FAN INSTALLATION EFFECTS – A GUIDE TO INSTALLED FAN PERFORMANCE

GUIDANCE NOTE 1

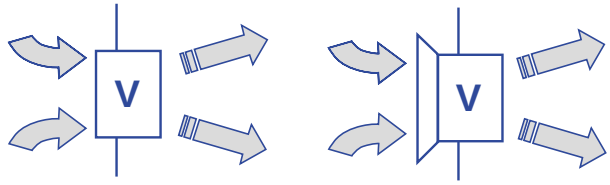
This leaflet has been produced by the Fan Manufacturers' Association. It is intended to assist designers in the selection and use of fans for industrial and commercial installations, and it is applicable to all fans, from all manufacturers.

1. FAN AIR FLOW AND PRESSURE DEVELOPMENT

1.1 Site Application

It is strongly recommended that clients ensure that the data provided by the fan supplier is for an installation category that matches the way in which the fan will be used. If this information is not available we recommend that a suitable correction is made using some of the approved reference documents listed under Section 3 of this guide. The internationally agreed installation categories from ISO 5801 are as follows:

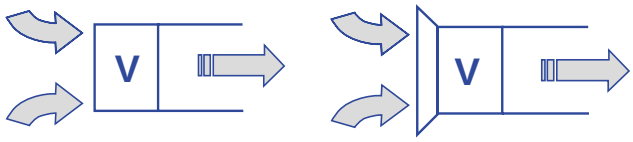
Category A - Open inlet and outlet (ie no ducting)



Note that open inlet measurements (categories A or B) may be taken with or without an inlet cone fitted. The fan performance without an inlet cone is likely to be less than that with a cone.

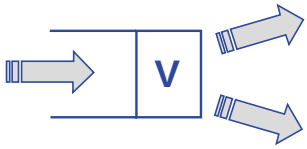
Restricted space around the inlet of a category A or B fan, or around the outlet of a category A or C fan, will affect the performance.

Category B - Open inlet and ducted outlet



For optimum performance there should be no restriction within 2 fan diameters. This is of major importance wherever the fan is contained within a machine or a box, such as an Air Handling Unit or a Dust Collection Unit.

Category C - Ducted inlet and open outlet



Fans mounted in a manner that does not reflect any of the standard categories (such as roof extract fans, or in AHUs) are likely to have altered performance characteristics.

Category D - Ducted inlet and ducted outlet

With good duct design, most fans give their highest performance under category D conditions (with propeller fans being one of the few exceptions). Reference to catalogues often shows which installation category has been used, but where there is doubt, you should contact the manufacturer for clarification, as the difference, whilst always present, varies between designs.

Ducting modifies the air flow into and out of the fan, so the design of ducting connected to the fan inlet and/or outlet is extremely important.

Ducting on the inlet side should be designed to ensure a fully developed, symmetrical air velocity profile, free from swirl. This will ensure that the fan can apply its full energy equally to all parts of the air stream.

Ducting on the outlet should preferably be straight to enable the distorted velocity profile to diffuse in a controlled manner. As a guide, the system designer should aim for at least six diameters. This will lead to a gradual exchange of the high velocity pressures at the fan discharge into usable static pressure. The aim should be to create a symmetrical fully developed swirl-free air velocity profile.

Many fan installations incorporate duct configurations at the fan inlet and outlet that do not permit these profiles to develop. As a result they cause additional unpredictable pressure losses that must be allowed for by the system designer and included as part of the system resistance. (Such allowances may be found in the approved reference documents listed under Section 3 of this guide.

Their magnitude can be very small or, with some especially bad configurations, very large and the effect on fan performance also varies.

1.2 Test Data

The fan performance figures published by fan suppliers have normally been obtained from tests carried out in accordance with the requirements of a recognised test standard. The standard used is ISO 5801, which is reproduced verbatim as BS 848 - 1:1997. It incorporates the test methods of BS 848 Part 1:1980, AMCA 210, DIN 24163 and AFNOR x10-200.

All these standards are laboratory test standards. They incorporate a number of different test methods that simulate the various ways in which a fan may be used in an installation.

2. NOISE

2.1 Site Application

Actual measured site noise levels often exceed the manufacturer's quoted standard average sound pressure level, and can be as much as 10 dB higher in highly reflective small rooms.

In practice, the sound pressure level (which is the level experienced by an observer) is dependent not only on the distance from the fan but also on a number of other factors:

- the position of the fan within a space (whether it is in the middle of the space, adjacent to the side wall, adjacent to the corner, etc.).
- the direction of the observer from the fan relative to how the sound propagates (Directivity Index).
- the position of the fan within any machine or other enclosure
- the characteristics of the space (its size and whether the surfaces are 'hard' and highly reverberant or 'soft' and absorbent).
- the number of fans and other noise sources in the space.
- the design of the ductwork system.
- whether the noise is propagated hemispherically or spherically.

Therefore, in any space, the observer and/or sound meter will be subject not just to the noise coming directly from the fan but also from reflected noise coming off the surfaces. Under these conditions, the same noise is being measured/heard more than once. The primary noise emanating from the fan is added to the reflected noise, often giving rise to higher noise levels than the quoted average free field noise level.

2.2 Test Data

Where noise information is given, this will normally have been measured in accordance with the requirements of a recognised standard. That most commonly used and recommended in the United Kingdom is BS 848 Part 2: 1985 which includes a number of methods to cater for the various types of fan and also the different test environments e.g., in-duct, reverberant room and anechoic chamber. The noise is specific to a particular volume flow rate and pressure. If the system resistance is more or less than that specified, then the fan noise may change both in level and spectrum.

Just as the fan aerodynamic performance will vary according to the Installation Category, so will the fan noise. The noise at the fan outlet can differ from the noise at the fan inlet. The forthcoming BS 848 Part 2.1 recognises these differences and therefore specifies a number of sound power levels that may be associated with a particular unit :

1. L_w(Ain) free-inlet sound power level; type A installation.
2. L_w(Aout) free-outlet sound power level; type A installation.
3. L_w(Atot) total sound power level of a fan type A installation (includes the contributions from the inlet, outlet, fan casing and drive).

Note 1 : Similar sound power levels are also specified for installation categories B, C and D. There are a total of 12 categories.

Note 2 : All of these symbols may be used to indicate levels in 1/3 -octave or 1/1-octave frequency bands as well as overall linear and A-weighted levels, provided that the sound power to which the symbols relate is clearly defined.

Note 3 : Where noise from the drive may contribute to the noise radiated from a casing then this should be clearly stated by the addition of +dr eg. L_w (Dcas +dr)

Note 4 : Not all of the above levels need to be measured for a particular fan.

There are other standards for measuring fan noise such as AMCA 300, DIN 45635 Part 38 and ISO 5136 that are also used. It is important to remember that the results obtained from tests are very much dependent on the fan, the inlet and/or outlet ducting and the terminal loads. It is therefore very difficult to compare results obtained from different standards, as the ducting requirements may differ. It must also be appreciated that the noise coming from an open inlet or outlet will not be the same as the noise transmitted along a duct.

Most of the standards specify methods to calculate the fan sound power level measured in dB re 10^{-12} Watts. This is the best figure for use by acousticians, who can then calculate the fan sound pressure measured in dB re 2 x 10^{-5} Pascals, in a particular environment.

Many manufacturers have sought to meet customer demand for a sound pressure level that indicates what might be heard around the fan. This is usually the breakout noise of a fully ducted fan, or the open inlet/outlet noise of a fan ducted on one side only.

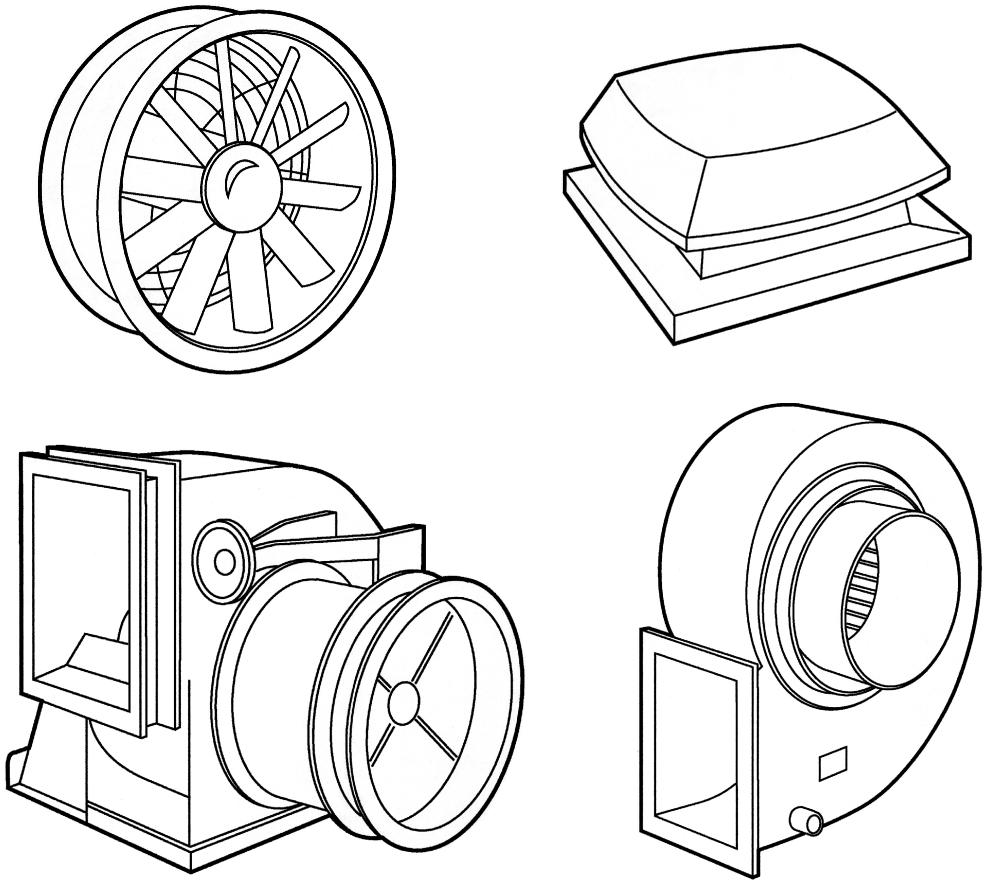
The Sound Pressure Level is calculated at a specific distance from the fan and is given under hypothetical 'free field conditions'. This distance is variously given in metres or fan diameters. Care must be taken that the distance is the same when making comparison between competitive units.

3. FURTHER INFORMATION

Further information can be obtained from the following publications.

FETA/FMA Fan Application Guide
FETA/FMA Fan Installation Effects
AMCA 200 Air Systems
AMCA 201 Fans and Systems
AMCA 203 Field Performance Measurements
AMCA 301 Methods for calculating fan sound ratings from laboratory test data
FETA/FMA Guide to Fan Noise and Vibration
CIBSE Guide B12: Sound Control

List of recognised fan manufacturers (www.feta.co.uk)



Typical fan products.

THE FAN MANUFACTURERS' ASSOCIATION

The Association is the specialist fan group within the HEVAC Association. By insisting on FMA companies when choosing your fan systems, you can be confident that you are getting the best service available.

WHAT CAN FMA COMPANIES DO FOR YOU?

The range and quality of fans and other products that is available to buyers from the FMA, together with the technical expertise in applying those products which is available from members, is widely respected by specifiers and installers.

Members are committed to producing quality products and offering clients expert advice on the application and installation of fan systems.

The FMA are a professional body of fan engineers and by working together, member companies promote high standards of quality, design, safety and workmanship in the industry. They ensure that national and international technical standards and publications reflect the requirements of the industry as a whole and, through their regular exchanges, members are kept upto date with the ever changing legislation and standards which affect their products. By using FMA fans, clients can be confident of getting a professional service.

Insist on fans from the FMA

For a list of FMA member companies, visit www.feta.co.uk

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