shows no residue on wipe
- Measurements recorded (length/width/depth/span position)
- Boundary feathered (no sharp edges)
- Dust removed; surface dry before primer/tape
- Tape aligned and applied without major wrinkles
- Edge sealant continuous (no gaps)

5.3 Post-Work Acceptance Checks

- Tape adhesion: attempt gentle lift at 3 points, no peeling allowed
- No trapped air pocket larger than 10 mm diameter
- Edge sealant intact, continuous, and not smeared onto running surface
- Leading edge profile smooth to hand and visual inspection
- Photos uploaded and work log completed
- If any acceptance item fails, rework before returning turbine to service

6.0 TROUBLESHOOTING

6.1 Symptom: Tape edges lift within minutes of application

Likely causes:

Surface contamination (oil, moisture)

Insufficient edge pressure or temperature too low Checks:

Wipe test on adjacent area; check for condensation Actions:

Remove tape, re-clean, allow drying time, re-apply with gentle warming and increased edge rolling

Apply edge sealant only after adhesion is confirmed

6.2 Symptom: Air bubbles form under tape after application

Likely causes:

Application from one side without center-out method

Surface texture too rough Checks:

Measure bubble size and location Actions:

For bubbles <10 mm: work with roller toward edge

For bubbles ≥ 10 mm: lift and re-lay while warming; if cannot be corrected, replace tape section

6.3 Symptom: Filler remains tacky beyond expected cure time

Likely causes:

Incorrect mixing ratio or low temperature Checks:

Confirm ambient temperature and mix method Actions:

Remove uncured filler, re-prep surface, remix properly, and cure within specified temperature range

7.0 CHANGE LOG

7.1 Summary of Changes

Added explicit stop criteria for deep erosion and intersecting cracks (Section 2.2)

Added edge sealing acceptance checks (Section 5.3)

Clarified escalation rules (Section 4.4)

END OF DOCUMENT