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AIR LEAKAGE RATE IN SHEET METAL AIR DISTRIBUTION SYSTEMS

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15 rue Montorgueil
F - 75001 PARIS

Tel 33.1.40.26.00.85
Fax 33.1.40.26.01.26

INTRODUCTION

This document concerns leakage rates in sheet metal air distribution ductwork. It is based on information derived from laboratory tests on such ductwork and also tests of complete air distribution systems assembled in accordance with good current practice.

During the preparation of this document, consideration was given to the standards of performance required in the various EUROVENT countries and in the USA.

Although leakage generally occurs only at seams and joints, for practical purposes the leakage flow rate is assumed in this document to be proportional to the surface area of the ductwork.

This document applies to the ductwork of the air distribution system between the air handling treatment plant and the air terminal devices, and gives a method of mesurement of leakage and an example of a test report sheet. The procedure described in this document are primarily intented for testing a complete or partially complete installation in site however provision is also made for laboratory Testing procedures.

The document has been prepared by Working Group 2 - Air Distribution and Air Diffusion - of the Technical commission of EUROVENT.

0 - DEFINITIONS

Symbol	Unit	Quantity	Formula
A	m^2	Surface area of ducting to be tested	-
q_{v1}	m^3s^{-1}	Leakage volume flow rate of ducting to be tested	-
p_{sm}	Pa	Arithmetical mean value of maximum and minimum values of static gauge pressure within the ducting to be tested	-
f	$m^3m^{-2}s^{-1}$	Leakage factor expressed as the air leakage rate per unit duct surface area	$\frac{q_{v1}}{A}$
q_v	m^3s^{-1}	System air flow rate	-
L		Leackage in % of system air flow rate	-
p_s	Pa	Value of test static gauge pressure	-

1. PURPOSE

It is generally accepted in practice that a degree of air leakage is usual in ductwork in a normal air distribution system. Airtight ducts may be required for distribution systems involving dangerous gases or contaminated air; such systems are outside the scope of this document.

It shoud be emphasised that damage to ductwork due to careless handling during transport or site storage and erection may significantly increase the leakage level.

An air leakage limit of a ductwork system is required for one or more of the following reasons:

a) to avoid the additional cost and wasteful use of energy resulting from the installation of oversized or inefficient plant,

b) to avoid the extra work and cost involved in achieving correct air distribution in cases where the ductwork has a high leakage rate,

c) to minimise the noise associated with air leakage.

2. LIMITATIONS OF VALIDITY

2.1 Experiments have indicated that, for a wide range of ductwork varying in sectional area, method of manufacture and sealing, and providing that the minimum static gauge pressure is not less than half the maximum static pressure, then $f.p^{0,65}$ is substantially constant within a range of normal conditions.

Therefore static gauge pressure testing of site installed ductwork can be accepted as a satisfactory test of acceptable leakage under operating conditions.

2.2 For normal ventilating and air-conditioning installations, three classes of air tightness, A, B, and C have been chosen for which the limits of leakage ($f.p^{0.65}$) are defined as :

Air tightness classes for installed duct testing :

Air tightness class	f_{max} $1.s^{-1}.m^{-2}$
A	$0.027.p^{0.65}$
B	$0.009.p^{0.65}$
C	$0.003.p^{0.65}$

Air tightness classes for laboratory duct testing :

Air tightness class	f_{max} $1.s^{-1}.m^{-2}$
A	$(0,027.p^{0.65}).0.5$
B	$(0.009.p^{0.65}).0.5$
C	$(0.003.p^{0.65}).0.5$

Maximum leakage rate for different installed duct test pressures :

Static gauge	Maximum leakage per class ($1.s^{-1}.m^{-2}$)		
	A	B	C
400	1.32	0.44	
1000		0.80	
1200			0.30
1500			0.35

Maximum leakage rate for different laboratory test duct pressures :

Static gauge	Maximum leakage per class ($1.s^{-1}.m^{-2}$)		
	A	B	C
400	0.66	0.22	
1000		0.40	
1200			0.15
1500			0.17

3. CHOICE OF AIR TIGHTNESS CLASS

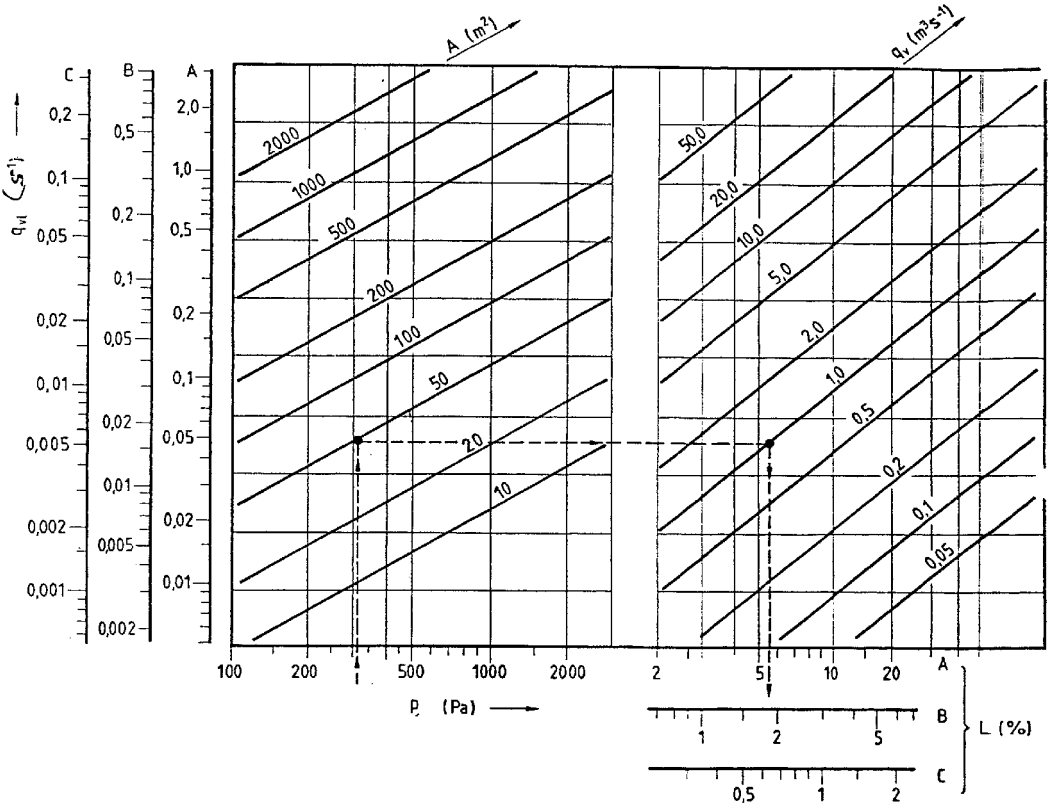
In order to assess permitted leakage it is useful to relate this to total air flow rate.

Fig. 1 can be used to assess this permitted leakage for systems in which all components of the ductwork are required to be of the same air tightness class.

From the parameters « mean pressure » (p_{sm}) and Surface Area of ducting (A) the permitted leakage rate for classes A, B and C can be obtained.

From the parameter « Air flow rate » (q_v), the leakage for classes A, B and C can be ascertained as a percentage air loss.

Table 1 - Value of the maximum leakage for the three classes at three typical test pressures



Symbol	QUANTITY
q_{vl}/m^2	Leakage volume flow rate of ducting to be tested
A	Surface area of ducting to be tested
q_v	System air flow rate
p_{sm}	Arithmetical mean value of static gauge pressures
L	leakage in % of system air flow rate

4. TESTING

4.1 Test Pressure

The test pressure for Class A or B ductwork should not exceed 1000 Pa or the maximum design static gauge duct pressure, whichever is the smaller.

In the case of Class C ductwork the test pressure can be increased to 2000 Pa.

Table 1 shows the value of the maximum allowed leakage rates for the three classes at typical test pressures for installed ducting.

Table 1

Class	Max. Leakage factor	Test static gauge pressure (p_s)			
	$m^3m^{-2}s^{-1}$	2000 Pa	1000 Pa	400 Pa	200 Pa
A	f_A	-	$2{,}4 \cdot 10^{-3}$	$1{,}32 \cdot 10^{-3}$	$0{,}84 \cdot 10^{-3}$
B	f_B	-	$0{,}8 \cdot 10^{-3}$	$0{,}44 \cdot 10^{-3}$	$0{,}28 \cdot 10^{-3}$
C	f_C	$0{,}42 \cdot 10^{-3}$	$0{,}28 \cdot 10^{-3}$	$0{,}15 \cdot 10^{-3}$	-

4.2 Test apparatus

The test apparatus shall consist of an appropriate fan, with pressure control and means of flow rate measurement, together with an airtight connection to the section of ductwork under test.

4.3 Test procedure

4.3.1 Before commencing the test, the sections to be tested shall be sealed off from the rest of the system.

For circular ducts shall at least 10 % of the total surface area of the system shall be tested, and for rectangular ducts at least 20 % shall be tested.

In either case the area to be tested shall normally be at least 10 m^2. A normal ratio between the total joint-/seamlength (L) and area (A) is L/A = 1,5 m^{-1}.

4.3.2 The section to be tested shall first be subjected to a pressure not less than its design operating pressure.

4.3.3 The static gauge pressure ps in the duct shall be maintained within 5 percent of the specified figure.

This pressure shall be kept constant for 5 minutes. No reading shall be recorded until this has been stabilised.

4.3.4 If the air leakage rate excess the permitted rate, the test shall be extended to include additional same percentage of the total surface area. If the air leakage still excess the permitted rate, the total surface area shall be tested.

4.4 Test report

For each section tested the values of q_{v1}, p_s and A shall be recorded together with the calculation of f . $p_{sm}{}^{+0,65}$.

The results shall then be compared with the specified leakage value.

A typical test report is attached as an annex.

ANNEX

AIR LEAKAGE TEST SHEET

Name of project .....

Building reference .....

Name of installer .....

Test personnel .....

Date of test .....

Test witnessed by .....

Design particulars

Ductwork (identify by drawing reference) .....

Air tightness classification (K_A, K_B or K_C) .....

Test apparatus

Identification of the test equipment used .....

TEST REPORT

Section of Duct	Measured Values			Calculated Values		Required Values
	A (m^2)	p_s (Pa)	q_{v1} ($m^3 s^{-1}$)	f $m^3 \cdot m^{-2} s^{-1}$	$f \cdot p_{sm}{}^{0,65}$ ($ms^{-1} Pa^{0,65}$)	K_A, K_B or K_C ($ms^{-1} Pa^{0,65}$)

LIST OF THE MEMBER ASSOCIATIONS

BELGIUM
FABRIMETAL
21 rue des Drapiers -
B-1050 BRUXELLES
Tel. 32/2/5102518 - Fax : 32/2/5102563

GERMANY
FG ALT im VDMA
Postfach 71 08 64 - D-60498 FRANKFURT AM MAIN
Tel. 49/69/6603 1227 - Fax : 9/69/6603 1218
E-mail: Lorenz_ALT@VDMA.org

SPAIN
AFEC
Francisco Silvela, 69-1°C - E-28028 MADRID
Tel. 34/1/4027383 - Fax : 34/1/4027638

FINLAND
AFMAHE
Etäläranta 10 - FIN-00130 HELSINKI
Tel. 358/9/19231 - Fax : 358/9/624462

FINLAND
FREA
P.O. Box 118
FIN-00811 HELSINKI
Tel : 358/9/759 11 66 - Fax : 358/9/755 72 46

FRANCE
UNICLIMA
F-92038 PARIS LA DEFENSE CEDEX
Tel : 33/1/47176292 - Fax : 33/1/47176427

GREAT BRITAIN
FETA (HEVAC and BRA)
Sterling House - 6 Furlong Road - Bourne End
GB-BUCKS SL 8 5DG
Tel : 44/1628/531186
Fax : 44/1628/810423
E-mail: info@feta.co.uk

ITALY
ANIMA - CO.AER
Via Battistotti Sassi, 11 - I-20133 MILANO
Tel : 39/2/73971 - Fax : 39/2/7397316

NETHERLANDS
NKI
Postbus 190 - NL-2700 AD ZOETERMEER
Tel: 31/79/353 12 59 - Fax : 31/79/353 11 15
E-mail: nki@fme.nl

NETHERLANDS
VLA
Postbus 190 - NL-2700 AD ZOETERMEER
Tel. 31/79/353 11 00 - Fax : 31/79/353 13 65
E-mail: vla@fme.nl

NORWAY
NVEF
Postboks 6697, St Olavs Plass –
0129 OSLO
Tel. 47/22202790 - Fax : 47/22202875

SWEDEN
KTG
P.O. Box 5510 - S-114 85 STOCKHOLM
Tel. 46/8/782 08 00 - Fax : 46/8/660 33 78
E-mail: bo.gostring@isab.postnet.se

SWEDEN
SWEDVENT
P.O. Box 175 37 - S-118 91 STOCKHOLM
Tel : 46/8/762 75 00 - Fax : 46/8/668 11 80

TURKEY
ISKID
ARCELIK A.S.
Klima Isletmesi
TR-81719 TUZLA ISTANBUL
Tel : 90/216 395 45 15
Fax : 90/216 423 23 59
E-mail: alatli@arcelik.com.tr