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Alternate construction materials for the ISO 10302 fan test plenum

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ABSTRACT

A plenum fixture for use in the measurement of acoustic emissions of air moving devices used to cool electronic equipment under the actual aerodynamic conditions of operation has been standardized in ISO 10302 and ANSI S12.11. The current standards specify the acoustic performance criteria to be achieved by, and the exact materials to be used for, the construction of the plenum.

Several users of the plenum have found that alternate materials and construction methods can meet the acoustic performance criteria and offer advantages in terms of plenum durability, usability, acoustic performance and automation. This author presented a previous paper on an Automated Plenum for the Acoustic and Aerodynamic Characterization of Air Moving Devices and the NoiseCon 2005 conference. This paper will follow up on that work, summarize suggested changes to ISO 10302/ANSI S12.11 that would accommodate alternate construction materials, and report on comments that have recently been submitted for consideration by ISO working group responsible for this standard.

1 INTRODUCTION

Air moving devices are used to cool a variety of electronic equipment and are a significant source of noise emissions from such equipment. A plenum based test fixture that creates the appropriate aerodynamic loads on the air moving device and that has specific acoustic performance characteristics to facilitate noise emission testing has been developed and standardized in both ISO and ANSI standards. These standards are currently under review and in need of update to support the current needs of the information technology industry.

2 BACKGROUND

2.1 Fan Test Plenum History

The fan test plenum was developed by George Maling of IBM in the 1960's [1]. Early versions of this plenum fixture were constructed of wood framing materials and utilized a polyester film membrane to form the sides of the plenum. The gate which controls pressure drop was operated manually and transducers for reading pressure drop, fan rotation, voltage, etc. were manually read and recorded. The plenum was sized to be appropriate for the size of the electronic systems to be cooled, the volume flow rate capacity of the air moving devices and the pressure drops that were expected at that time. This resulted in a plenum design with a volume of about 1.3 cubic meters that was capable of characterizing fans with volume flow rates up to 1 m^3/sec (2,100 ft^3/min) and pressure drops up to 750 Pa (3 in H_20).

The initial fan plenum design was introduced to the technical community in 1982 [2,3]. Shortly thereafter, an Institute of Noise Control Engineering (INCE) Technical Report (TR) was developed by the INCE Technical Committee on Information Technology Equipment Noise

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Emissions. The plenum and the associated test procedures were then standardized as ANSI S12.11 in 1987 [4]. The fan test plenum was adopted as an international standard as ISO 10302 in 1996 [5]. The fan test plenum test method was then updated to ANSI S12.11 Part 1 in 2003. At the same time, ANSI S12.11 Part 2 on the measurement of structure-borne vibrations from small air moving devices was also developed [6].

2.2 Current Work using the ISO 10302 Fan Plenum

Noise emissions from small air moving devices have become a significant issue for the information technology industry in recent years. As a result, there has been renewed interest in the use of the plenum, both for production system design and for conducting basic research on fan noise emissions. A number of papers have been recently published, including several at this conference, that have utilized fan test plenums using the basic plenum design outlined in ISO 10302 [8,9,10,11,12,13]. Some of this work has been conducted fully automated plenums that are constructed of materials other than those outlined in the current standards [7]. The addition of automation to the fan test plenum improves measurement throughput in a production testing environment. In basic fan acoustics research applications, the automated plenum allows the collection of the large amount of test data often needed to understand basic fan principals.

2.3 Need for Revision of Current Industry Standards

The industry standards related to the use of the fan test plenum are in need of revision to accommodate the current needs of the information technology industry. The physical size, volume flow rate capacities and pressure drops associated with air moving devices used to cool electronic equipment have changed significantly since the plenum fixture was first standardized. Some of the plenum construction materials, which were specified in detail but without any tolerances, are no longer readily commercially available. In addition, new ideas for plenum construction have emerged and the desire for test automation has increased. Several users have constructed plenum frames of alternative materials and several options have emerged for fan test plenum automation. While these alternative designs have proven to meet the key acoustic and aerodynamic performance requirements outlined in the relevant standards, the current standard language makes these alternative plenum designs non-compliant with current standard requirements.

2.4 Standards Revision Process

ISO Technical Committee 24, Subcommittee 1, Working Group 23 is currently revising the ISO 10302 standard. ISO 10302-1 Committee Draft 2 was recently circulated for comment to the working group members. The proposed changes to ISO 10302-1 summarized in the next section outlines those changes incorporated into the current committee draft document and those proposed in the comments received in response to the working group vote on the committee draft document.

3 CHANGES PROPOSED TO ISO 10302

3.1 Provisions for Smaller Plenums for Smaller Fans

The current ISO 10302 provides for plenum designs that range from full scale (1.3 m^3) to one-half scale (0.16 m^3). Industry needs to measure noise emissions from even smaller fans, referred to as “micro fans” has created the need to allow even smaller plenum designs. ISO 10302-1 CD2 proposes to allow one-quarter scaling of the plenum design to 0.02 m^3. There are several advantages to the one-quarter size plenum for small fans. The smaller plenum volume allows for faster settling of aerodynamic conditions after the plenum slider has been moved. In addition, the smaller physical size of the plenum allows for the use of 0.5 meter hemispherical measurement surface for sound power level determination, thus improving signal to noise ratio on these small, low noise fans.

3.2 Pressure/Flow Measurements on Micro Fans

In addition to allowing smaller plenums for testing of smaller fans, a new normative Annex A, proposed in ISO 10302-1 CD2 outlines new requirements for the measurement of the pressure versus flow (P-Q) properties of these small “micro fans”. The current proposal is based on methods outlined in JBMS-72.

3.3 Annex E on Measurement Uncertainty

ISO 10302-1 CD2 contains a new annex that provides guidelines for use by laboratories in developing measurement uncertainty estimates. As this is the first draft of a measurement uncertainty annex for this test method, it is currently, but its own admission, incomplete. The annex does attempt to outline the factors that influence measurement uncertainty for each of the allowed sound power level determinations methods (free field over reflecting plane and comparison method in reverberation chamber). However, it does not attempt to address any of the known systematic bias introduced by each of these methods.

3.4 Proposed Changes to Plenum Construction Materials

Both the current ISO 10302-1996 and ISO 10302-1 CD2 specify that the plenum be constructed of wood framing materials. In addition to the exact construction specifications for the plenum, these documents also provide acoustic performance criteria for the plenum. Several users of these plenum systems have found it advantageous to construct the plenum framework of aluminum tubing. These users have found that it is still possible to meet the specified acoustic performance criteria when using aluminum tubing for the plenum framework[7].

The use of alternative materials for plenum construction offers several advantages. Materials such as aluminum tubing have a number of manufacturing and structural advantages when compared to the currently specified wood framework. On the principal advantages to the aluminum framework has been the ability to create bolted mounting points for both securing the polyester film and for mounting of automation components. The ability to more tightly stretch the polyester film onto an aluminum frame work reduces flutter noise from the plenum when operating fans near points of instability.

3.5 Proposed Changes to Material Tolerances

Both the current ISO 10302-1996 and ISO 10302-1 CD2 specify exact dimensions for the plenum construction materials, such as the framing and polyester film. In some cases, materials with these exact dimensions may no longer commercially available. For example, 38μm polyester film corresponds to a 1.5 mil thickness film. In the US, both 1 mil and 2 mil thicknesses are commercially available, whereas 1.5 mil materials can be difficult to obtain. Experience has shown that 1 mil film is acceptable for the small scale plenum and that 2 mil film still allows the acoustic performance criteria to be met for full scale plenums. Therefore, it has been recommended in the comments to the CD2 document that dimensional tolerances be specified on the construction materials such that commercially available materials that satisfy the aerodynamic and acoustic performance criteria would be in compliance with this standard.

3.6 Adoption of Part 2 on Structure-borne Vibrations

The update of ISO 10302 also anticipates the incorporation of the methods developed under ANSI S12.11-2003 Part 2 on the measurement of structure-borne vibrations from small air moving devices. Therefore, the update of ISO 10302 will take on the Part 1 (Airborne Noise Emissions) and Part 2 (Structure-borne Vibrations) format of its ANSI S12.11 counterpart.

3.7 Other Proposed Changes

In addition to the changes to ISO 10302 outlined above, both the ISO 10302-1 CD2 document and the comments received in response to the CD draft have proposed a number of other changes. Some of these are editorial in nature or provide clarification to existing standard language. Other proposals are more substantive, such as a correction of the effect of barometric pressure on the sound power emissions of the air moving device, which would make Annex B normative, rather than informative.

4 SUMMARY

The fan test plenum currently standardized in ISO 10302-1996 and ANSI S12.11-2003 has proven to be a valuable test fixture for determining noise emissions from small air moving devices. The information technology industry has increasingly been using this plenum fixture and the associated test standard to assist with the design of production system and for the study of the basic acoustic and aerodynamic properties of the air moving devices. The use of smaller air moving devices has necessitated the need to update the current standards to accommodate smaller plenums. The desire to automate the plenum to increase test throughput and industry adoption of the plenum has created a need to consider alternative construction materials and design specifications.

The current ISO 10302 documents provide both exact construction specifications and acoustic performance criteria for the plenum. Several users have found that there are alternative ways to construct the plenum fixture that will meet the acoustical performance criteria and offer advantages in turns of construction methods, durability, acoustic performance and facilitating automation. In this author’s opinion, the updated ISO 10302 should focus on the performance criteria and provide construction details as guidelines to users that wish to construct the plenum fixture.

ISO TC23/SC1/WG23 will be considering the proposed changes to ISO 10302 over the next several months and will be developing an updated Draft International Standard (DIS) that will be considered for adoption in the near future.

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