

■ Vibration Severity - ISO 10816/20816 Zone Guidance (velocity, mm/s RMS)

Machine Class	Zone A (new)	Zone B (acceptable)	Zone C (restricted)	Zone D (damage risk)
Small machines (<15 kW)	< 0.71	0.71 - 1.8	1.8 - 4.5	> 4.5
Medium (15-75 kW)	< 1.12	1.12 - 2.8	2.8 - 7.1	> 7.1
Large rigid foundation	< 1.8	1.8 - 4.5	4.5 - 11.2	> 11.2
Large flexible foundation	< 2.8	2.8 - 7.1	7.1 - 18.0	> 18.0

Values are general guidance - always apply the machine-specific standard part and OEM limits.

■ Spectrum Signatures

Frequency	Classic Cause
1x RPM	Unbalance (radial, steady phase); also bent shaft (axial high)
2x RPM	Misalignment (high axial); looseness harmonics also present
Sub-synchronous (0.38-0.48x)	Oil whirl in journal bearings
Blade/vane pass (n x RPM)	Flow-related: recirculation, gap issues
Non-synchronous spikes + harmonics	Rolling element bearing defects (BPFO, BPFI, BSF, FTF)
Gear mesh (teeth x RPM) w/ sidebands	Gear wear/misalignment; sideband spacing = shaft speed

■ Bearing Defect Frequency Formulas (Hz)

BPFO	$(n/2) \times fr \times (1 - (d/D)\cos\phi)$	Outer race defect
BPFI	$(n/2) \times fr \times (1 + (d/D)\cos\phi)$	Inner race defect
BSF	$(D/2d) \times fr \times (1 - ((d/D)\cos\phi)^2)$	Ball spin/rolling element
FTF	$(fr/2) \times (1 - (d/D)\cos\phi)$	Cage frequency

n = number of rolling elements, fr = shaft speed (Hz), d = ball dia., D = pitch dia., ϕ = contact angle