EUROVENT 8/7 - 92

SILENCER TEST CODES

CODES D'ESSAI DES SILENCIEUX

PRÜFVORSCHRIFTEN FÜR SCHALLDÄMPFER

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E U R O V E N T

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AIMS AND OBJECTIVES

Founded in 1959, the European Committee of Air Handling and Air conditioning Equipment Manufacturers, EUROVENT, is made up of 11 national trade associations representing the manufacturers of air handling equipment in Europe :

Belgium - Germany - Spain - France - Great Britain -
Italy - Norway - Netherlands - Portugal - Sweden - Finland

EUROVENT has the aim, on a European level, to facilitate closer ties between the companies of the profession, to promote all desirable and possible exchanges between European manufacturers, and to contribute to an improvement of the profession.

EUROVENT represents the profession in relations with the European authorities and the International Organizations.

DEFINITION ET BUTS

Fondé en 1959, le Comité Européen des Constructeurs de Matériel aéraulique, EUROVENT, rassemble 11 associations professionnelles nationales représentatives des constructeurs de matériel aéraulique en Europe :

Belgique - Allemagne - Espagne - France - Grande Bretagne
Italie - Norvège - Pays-Bas - Portugal - Suède - Finlande

EUROVENT se propose de faciliter sur le plan européen un rapprochement des entreprises de la profession, d'aider à tous les échanges souhaitables et possibles entre les constructeurs européens et de contribuer à une amélioration des conditions d'exploitation des marchés et au développement général de la profession.

EUROVENT représente la profession auprès des autorités européennes et des organismes internationaux.

AUFGABEN UND ZIELE

Das 1959 gegründete Europäische Komitee der Hersteller von luftechnischen Geräten und Anlagen, EUROVENT, umfasst 11 nationale Fachverbände, die die Hersteller in Europa repräsentieren.

Belgien - Deutschland - Spanien - Frankreich - Grossbritannien
Italien - Norwegen - Niederlande - Portugal - Schweden - Finnland

EUROVENT hat es sich zur Aufgabe gemacht, die Annäherung zwischen den Firmen auf europäischer Ebene zu erleichtern, beim wünschenswerten und möglichen Erfahrungsaustausch zwischen den europäischen Herstellern zu helfen, die Marktbedingungen zu verbessern und zu einer allgemeinen Förderung des Fachbereiches beizutragen.

EUROVENT vertritt die Interessen des Berufszweiges gegenüber den europäischen Behörden und den internationalen Organisationen.

SUMMARY

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INTRODUCTION

Currently there are in existence three published and accepted Test Codes for silencer testing. These are :

British Standards Institution :

Method of Test Silencers for Air Distribution Systems
BS 4718:1971

American Society for Testing and Materials :

Method of Testing Duct Liner Materials and Pre-fabricated Silencers for Acoustical and Airflow Performance ASTM E 477-1973

Deutsche Institut fur Normung :

Measurement Procedures for Duct Silencers
Messungen an Schlldampfern in Kanalen
DJN 45 646

There is a draft Test Standard from ISO which has now been finalised and submitted for publication, and is very much on the lines of the German Test Standard above.

Quantities to be measured

1 • Noise stopping ability
2 • Flow generated noise
3 • Aerodynamic pressure loss

All these quantities are evaluated in the duct-to-duct situation.

COMMENTS

1 • NOISE STOPPING ABILITY - INSERTION LOSS

Formally this may be classed as the attenuation of the silencer in decibels, but in reality the property measured by all the Test codes is INSERTION LOSS. To this end, the various test assemblies are employed to measure a noise level - firstly with the silencer in the test rig and, secondly, a measurement for which the silencer is substituded or replaced by a length of equivalent ductwork.The difference between these two noise levels represents the INSERTION LOSS which will result from inserting the silencer instead of ductwork.

This concept fits in with the tradition of the industry for calculating required attenuations during which the total design assembly is assessed for its natural attenuation without any silencers, and only if this calculation indicates that extra attenuation is necessary is such a silencer SUBSTITUTED or INSERTED instead of some existing ductwork.

For a brief period the International Standards Organisation were proposing the direct measurement of transmission loss. This involved establishing the sound energy incident onto the silencer and the result of the sound energy radiated from the silencer. The introduction of intensity meters into this situation would, in principle, help the test assembly, but generally there has been universal reluctance to accept the concept of energy transmission. Part of this resistance stems from the risk that an alternative parameter may not in reality give the same answers as INSERTION LOSS, so for the moment INSERTION LOSS is universally adopted in principle, in total and in calculation procedures.

Mention has not been made of the existence of airflow and the current British Standard (BS4718:1971) does not allow for the measurement of INSERTION LOSS in the presence of airflow. However, both the American Standard and the German Standard do allow for the INSERTION LOSS to be established with and without various airflow rates.

The figure mentioned earlier without airflow has become known as the STATIC INSERTION LOSS, whilst the second evaluation in the presence of flow is termed the DYNAMIC INSERTION LOSS. However, it should be noted that DYNAMIC INSERTION LOSS is used by some reputable authorities as having another meaning linked to the presence of flow generated noise *(see Section 2).* The American Code measures the sound pressure levels in a reverberation chamber and the sound pressure level should notionally be able to be free from other noise problems at the microphones. However, the German standard and the proposed International Standard include for the etablishment of DYNAMIC INSERTION LOSS with the microphone measurement locations in the duct in the presence of the turbulent airflow. A procedural check is included to ensure that the flow noise is dB below the attenuated test signal. The older British Standard is under review and does acknowledge the need for revision to include the DYNAMIC INSERTION LOSS. It is unlikely that this will be allowed by the in-duct method and the principles of the American Code will be adopted where the sound pressure level measurements in the presence of flow are only allowed in the reverberation chamber.

2 • FLOW GENERATED NOISE

When airflow is passed or forced through the flow resistive features of a silencer, flow noise and turbulence are created. In all three published Codes this flow noise is measured in the freedom of the diffuse field of a reverberation chamber.

In-duct measurements are not permitted. The turbulence component is allowed to settle out and not affect the microphone outputs. Again, whilst intensity meters might allow the evaluation of this flow generated noise from in-duct measurements, currently the techniques are considered too unproven for formal adoption into a Test Code.

The flow generated noise is required as a sound power level and to this end the reverberation chamber is calibrated.
This calibration is usually allowed to be established from the use of a supplementary noise source or, alternatively, from the measurement of the reverberation time.

3 • AERODYNAMIC PRESSURE LOSS

This is a fairly traditional in-duct aerodynamic measurement in which the flowrate is etablished in a sufficiently long test duct upstream of the silencer, also coupled to a sufficiently long section of downstream ductwork. Static pressure tappings are established on the upstream and downstream sides of the silencer at positions appropriate to good aerodynamic measurement practice. Flow straight-eners and resistant screens are usually incorporated. For all three Codes the pressure loss is taken as an INSERTION LOSS by reference to the small pressure loss of a substitution duct.

4 • THE TEST RIGS

In principle, it is possible to construct a test rig which will measure DYNAMIC INSERTION LOSS, flow generated noise and aerodynamic pressure loss all in the same rig.
However, in practice organisations tend to break the test rig into three more convenient alternatives, each one closely complying to the required rules.

INSERTION LOSS - The test assembly consists quite simply of a loudspeaker noise source, a duct test section in which the silencer substitutes, and an outlet section containing the measurement microphones for the in-duct technique and feeding via a transition into the reverberation chamber for this technique.

The noise source - This is based on loudspeakers for all the Test Codes, and in the British Standard, the German Standard and the draft International Standard the source is arranged in an attempt to generate only plane waves into the test duct. When no airflow is present, the noise source is a unique bank of loudspeakers over the end of the inlet duct. These are connected in phase and, consequently, primarily produce plane waves. When airflow is present, it is necessary that the air enters from a plenum whereupon, in the German and draft International Codes, this bank of loudspeakers is arranged to be wider than the test duct and again produce predominantly plane waves into the test duct. As mentionned earlier, the british Standard does not allow for the measurement of INSERTION LOSS in the presence of flow. The american Test Code does not make the situation sufficiently clear, but in general is not specially arranged to attempt to produce plane waves. The use of loudspeakers in the side walls of the ducts to excite cross modes has been shown to lead to the least repeatable results when comparisons are made between different laboratories - hence the adoption of plane wave biased techniques.

The Test Duct - This is simply the connecting member between the sound source and the measurement section, and it is within this length that the test silencer is substituded. The walls of this test rig generally have to have a high noise retention ability, as is also true of the total assembly.

In all the current Test Codes transition pieces are allowed to transform from standard test duct dimensions onto the many various cross-sections of the test silencer. However, limitations are placed on these transitions, such as the cross-sectional area change and the angle of divergence. In the American, British and German Test Codes these conditions imply that the transitions have zero effect on the silencer's apparent performance. Experience has shown that this is not the case and to this end, in the draft International Standard, these transition pieces are to be considered as part of the silencer test assembly under investigation. For absolute silencer performance, the test duct cross-section must match that of the silencer ; this concept will be retained in the revised British Standard.

5 • MEASURING SECTION

Two formats are generally permitted for measuring the outlet sound levels :

a) reverberation room
b) in-duct microphone assembly

a) Reverberation room - In this method the outlet of the test duct is fed into the reverberation room via a transmission element, which is designed and specified to transfer sound energy from the duct into the room minimising acoustical reflections. However, for the older British Standard abrupt duct terminations are permitted and end reflection corrections included in the Test Standard.

The average sound pressure level in the room is established by any of the common techniques, such as spatial averaging, swinging booms, rotating diffusers and microphone traverses.This reverberation room technique is the only one allowed in the American Standard.

b) In-duct Microphone Assembly - In this method the test duct is connected to a matching measurement section of duct across which a diagonal traverse or array of microphone locations is defined. This measurement section is terminated by an anechoic termination intended to minimise the sound energy reflected and, hence, minimise the formation of standing waves.

The reverberation room may be used for STATIC or DYNAMIC INSERTION LOSS evaluations in the case of the american, German and draft International Standards. Airflow is also permitted in the German Standard and draft International Standard for the in-duct DYNAMIC INSERTION LOSS tests, albeit with a background flow noise level.

6 • FLOW GENERATED NOISE

This is sometimes known as self-noise or generated noise and is a dynamic property of the silencer resulting from the passage of the airflow through the unit. All Test Codes and draft Test Codes currently recommend the use of a reverberation chamber for these measurements. Induct dynamic measurements are not permitted. In general terms, the test assembly consists of a source of quiet air feeding into the silencer through a reflection-free supply duct. The flow noise from the silencer is ducted to the reverberation room via a reflection-free transmission element (horn). The sound power level is established from the reverberation room method by one of the few techniques involving a spatial and temporal averaging of the sound pressure level, and a corresponding room calibration is established for conversion from the measured sound pressure levels and the required sound power levels.
This is an area in which the Codes are in universal agreement, although defining some of the parameters such as "quiet air" and "smooth air", etc., becomes quite important and difficult.

7 • AERODYNAMIC PRESSURE LOSS

The silencer is installed in a duct-to-duct test rig, and in this case for the aerodynamic requirements the test ducts each side of the silencer must be of matching cross-section.

Provision is usually requested for resistant screens and flow straighteners to establish smooth airflow free from swirl. Flow measurement is allowed by various methods such as pitot traverse, venturi nozzle boxes, inlet cones, orifice plates, as laid down in various National and International Standards. The pressure measuring plane locations are clearly defined, together with the necessary straight lengths of matching duct assembly. An INSERTION LOSS evaluation is required in which a substitution duct is also included. Here again, all the current Codes and drafts are in good agreement.

8 • SITE MEASUREMENTS

Due to the emphasis on the INSERTION LOSS techniques in these Codes, together with the use of reverberation chambers, they obviously do not lend themselves to site evaluations.
For this situation in which the silencer must generally be considered a permanent fixture, the transmission loss concept would be more appropriate. In this case it would be necessary to measure the incident energy onto the silencer and the incident energy radiated away from the outlet of the silencer.
However, the undefined inlet and outlet situations around the silencer represent bad acoustic environments for this evaluation simply from sound pressure level measurements themselves. Anechoic conditions are not generally achievable.

Looking to the future, it is possible that traversing and averaging intensity techniques will allow evaluations of the confused sound level on the inlet and outlet of the silencer, to enable a more meaningful evaluation of transmission loss in site situations. Under ideal situations with anechoic terminations, the transmission loss and INSERTION LOSS should be numerically equal.

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