Leading Edge and Surface Laminate Cracks - Assessment and Field Response

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Intended audience: Blade inspection technicians, composite repair technicians, O&M; engineers
Scope: Identification, sizing, and response selection for cracks near the leading edge and superficial laminate cracks on blade surfaces. Includes containment actions and escalation criteria. Excludes major structural spar repairs.

Revision table

Version (date)	Change
1.0 (2025-09-18)	Initial issue
2.0 (2026-01-03)	Added crack class thresholds and stop criteria
2.1 (2026-01-17)	Updated verification steps and troubleshooting

1.0 TERMS AND DEFINITIONS

1.1 Crack: A visible separation in coating or laminate, may be linear or branched.

1.2 Through-coat crack: Crack confined to paint/gelcoat layer.

1.3 Laminate crack: Crack extends into composite laminate.

1.4 Delamination: Separation between laminate layers, often detected by tap testing.

1.5 Bond line: Adhesive joint region (often near trailing edge; cracks can migrate from stress concentration areas).

1.6 Crack length: Measured along the crack path (not straight line distance).

2.0 SAFETY

2.1 General

Apply LOTO before close inspection and any repair work.

Use cut-resistant gloves when probing crack edges.

Do not grind into suspected structural areas without authorization.

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

Any crack at or crossing the leading edge with length >100 mm and confirmed laminate involvement.

Any crack accompanied by soft/void sound on tap test over area >100 cm2.

Any crack showing moisture seepage, dark staining, or active propagation (new branching since last inspection).

Any crack within 0-10% span that is longer than 50 mm (root zone concerns).

3.0 INSPECTION

3.1 Inspection Objective

Distinguish coating cracks from laminate cracks, assess extent, and select appropriate response: monitor, seal, minor repair, or escalate.

3.2 Crack Classification Table

TABLE 3.2 (ASCII)

Class	Description	Typical Action
C1	Hairline in coating only, <50 mm	Clean, seal, monitor
C2	Coating crack 50-200 mm, no laminate signs	Seal + follow-up inspection
C3	Suspected laminate crack <=100 mm	Local repair + verify
C4	Laminate crack >100 mm or delamination signs	Stop and escalate

3.3 Inspection Methods

Visual under angled light and magnification (if available)

Crack edge probe with plastic pick (no metal scraping)

Tap test: coin or small hammer; compare with adjacent area

Moisture indicator check if staining is present

Record span position: 0-20%, 20-60%, 60-100%

3.4 Reporting Fields

Turbine ID, blade ID, date/time

Span position (start/end in %), side (pressure/suction), region (leading edge zone or surface)

Crack length (mm), max opening (mm), any branching

Tap test boundary (drawn outline), moisture/staining notes

Photo set: overview, close-up with scale, close-up at 45 degrees, tap test boundary photo

4.0 PROCEDURE

4.1 Procedure Overview

This procedure provides steps for crack assessment and two field responses: sealing/coating crack containment and minor laminate repair for small cracks. For C4, escalate.

4.2 Tools and Materials

Cleaner, lint-free wipes

Abrasives: 180, 240, 320 grit

Plastic pick, flexible ruler, marker

Sealant compatible with coating system (for C1-C2)

Patch resin system (for limited laminate repair), mixing supplies

Peel ply (optional), small vacuum bag kit if approved

Paint/finish materials for top coat restoration

4.3 Step-by-Step Procedure: Assessment (All crack classes)

Confirm turbine is safe and locked out. Record turbine state.

Locate the crack and mark its ends with a fine marker.

Clean the area gently. Remove dirt that can hide crack branching.

Photograph overview and close-up with scale before any sanding.

Measure crack length along path. Record max opening if visible.

Probe crack edge with plastic pick. Note if edges are raised or if material flakes.

Perform tap test in a grid around the crack (approx 50 mm spacing). Mark any dull-sounding boundary.

If staining/moisture suspected, wipe and observe if fluid reappears. Note odor and color (do not taste).

Classify crack per Table 3.2 and decide response path:

IF C1 or C2 THEN proceed to Section 4.4.

IF C3 THEN proceed to Section 4.5.

IF C4 THEN proceed to Section 4.6.

4.4 Step-by-Step Procedure: Seal and Contain (C1-C2)

- 10) Sand lightly along the crack line (320 grit) to open the surface for sealant adhesion (do not widen crack aggressively).
- 11) Clean sanding dust and allow surface to dry fully.
- 12) Apply sealant along crack using controlled bead. Work it into the crack with a plastic spreader.
- 13) Remove excess sealant and feather edges for smooth runoff.
- 14) Allow cure per product spec. Protect from rain during cure.

- 15) Apply touch-up coating if required. Confirm the surface is smooth to the hand.
- 16) Document final photos and schedule follow-up inspection within 30-90 days (depending on span location and crack length).

4.5 Step-by-Step Procedure: Minor Laminate Repair (C3)

- 17) Define repair boundary: at least 30 mm beyond crack ends and 20 mm to each side.
- 18) Sand the boundary to remove coating down to laminate where required. Create a smooth taper (no sharp steps).
- 19) Clean thoroughly. Ensure no moisture is trapped; if moisture suspected, stop and escalate.
- 20) Prepare resin system and reinforcement per approved kit. Do not substitute materials without approval.
- 21) Apply resin and reinforcement to bridge crack zone. Maintain leading edge contour; avoid creating a ridge.
- 22) If peel ply is used, apply and compress to remove excess resin and improve surface finish.
- 23) Allow cure. Verify cure by hardness check (no tack, stable under light pressure).
- 24) Sand cured patch flush (240-320 grit) and restore protective coating.
- 25) Perform tap test on repaired zone and adjacent area. Confirm no new dull areas formed.
- 26) Complete documentation: measurements, photos, batch numbers, ambient conditions.

4.6 Escalation and Temporary Measures (C4)

- 27) Stop work. Do not grind or drill.
- 28) Mark boundaries of suspected delamination and crack ends clearly.
- 29) Capture detailed photos including tap test boundary.
- 30) Notify supervisor and request engineering review and OEM work instruction.
- 31) If approved, apply temporary environmental seal only (thin sealant coat) to prevent moisture ingress; do not claim structural restoration.

5.0 CHECKLIST

5.1 Assessment Checklist

- LOTO verified
- Photos taken before sanding
- Crack length and opening measured
- Tap test performed and boundary recorded
- Span position recorded (0-20 / 20-60 / 60-100)
- Crack class assigned per Table 3.2

5.2 Repair Checklist (Seal path)

- Surface cleaned and dry
- Light sanding performed for adhesion
- Sealant applied and smoothed
- Cure protected from weather
- Follow-up inspection scheduled

5.3 Repair Checklist (Laminate repair path)

- Boundary includes margins beyond crack ends
- Taper smooth, no sharp edges
- Materials mixed correctly; batch recorded
- Patch flush with contour
- Tap test passed after cure
- Coating restored

6.0 TROUBLESHOOTING

6.1 Symptom: Crack reappears through sealant after cure

Likely causes:

Crack is moving (laminate involvement)

Sealant not compatible or poor surface prep Checks:

Inspect for branching; repeat tap test Actions:

Reclassify. IF signs of laminate or delamination THEN escalate (Section 4.6).

If coating-only, remove sealant, re-prep, re-apply with proper primer if specified.

6.2 Symptom: Repair patch forms a ridge that catches water

Likely causes:

Excess resin or insufficient sanding Checks:

Visual and hand check along airflow direction Actions:

Sand and feather edges, restore coating, re-check contour.

6.3 Symptom: Dull tap sound appears after sanding

Likely causes:

Delamination exposed or extended by aggressive grinding Checks:

Map dull area boundary Actions:

Stop and escalate. Document boundary and avoid further material removal.

7.0 CHANGE LOG

7.1 Summary of Changes

Added root-zone stop criteria and moisture warnings

Clarified seal vs laminate repair decision logic

Added troubleshooting for ridge formation and recurring cracks

END OF DOCUMENT