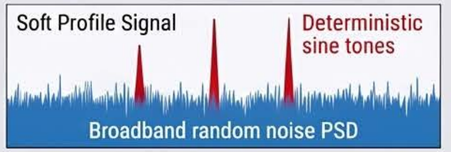
Navigating Sine-on-Random Fatigue Assessment: A Practical Engineering Guide

Context Summary: In aerospace and rotating machinery, components face 'mixed-mode' Sine-on-Random (SoR) vibrations—deterministic sine tones superimposed on broadband random noise. While time-domain 'Rainflow Counting' is the accurate gold standard, it is computationally too expensive for design phases. This infographic compares frequency-domain alternatives that balance speed with predictive accuracy.



THEORETICAL FRAMEWORK (PDF EQUIVALENCE)

Rice's Method: Rigorous Analytical Approach

Derives analytical stress cycle distributions without assuming Gaussian behaviour.

Accuracy vs. Conservation Gauge

HIGH ACCURACY
(In-Band)

0.6% error when sine frequencies match random background mean.

EXCESSIVE CONSERVATION
(Out-of-Band)

Up to 700% conservation risk when sine and random frequencies are separated.

PRACTICAL FRAMEWORK (PSD EQUIVALENCE)

Practical Methods (Lalanne, Irvine): Synthesised Profile Approach

Synthesises a purely stochastic random profile to match SoR damage.

Performance Benchmark Gauge

TYPICAL ACCURACY
(±20%)

Achieved via 'Error Cancellation' balancing peak underestimation with tail inflation.

MIL-STD-810 Reliability: For complex multi-sine helicopter profiles, Lalanne and irvine methods provide the most reliable engineering estimates.

DECISION TREE & METHOD SELECTION

Vibration Scenario?

In-Band Resonance

Recommended Method: Rice's Analytical PDF

Typical Accuracy: **High** (~99%)

Wideband / Out-of-Band

Recommended Method: Irvine or Lalanne (PSD)

Typical Accuracy: **Moderate** (±20%)

Multi-Sine (MIL-STD)

Recommended Method: Lalanne Iterative

Typical Accuracy: **Moderate** (Best for complex tones)