

DRAFT CMVA GUIDELINE:

CMVA-AC-SO1 Rev. 1.3 1995/12/15

**VIBRATION ACCEPTANCE GUIDELINES FOR
NEW AND REBUILT UNCOUPLED AC & DC
ELECTRIC MOTORS AT NO LOAD**

SCOPE: These guidelines apply to AC and DC electric motors with rolling element (anti-friction) bearings. Motors with journal bearings, specialty motors and variable speed AC motors are not included.

1. INSTRUMENTATION REQUIREMENTS

1.1 Vibration measurements will be made with an FFT type analyzer utilizing 800 lines resolution unless otherwise specified. For overall measurements an analogue instrument may be used.

1.2 The dynamic range of vibration analysis instruments shall not be less than 70 dB enabling the instrument to identify frequency components with small amplitudes.

1.3 Instrumentation is required to be calibrated annually at a certified location and records kept.

1.4 Transducer and mounting should be such that they will give a reasonably flat response from 0.4 x running speed to maximum display frequency F_{max} .

1.5 At a position where a magnetic mounted transducer is used, there shall be no "rocking" of the transducer.

1.6 The FFT analyzer shall be set to take each measurement with a minimum of four (4) averages using a Hanning window.

1.7 Vibration amplitude shall be measured in the following units:-

Velocity inch/sec (Peak)

Velocity values in in/sec (peak) can be obtained by dividing mm/sec peak values by 25.4. Most instruments obtain "peak" values by multiplying root-mean-square (rms) values by 1.414; therefore to obtain peak values multiply rms values by 1.414 (i.e., square root of 2).

1.8 Spectral frequency display range (Fmax) values shall be set according to the following criteria.

1.8.1 If overall (unfiltered) amplitude reading is requested then the Fmax shall be not less than 240,000 cpm (4000 Hz).

For all motors:

1.8.2 60 x running speed for identification of bearing faults (800 lines or equivalent resolution).

For AC motors only:

1.8.3 360,000 cpm (6000 Hz) for identification of electrical faults in two (2) pole motors. For all others 240,000 cpm (4000 Hz) is sufficient for stator and rotor bar fault identification (1600 lines or equivalent resolution).

1.8.4 10,000 cpm (166 Hz) for identification of electrical faults at two (2) times line frequency. Resolution of 3200 lines or equivalent is required to determine if frequency is 2 times line frequency or a harmonic of running speed.

2. MEASUREMENT REQUIREMENTS

2.1 Motors shall be divided into three (3) categories:-

2.1.1 Under 5 hp (3.7 kW)

2.1.2 5 to 75 hp (3.7 to 56 kW)

2.1.3 Greater than 75 hp (56 kW)

2.2 AC motors shall be vibration tested at synchronous speed minus slip, at rated voltage and frequency, and at no load. DC motors shall be tested at highest rated speed.

2.3 Motors shall be tested sitting on a foundation whose natural frequencies are at least 25% different from rotational excitation frequency.

2.4 All vibration checks will be done with a half key in the key way. (A half key is a full length key flush with top of keyway as per ISO standard ISO 8821).

2.5 Motor feet are to be checked for flatness to a least detect bent or angled feet. Any defects are to be reported in documents supplied with motor.

2.6 Vibration shall be measured as close as possible to bearing location.

3. LIMITS

3.1 Amplitudes of vibration shall not exceed limit in any direction (horizontal, vertical, axial).

3.2 If measurement in the axial direction exceeds 50% of radial readings, the vendor is to notify the purchaser as soon as possible for motors 50 hp and larger.

3.3 Vibration requirements as per Section 2 are as follows. See Tables 1 and 2 for summary.

3.3.1 All motors under 5 hp shall not exceed an overall vibration level of 0.15 in/sec peak. It is not required to supply vibration data supporting this criterion.

3.3.2 All motors under Section 2.1.2 shall not exceed an overall vibration level of 0.10 in/sec peak. Records of overall vibration readings shall be supplied with the motor. A minimum of three (3) readings shall be required, one in the radial direction at both ends and one in the axial direction at the drive end of motor.

3.3.3 All motors under Section 2.1.3 shall be supplied with:

Overall vibration readings for both radial and axial positions. The radial direction readings must not exceed 0.10 in/sec peak.

The following spectrums shall also be supplied with motor:

For all motors:

FFT spectrums with a Fmax as per Section 1.8.2 taken in the radial direction at both ends and one in the axial direction at the drive end of the motor.

For AC motors only:

An FFT spectrum as per Section 1.8.3 in the radial direction at the motor non drive end.

An FFT spectrum as per Section 1.8.4 in a radial direction. If a frequency of two (2) times line frequency is identified to have an amplitude in excess of 0.05 in/sec peak, the vendor is required to inform the purchaser as soon as possible.

All FFT spectra will have a frequency and amplitude listing with a threshold setting of 0.005 in/sec peak.

Table 1 - Overall Vibration Limits

Motor size	Overall Limit	Documentation Needed
Under 5 hp	0.15 in/s pk	None
5 to 75 hp	0.10 in/s pk	Overall radial direction at each end and axial dir. at drive end
Over 75 hp	Radial: 0.10 in/s pk Axial: 50% of radial	Overall radial direction at each end and axial dir. at drive end. Spectrums and peak lists (see Table 2)

Table 2 - Requirements for Spectrum Plots and Peak Lists for Motors Over 75 hp

Sect.	Motor type	Fault type	Equiv. Resolution	Fmax	Location and direction
1.8.2	All motors	Bearing	800 lines	60 x rpm	Radial at both ends and axial at drive end
1.8.3	AC 2-pole	Electrical	1600 lines	360,000 cpm	Radial at non-drive end
	AC n-pole (n2)			240,000 cpm	
1.8.4	AC n-pole	Twice line freq.	3200 lines	10,000 cpm	Radial direction

3.4 Limiting values for vibration frequency components other than 1x (synchronous) are given in Table 3.

Table 3 - Limits on Frequency Components Other Than Synchronous

Frequency component	Limiting value
Harmonic multiple of running speed (2x, 3x, etc.)	0.05 in/sec peak
Frequency other than a harmonic of running speed	0.025 in/sec peak

Additional Recommendations

A.1 BALANCING

In order to achieve the above vibration limits for an assembled motor it is recommended that the following minimum rotor balancing standards be used. Balancing for motors below 5 hp is not necessary unless requested.

4.1 Rotor balancing shall be two-plane dynamic balancing.

4.2 The minimum balance quality grade obtained at balancing speed should be equivalent to ISO 1940 G-1.0 at normal running speed.

4.3 All rotors to be balanced with a half key as described in Section 2.4.

A.2 TRANSPORTATION

To ensure that a motor reaches the purchaser in the same condition as it left the vendor:

5.1 All new and rebuilt motors in Section 2.1.3 shall have the rotor blocked in such a manner that will prevent any axial movement in the bearings during transportation.

5.2 Although not specified in Section 5.1 it would be beneficial if all motors be shipped in such a manner that the bearings not be exposed to any more vibration than absolutely necessary.

A.3 PRECAUTIONS DURING TESTING

Vendors should be aware that bearing damage can possibly occur when cylindrical roller bearings are loaded insufficiently. Prolonged running times with no load should be avoided.

Send comments to:

CMVA - Atlantic Chapter, Electric Motor Sub-Committee

<http://www.cmva.com/chapters/at.html>