WILL IT FLY? · WHAT'S UNDER THE GAUGE

HOW THE FATIGUE ENGINE ACTUALLY WORKS

The Flight Test is a real fatigue machine fed mostly synthetic inputs. Exactly one curve in the whole engine is anchored to coupon data — the C150 aluminum spar-cap fit. Everything downstream is that one curve, rescaled or stylized.

SUBJECT	Surrogate fatigue model · MmM Flight Test
ANCHOR	C150 SC FLC · **Cessna 150 — aluminum airframe, small GA**
CURVE	Basquin $S = a \cdot N^b$ a = **82.05 ksi** b = **−0.1448**
BASIS	MMPDS-05 S-N · K_t 2.0 & 4.0 interpolated to $K_t \approx 3.0$
READ AS	Logic walkthrough — provenance tagged at every stage

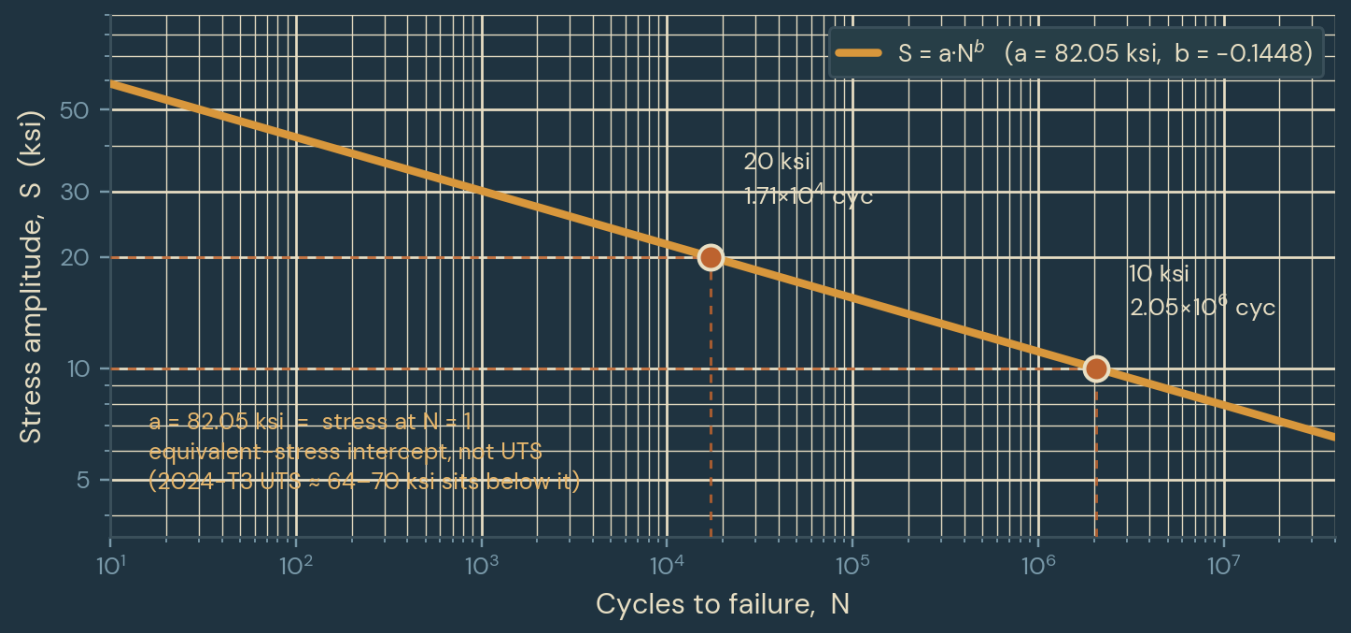

FIG 1 — The anchor S-N curve. The single coupon-traceable relationship in the engine: an aluminum spar-cap finite-life fit. The two rust points are worked examples used on p.3.

THE ONE NUMBER THAT TRACES TO TEST DATA

The slope **b = −0.1448 is a normal aluminum slope** — and that is the whole point. Because the C150 is a small aluminum airframe, every other material in the engine reuses this aluminum curve's shape. The intercept **a** is the stress at N = 1 (a fit intercept, not a strength; 2024-T3 UTS ≈ 64–70 ksi sits below it). Nothing else in the engine is coupon-anchored.

01 · THE PIPELINE

FROM ONE CURVE TO A VERDICT

Every surrogate runs the same stack. The tags mark provenance — what is **documented**, what is **inferred**, and what is **synthetic or editorial**.

FIG 2 — The five-stage engine. A material's v17 rank scales the anchor curve; the chosen mission supplies the load block; Goodman corrects for mean stress; Palmgren-Miner integrates damage to D = 1 for the safe life; a design-mission override then sets the final verdict.

MISSIONS ARE LOAD SPECTRA

Each mission is four rainflow bins — amplitude and mean as a fraction of UTS, with a yearly cycle count. The dashed line is UTS; only the **Sailplane / Monk** block stays well clear of it, and that single fact drives the next page.

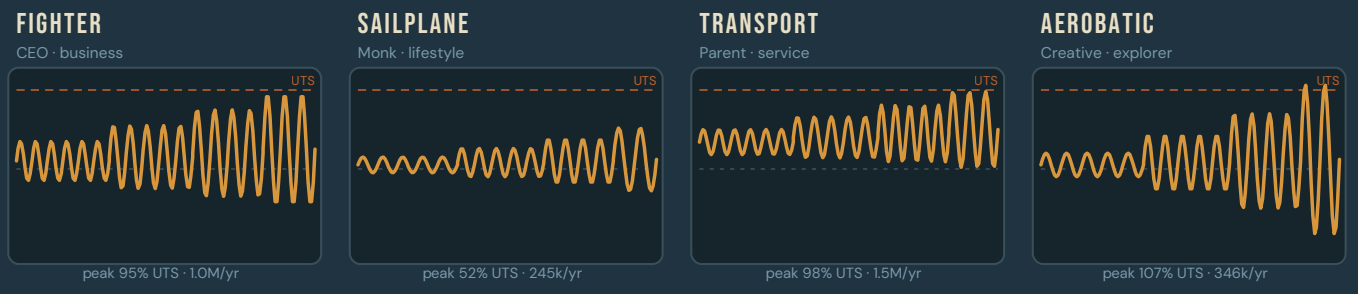

FIG 3 — The four mission spectra, stress as a fraction of UTS over time; the dashed line marks UTS. Sailplane stays well clear; Transport rides near UTS on a high mean; the Aerobatic shock spike crosses it. Figures are peak stress and total cycles per year.

02 · WHY BENIGN LOADS BUY HUGE LIFE

THE SLOPE DOES THE WORK

Invert Basquin and life becomes stress raised to the −6.9 power: $N = (S / a)^{1/b}$, with $1/b = -6.91$. A small drop in stress returns an enormous gain in life.

$S = 20$ ksi → $N \approx 1.71\times10^4$ cyc · $S = 10$ ksi → $N \approx 2.06\times10^6$ cyc · **÷2 stress → ×120 life** ($0.5^{-6.91} \approx 120$)

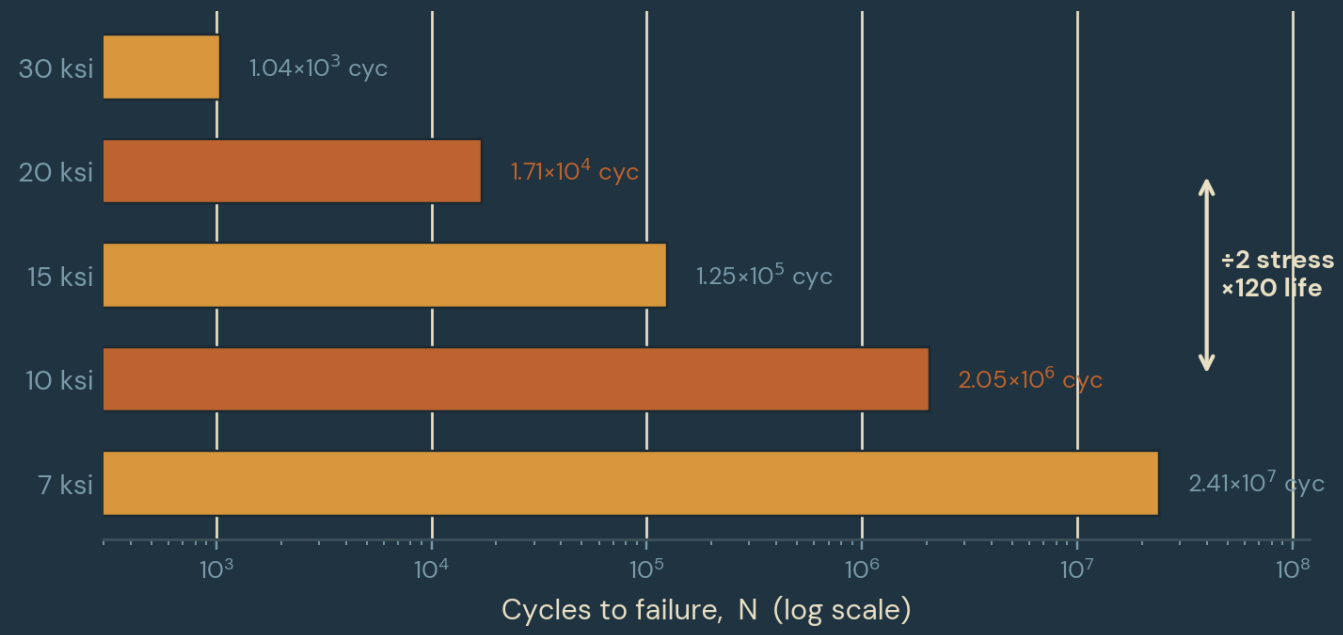

FIG 4 — Cycles to failure across stress level on the anchor curve. Each step down in stress multiplies life by more than a decade; halving the stress buys roughly 120× the cycles.

THE CRUX

The Sailplane / Monk block is the benign one. Push any high-strength material through it and the curve alone returns a long life — composite included. So the verdict "composite is not ideal for Monk" is not coming from the fatigue layer. It comes from the next one.

03 · WHERE "NOT IDEAL" COMES FROM

TWO LAYERS, PULLED APART

LAYER 1 — FATIGUE LIFE · THE CURVE

Under the benign Monk block, composite's high strength holds stresses low → low Miner damage → long computed life.

READS
FINE

LAYER 2 — MISSION FIT + OVERRIDE · THE PERSONA

Monk rewards low maintenance & longevity. Composite is loaded brittle · hides internal damage · high inspection burden · design-home = Fighter — low on exactly that axis.

VERDICT
NOT IDEAL

The verdict you see is the **second** layer. The model's instinct is correct physics — composite does hide damage — but it is used as a mission **disqualifier** instead of an inspection-interval **driver**. That is the conflation, in one diagram.

THE HONEST BOUNDARY

DOCUMENTED

- **a = 82.05, b = −0.1448** + MMPDS-05 basis
- rainflow → Palmgren-Miner, D = 1
- the design-mission override exists — the v18 Steel / PU-foam quirks prove it

INFERRED

- per-material scaling — likely scales intercept **a**, holds slope **b** (materials may be affine transforms of one AI curve)
- Goodman mean-stress correction
- mission blocks calibrated to the 2,376-day curve, or hand-set?

ONLY THE FILE SETTLES

- literal per-material **a** values
- mission (amplitude, mean, cycles) triples
- verdict thresholds

WHAT'S YOUR SPECIFIC SPECTRA?

iSight Laboratories has built and proven out a tracking program for human wellness — **Hindsight 80/20**. To begin capturing your life's flight data today, join the fleet-tracking iSIP program. **Open the fatigue sheet →**