ANSI/ASHRAE Standard 87.2-2002

ASHRAE® STANDARD

In-Situ Method of Testing Propeller Fans for Reliability

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Approved American National Standard

ANSI

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.

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(This foreword is not part of this standard but is included for information only.)

FOREWORD

This standard is classified as an ASHRAE Standard Method of Testing. Its intent is to recommend procedures that will permit evaluation of the dynamic characteristics of propeller fan assemblies as tested in the equipment in which they will be applied.

Experience has shown that there are many instances in which excessive vibration and/or failures occur in heating, ventilating, and air-conditioning (HVAC) equipment when the propeller fan assembly, consisting of a fan impeller, its drive motor, and support structure, is operated at or near a resonance frequency of the system. Excitation at these resonance frequencies can occur in a variety of ways, which may include unbalance, aerodynamic forces, motor torque pulsations, or blade flutter and may be encountered during normal steady-state operation of the equipment. Transient excitation (e.g., start-up) forces must also be considered.

Methods described herein will permit the evaluation of the dynamic characteristics of the propeller fan assembly early in the development process so that problems can be identified and corrective action taken. For the purposes of this standard, the fan specimens should reflect production or near production designs. Guidance will be provided to assist the investigator in collection and interpretation of data necessary to estimate reliability; however, identification of specific acceptance criteria is beyond the scope of this standard.

1. PURPOSE

The purpose of this standard is to establish a method of testing propeller fans to measure those dynamic characteristics that are essential in the proper selection and application of such fans to minimize the potential for fatigue failure.

2. SCOPE

2.1 This standard applies to propeller fans used in heating, ventilating, refrigerating, and air-conditioning equipment that

(a) built up or of monolithic construction,

(b) may include a slinger ring or hub, or both, and

(c) is direct or belt driven.

2.2 This test method characterizes the fan in the application for which it is intended.

3. DEFINITIONS

The definitions of vibration terms used in this standard conform to those given in ANSI S1.1-1960 (R1976)[2] and in ISO Standard 2041:1990.[5] The most important definitions used in the standard are given below.

resonance frequency: the frequency at which operation of the equipment leads to a peak in the response spectrum. **Note:** For lightly damped structures, the resonance frequency can be taken to be the natural frequency.

natural frequency: a frequency at which a structure will vibrate when excited. **Note:** All practical structures possess many natural frequencies.

4. REQUIREMENTS

This standard requires that the specimen fan under investigation be tested in a manner that replicates both the support of the fan/motor subassembly and the flow conditions to which the fan will be subjected in the actual application. These conditions include the static pressure rise and volume flow rates that the fan will produce during the actual application as well as the presence of all upstream or downstream obstructions that may be present in the actual application.

The preferred test environment is the actual unit in which the fan will be operated. This would include units with multiple fans. The unit should be situated in a manner that replicates the normal recommended application for the unit and be capable of operating over the entire speed range for the product.

An acceptable alternative is a mockup or master fan test environment, which replicates the actual unit in terms of airflow resistance, upstream and downstream obstructions, and the support structure for the fan or fan/motor subassembly. In addition, the stiffness associated with the structure that supports the propeller fan assembly must be replicated.

To meet the intent of this standard, the specimen fan must be manufactured in a manner similar to the manufacturing processes anticipated for this product.

5. GENERAL APPROACH

5.1 The inherent stiffness and mass of each of the components of the propeller fan assembly will give rise to resonance frequencies when the assembly is excited. A fan will be considered reliable when the induced mean and alternating stress levels in any part of the fan are sufficiently low as to not cause fatigue when the fan is run at any anticipated operating condition. It is recommended that the fan should not be operated within ±5% of any speed that causes the excitation of a resonance frequency.

5.2 A common method to determine stress levels in fans is through the use of strain gages placed at strategic locations on the fan. The fan is assembled into an actual unit or appropriate mockup. Strain measurements are then recorded and analyzed over the full speed and static pressure ranges for the fan. From these mean and alternating strain measurements, stresses can be calculated.

5.3 Some form of endurance test should be considered and may be required.

6. APPARATUS AND INSTRUMENTATION

6.1 Transducers—Strain Gages

The preferred method for determining the state of stress on the surface of a fan blade or support structure uses bonded, metallic foil, resistance strain gages. If the stress field is clearly defined to be in a single direction, a single gage can be used. A more common occurrence is a biaxial stress condition. In that case, a rosette gage configuration should be used.