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ISO /TC 117~~/WG 12~~

Secretariat: BSI

Fans — System effects and system effect factors

Ventilateurs — Effet système et facteurs d'effet système

Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO ~~documents~~document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Field Code Changed

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see ~~www.iso.org/iso/foreword.html~~www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 117, *Fans*.

This second edition cancels and replaces the first edition (ISO 16219:2020), which has been technically revised.

The main changes are as follows:

— Annex C has been added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Field Code Changed

Introduction

ISO 5801 provides the information for accurately measuring the performance of fans when tested under standardised laboratory conditions. The ducting where specified ensures a fully developed symmetrical velocity profile at the fan inlet. There can also be sufficient straight ducting at the fan outlet to ensure efficient conversion of the distorted velocity profile at the fan outlet to a measurable stable and homogeneous profile at the measuring station.

This document shows how fan performance is affected by both inlet and outlet connections to it. System designers must not only look at the ideal performance curve and calculated system pressure drop but also take into account the losses at the entry and exit points of the fan. These are described in the document.

The concept of the system effect factor (SEF) was introduced to the fan industry by AMCA in 1973. Since its inception it has become widely accepted worldwide. In more recent years, it has been realized that the SEF depends not only on the fan type and the fitting geometry but also on the fan design and manufacturing. Some less efficient fans can sometimes be less sensitive to system effect induced by poor inlet flow conditions than more efficient fans of the same type.

Furthermore, the origin of the system effect induced by a fitting at the fan inlet is different from the one due to the same fitting located on the fan outlet. That is why two different definitions of SEF are proposed in this document according to whether the appurtenance is at the fan inlet or fan discharge.

Fans - — System effects and system effect factors

1 Scope

This document deals with the likely degradation of air performance of fans tested in standardized airways in accordance withaccording to ISO 5801 when compared with the performance of fans tested under actual site conditions. It deals with the performance of a number of generic types of fan and fittings. The results given are intended as guidelines and only provide trends, as the system effect depends on the exact geometry of the fan and disturbing component.

The test data presented in this document are taken from an extensive experimental program conducted 20- years ago by NEL (National Engineering Laboratory, UK), mainly on axial and centrifugal fans. Data are also taken from several research projects financially supported by ASHRAE, some of them being carried out in the AMCA laboratory in Chicago, as well as from results published previously by individual fan manufacturers.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and symbols

No terms and definitions are listed in this document.

ISO and IEC maintain terminologicalterminology databases for use in standardization at the following addresses:

— ——ISO Online browsing platform: available at https://www.iso.org/obphttps://www.iso.org/obp

— ——IEC Electropedia: available at http://www.electropedia.org/https://www.electropedia.org/

The following symbols are used:

Symbol	Description	SI units	I-P units
A_2	Fan outlet area	m^2	ft^2
C	System effect (SE) coefficient (see 5.2)5.2)	Dimensionless	Dimensionless
p_C	Conventional pressure loss (see 5.2)5.2)	Pa	in. wg
p_f	Fan pressure	Pa	in. wg
p_{fd}	Fan dynamic pressure (see Clause 4)Clause 4)	Pa	in. wg
p_{fs}	Fan static pressure	Pa	in. wg
p_{SE}	System effect (see 5.2)5.2)	Pa	in. wg
p_{SEo}	Additional pressure loss due to non-uniform flow (see 5.2)5.2)	Pa	in. wg
q_{V1}	Volume flow rate of the fan	m^3/s	cfm
S_{EF}	System effect factor	Dimensionless	Dimensionless
ξ ξ	Loss coefficient (see 5.1)5.1)	$(m^3/s)/(Pa^{0,5})$	
ρ	Density of air	kg/m^3	lbm/ft^2

Symbol	Description	SI units	I-P units
ρ_{std}	Standard air density	kg/m^3	lbm/ft^2
NOTE ~~—~~ The term “fan dynamic pressure” or “dynamic pressure” is used throughout this document and is equivalent to the term “velocity pressure” as used in some countries.			

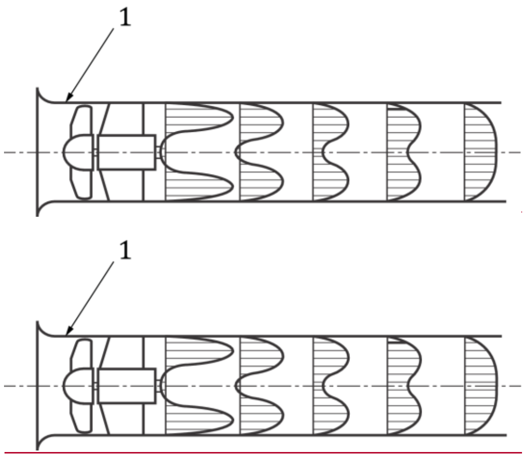
4 Origin of fan system effects

Manufacturers’ fan performance ratings are mostly based on tests carried out in a laboratory under ideal conditions. Ideal conditions refer to uniform, swirl-free air velocity profiles at fan inlet and outlet, like those of the test rigs described in ISO 5801 and AMCA 210. In ‘real life’ fan installations, it is possible that such ideal conditions ~~might~~are not ~~be~~ present due to improper connection of the fan to the system. Such improper connections include obstacles at fan inlets and outlets that alter the aerodynamic characteristics of the fan and lead to deficient performance in relation to catalogue ratings, even when the system pressure losses have been estimated accurately. The term “system effect” is a measure of this degradation of fan performance.

The origin of system effect is different at fan outlet and at fan inlet. At the fan outlet, for example in the case of an improperly connected outlet fitting such as an elbow, damper or duct branch, the system effect is linked to less-than-optimum non-uniform flow profiles induced by the fan at the entrance to the fitting ~~(Figure 1).~~(Figure 1). This degraded flow will create more pressure loss across the fitting than would be the case when measuring the fitting loss assuming uniform homogeneous flow profiles or when estimating it from standard handbooks such as the ASHRAE Handbook of Fundamentals~~[14].~~[14].

When the fitting is at the fan inlet, for example an elbow or a fan inlet duct/box ~~(Figure 2),~~(Figure 2), the velocity profiles at the inlet to the fitting can be uniform and the fitting pressure loss as measured or estimated from standard handbooks can be valid. However, the flow patterns at the fan inlet (or fitting outlet) can be disturbed with the presence of a vortex, spin or vena-contracta. This less than optimum flow condition at fan inlet caused by the fitting will lead to a reorganization of the flow inside the impeller and therefore a deterioration of fan performance in relation to catalogue ratings. Not only the fan curve can be affected by this disturbing obstacle but also sometimes, but not always, the fan power curve. A companion document will be drafted at a later date to show the influence of the inlet obstacles on the fan power curve for the same configurations of fans and fittings as in this document.

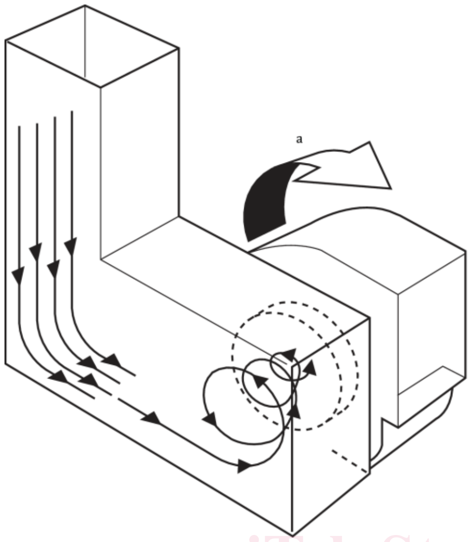
In both cases, the resulting air flow of the fan-system combination deteriorates, but for distinct physical reasons. For this reason, two different definitions and treatment of fan system effect are incorporated, depending on whether the fitting is at the fan inlet or fan outlet. It is also recognized that in some situations, obstacles very close to fan discharge (e.g. side walls at a short distance of a plenum fan impeller as shown in ~~Figure 20)~~Figure 20) can also deteriorate fan performance in the same manner as components located at fan inlet.

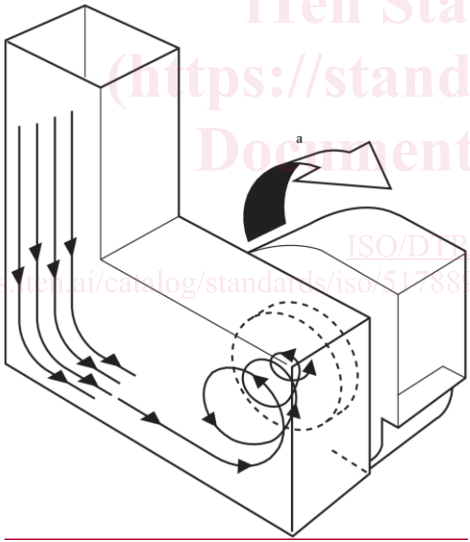


Key

1 axial fan

Figure 1 — Non-uniform velocity profiles at fan outlet

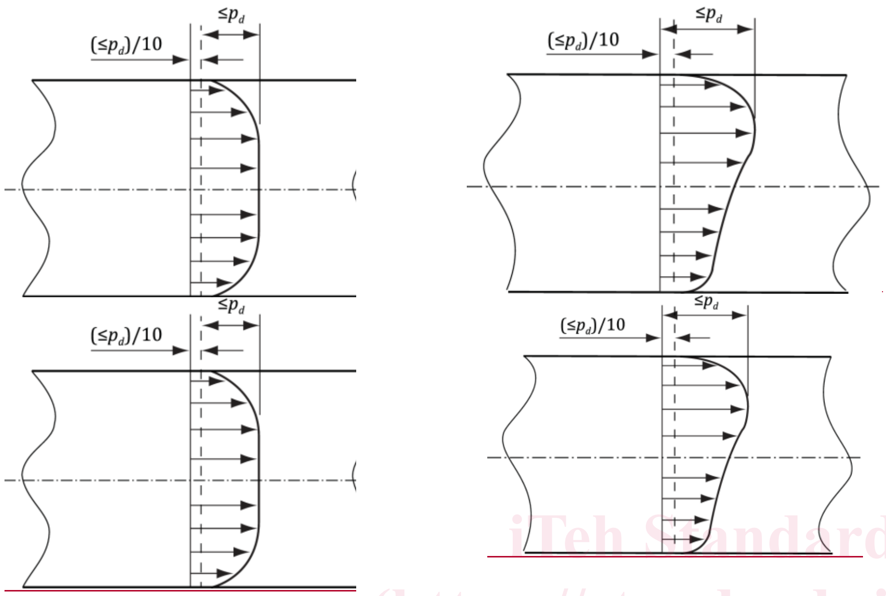




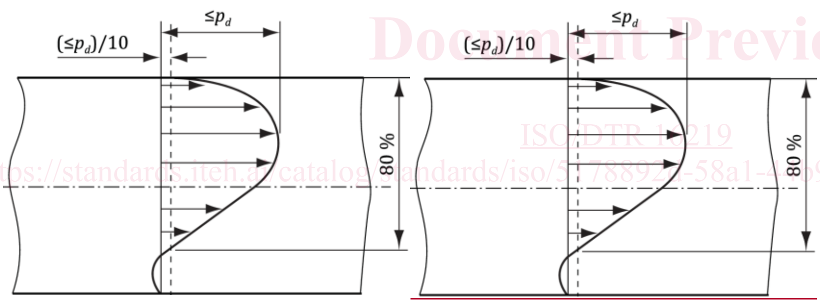
a Impeller rotation.

Figure 2 — Vortex at fan inlet

An ideal connection to a fan would be one which results in a velocity distribution across the fan inlet connection plane which is relatively uniformly distributed and without appreciable swirl component, as shown in ~~Figure 3.~~Figure 3.



a) Ideal p_d distribution b) Good p_d distribution[a]



c) Satisfactory p_d distribution[b]

Deleted Cells

Deleted Cells

Key

p_d mean dynamic pressure of the duct flow

[a] Also satisfactory for flow into fan inlets, but can be unsatisfactory for flow into inlet boxes, can produce swirl in boxes.

[b] More than 75 % of p_d readings greater than p_{dmax}/10 (unsatisfactory for flow into fan inlets of inlet boxes).

Figure 3 — Ideal fan connections