

ANSI/AMCA Standard 204-20

Balance Quality and Vibration Levels for Fans

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Air Movement and Control Association International

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Balance Quality and Vibration Levels for Fans

1. Purpose

This standard addresses the subjects of fan balance and vibration (BV). It is part of a series of standards and publications listed in Annex F that cover important aspects related to fan design, manufacture and use.

Other standards exist that deal with machine vibration in general. This standard only considers fans. Vibration is recognized to be an important parameter regarding fan mechanical operation. Balance quality is a precondition to satisfactory mechanical operation.

The purpose of this standard is to define appropriate fan balance quality and operating vibration levels to individuals who specify, manufacture, use and maintain fans.

2. Scope

This standard covers fans with rigid rotors generally found in commercial heating, ventilating and air conditioning; industrial process applications; mine/tunnel ventilation applications; and power generation applications. Other applications are not specifically excluded, except as follows:

- Installations that involve severe forces, impacts or extreme temperatures acting on the fan are excluded.
- Fan foundations and installation practices are beyond this standard's scope. Foundation design and fan installation are not normally the fan manufacturer's responsibility. It is fully expected that the foundation upon which the fan is mounted will provide the support and stability necessary to meet the vibration criteria of the fan as-is from the factory.
- Other factors, such as impeller cleanliness, aerodynamic conditions, background vibration, operation at rotational speeds other than those agreed upon and fan maintenance, affect fan vibration levels but are beyond this standard's scope.
- This standard is intended to cover only the fan's balance or vibration and does not consider the effect of fan vibration on personnel, equipment or processes.

Any or all portions of this standard or modifications thereof are subject to agreement between the concerned parties.

3. Normative References

The following standards contain provisions that, through specific reference in this text, constitute provisions of this standard. At the time of this standard's publication, the editions indicated were valid.

All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below.

ISO 21940-2:2017, Mechanical vibration — Rotor balancing — Part 2: Vocabulary

ISO 21940-11:2016, Mechanical vibration — Rotor balancing — Part 11: Procedures and tolerances for rotors with rigid behavior

ISO 21940-21:2012, Mechanical vibration — Rotor balancing — Part 21: Description and evaluation of balancing machines

4. Definitions/Symbols

4.1 Definitions

4.1.1 Amount of unbalance

Product of the unbalance mass and the radial distance of its center of mass from the journal axis.

4.1.2 Balancing

The process of adding or removing mass in a plane or planes on a rotor to move the center of gravity toward the axis of rotation.

4.1.3 Balance quality grade

The recommended limits for residual unbalance of a rotor based upon the intended application. (Commonly used balance quality grades in ISO 21940-11:2016 refer to the vibration that would result if the rotor operated in free space; e.g., Balance Quality Grade G6.3 corresponds to a shaft vibration of 6.3 mm/s velocity at the operating rotational speed of the rotor.) The value represents the product of the unbalance multiplied by the angular velocity and divided by the weight of the rotor.

4.1.4 Displacement

The distance that a body moves from a stationary or neutral position.

4.1.5 Electrical run-out

The total measured variation in the apparent location of a ferrous shaft surface during a complete slow rotation of that shaft as determined by an eddy current probe system. This measurement may be affected by variations in the electrical/magnetic properties of the shaft material as well as variations in the shaft surface.

4.1.6 Fan application category

A grouping used to describe fan applications, their appropriate balance quality grades and recommended vibration levels.

4.1.7 Fan assembly

The fan assembly consists of those items typically packaged together as a complete fan including, as applicable, rotor, bearings, belts, housing, motor, sheaves and mounting base/structure. In the case of a cooling tower application, the fan assembly is considered to consist of the rotor alone.

4.1.8 Fan rotor

An assembly consisting of a fan impeller mounted on its shaft or bearings (ANSI/AMCA Standard 99).

4.1.9 Fan vibration level

The vibration amplitude measured at a fan bearing and expressed in units of displacement or velocity.

4.1.10 Filter

A device used to separate vibration based on its frequency. Vibration meters normally have adjustable filters to allow measurements at a frequency range of interest.

4.1.11 Filter-in; sharp

Vibration measured only at a frequency of interest.

4.1.12 Filter-out; broad pass

Vibration measured over a wide frequency range (typically 10-1,000 Hz); sometimes called overall vibration.

4.1.13 Flexible support

A fan support system designed so that the first natural frequency of the support is well below the frequency corresponding to the fan's operating rotational speed. Often, this involves compliant elastic elements between the fan and the support structure. According to the National Electrical Manufacturers Association (NEMA), "This condition is achieved by suspending the machine on a spring or by mounting on an elastic support (springs, rubber, etc.). The

natural oscillation frequencies of the suspension and machine are typically less than 33% of the frequency corresponding to the lowest speed of the machine under test" (NEMA MG 1-2016, sec. 7.6.2).

4.1.14 Foundation

Refers to the component to which the fan is mounted that provides the necessary support. A fan foundation must have sufficient mass and rigidity to avoid vibration amplification.

4.1.15 Frequency

In cyclical motion, the number of cycles per second (Hz) or cycles per minute (cpm).

4.1.16 Mechanical run-out

The total actual variation in the location of a rotor surface during a complete slow rotation of the rotor as determined by a stationary measurement device, such as a dial indicator.

4.1.17 Journal

Part of a rotor that is supported radially or guided by a bearing in which it rotates.

4.1.18 Journal axis

Mean straight line joining the centroids of cross-sectional contours of a journal.

4.1.19 Journal centers

Intersection of the journal axis and the radial plane of the journal where the resultant transverse bearing force acts.

4.1.20 Mil

A unit of measure that describes displacement. One mil equals one-thousandth of an inch (1 mil = 0.001 in.).

4.1.21 Overall fan vibration

See Section 4.1.12: filter-out; broad pass.

4.1.22 Peak (pk)

A displacement, velocity or acceleration value occurring at the maximum deviation from a zero or stationary value. See Figure 4.1.

4.1.23 Peak-to-peak (pk-pk)

The total range traversed in one cycle. Peak-to-peak readings apply to displacement only.

4.1.24 Residual unbalance

Unbalance of any kind that remains after balancing.

4.1.25 Rigid support

A fan support system designed so the system's first natural frequency is well above the frequency corresponding to the fan's operating rotational speed. NEMA notes, "The rigidity of a foundation is a relative quantity. It must be considered in conjunction with the rigidity of the machine bearing system. The ratio of bearing housing vibration to foundation vibration is a characteristic quantity for the evaluation of foundation flexibility influences. A foundation may be considered massive if the vibration amplitude of the foundation (in any direction) near the machine's feet or base frame is less than 25% of the maximum amplitude that is measured at the adjacent bearing housing in any direction" (NEMA MG 1-2016, sec. 7.6.2).

4.1.26 Rigid rotor behavior

The flexure caused by a rigid rotor's unbalance distribution can be neglected with respect to the agreed unbalance tolerance at any speed up to the maximum service speed. A rotor that behaves as rigid under one set of conditions (e.g., service speed, initial unbalance and unbalance tolerances) may not behave as rigid under another set of conditions.