INTAS

Database and report on EN/IEC/ISO technical standards

Annex B: Large fans

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Industrial and tertiary product Testing and Application of Standard

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About the INTAS project

The aim of the INTAS project is to provide technical and cooperative support, as well as capacity building activities, to Market Surveillance Authorities (MSAs). The need for the INTAS project arises from the difficulty that MSAs and market actors face in establishing and verifying compliance with energy performance requirements for large industrial products subject to requirements of the Ecodesign Directive, specifically transformers and industrial fans. Therefore, the project aims to:

- Support European Member State MSAs deliver compliance for large products (specifically for transformers and large fans);
- Support industry to be sure of what their obligations are under the Ecodesign Directive and to deliver compliance in a manner that will be broadly accepted by MSAs;
- Foster a common European approach to the delivery and verification of compliance for these products.

List of project partners:

WIP Renewable Energies	Europe
European Environmental Citizens' Organisation for Standardisation	Europe
European Copper Institute	Europe
Engineering Consulting and Design	Europe
Waide Strategic Efficiency	Europe
Austrian Energy Agency	Austria
Federal Public Service Health, Foodchain, Safety and Environment	Belgium
SEVEn Energy Efficiency Center	Czech Republic
Danish Technological Institute	Denmark
Finnish Safety and Chemicals Agency	Finland
The Polish Foundation for Energy	Poland
Directorate General of Energy and Geology	Portugal
Romanian Regulatory Authority for Energy	Romania
Foundation for the Promotion of Industrial Innovation	Spain
Italian National Agency for New Technologies, Energy and Sustainable Economic Development	Italy
Food and Economic Safety Authority	Portugal

Annex B:
D2.1B Large fans testing worldwide and EU technical standard and legislation framework

B1. Introduction

This document is extracted from Deliverable 2.1 of the INTAS project, published in October 2016. The full document, entitled Database and report on EN/IEC/ISO technical standards, includes the present content focusing on technical standards applicable to large electrical fans, as well as Annex A, focusing on the standards applicable to power transformers. An introductory section on the main standardization organizations mentioned in this annex is also provided. The full report, separate annexes and related spreadsheet databases are publically available on the project website at http://intas-testing.eu/project-documents.

The present Annex B reports the results of the research carried out regarding large electrical fans (Group B) in Task 2.1 „Worldwide and EU Technical standard and legislative framework into the WP2 - Landscape of testing avenues“ of the INTAS project.

B2. Scope

This is the report of task 2.1.B for large fans: ***Worldwide and EU technical standard and legislation framework***

In this context, large fans are considered fans covered by Regulation (EU) No. 327 and with a power input of minimum 10 kW, but not larger than 500 kW.

In this Annex are identified the current ISO/EN/IEC/other technical standards and national EU legislative documents of interest for testing. A more detailed analysis is provided for the most relevant standards.

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B3. Technical standards

There are a large number of technical standards that are of importance/interest for testing energy performance of large fans. The most important standards are the international ISO standards, but also European or national standards.

B3.1 ISO standards

The ISO-standards listed in the following relate to performance testing of large fans. The standards are addressing issues such as test and rating methods for fans or systems incorporating a fan.

Table 1 – General ISO-standards relevant for testing of large fans

ISO 3258:1976	Air distribution and air diffusion — Vocabulary
ISO 7807:1983	Air distribution — Straight circular sheet metal ducts with a lock type spiral seam and straight rectangular sheet metal ducts — Dimensions
ISO 13349:2010	Fans — Vocabulary and definitions of categories
ISO 13351:2009	Fans — Dimensions
ISO 14617-9:2002	Graphical symbols for diagrams — Part 9: Pumps, compressors and fans

Table 2 – ISO-standards addressing performance testing of large fans

ISO 5221:1984	Air distribution and air diffusion — Rules to methods of measuring air flow rate in an air handling duct
ISO 5801:2007/ Cor 1:2008	Industrial fans — Performance testing using standardized airways
ISO/DIS 5801:2014	Fans — Performance testing using standardized airways
ISO 5802:2001/ Amd 1:2015	Industrial fans — Performance testing in situ
ISO 13350:2015	Fans — Performance testing of jet fans
ISO 12759:2010	Fans — Efficiency classification for fans
ISO/NP 12759-2	Fans — Efficiency classification for fans — Part 2: Part load determination
ISO/NP 12759-3	Fans — Efficiency classification for fans — Part 3: Non driven fans at maximum operating speed, impeller only
ISO/NP 12759-4	Fans — Efficiency classification for fans — Part 4: Driven fans at maximum operating speed
ISO/NP 12759-5	Fans — Efficiency classification for fans — Part 5: Jet fan
ISO/NP 12759-6	Fans — Efficiency classification for fans — Part 6: Fan efficiency ratio
ISO 13348:2007	Industrial fans — Tolerances, methods of conversion and technical data presentation

B3.2 EN standards

The EU has chosen to adopt all the ISO-standards listed in table 1-1. The only difference is that the European Standard (EN) adoptions have later issue dates than the ISO-standards. The member states in the EU have also chosen to adopt all the ISO-standards listed in table 1-1.

Example: ISO 5801:2007, EN ISO 5801:2008, DS/EN ISO 5801:2009 (Danish standard)

The EU has a relevant standard EN 13779:2007 "Ventilation for non-residential buildings – Performance requirements for ventilation and room-conditioning systems", which is not an adapted standard.

B3.3 IEC standards

IEC 60034 is an international standard of the International Electrotechnical Commission for rotating electrical machinery. In table 1-3, the most important parts of the standard regarding electric motors for large fans are listed. The not yet published standard IEC 61800-9-2 "Ecodesign for power drive systems, motor starters, power electronics & their driven applications" is also listed in the table.

Table 3 – IEC-standards addressing performance testing of electrical motors (for large fans)

IEC 60034-1:2010	Rotating electrical machines - Part 1: Rating and performance
IEC 60034-2-1:2014	Rotating electrical machines - Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)
IEC 60034-2-2:2010	Rotating electrical machines - Part 2-2: Specific methods for determining separate losses of large machines from tests - Supplement to IEC 60034-2-1
IEC TS 60034-2-3:2013	Rotating electrical machines - Part 2-3: Specific test methods for determining losses and efficiency of converter-fed AC induction motors
IEC TS 60034-25:2014	Rotating electrical machines - Part 25: AC electrical machines used in power drive systems - Application guide
IEC TS 60034-30:2014	Rotating electrical machines - Part 30-1: Efficiency classes of line operated AC motors (IE code)
IEC TS 60034-31:2010	Rotating electrical machines - Part 31: Selection of energy-efficient motors including variable speed applications - Application guide
IEC 60034-30-2	Efficiency classes of variable speed AC motors (expected to be published in 2016/17)
IEC 61800-9-2	Ecodesign for power drive systems, motor starters, power electronics & their driven applications - Energy efficiency indicators for power drive systems and motor starters (expected to be published in 2016/17)

B3.4 IEEE standards

The Institute of Electrical and Electronics Engineers (IEEE) has a number of technical standards related to performance testing of electrical motors (for large fans). In table 1-4, the most important standards are listed.

Table 4 – IEEE-standards addressing performance testing of electrical motors (for large fans)

P112 – D5, October 2015	IEEE Draft Standard for Standard Test Procedure for Polyphase Induction Motors and Generators
112-2004	IEEE Standard Test Procedure for Polyphase Induction Motors and Generators
62.2-2004	IEEE Guide for Diagnostic Field Testing of Electric Power Apparatus - Electrical Machinery

B3.5 AMCA standards

AMCA is the Air Movement and Control Association, which is a not-for-profit association of the world's manufacturers of fans, louvers, dampers, air curtains, airflow measurement devices, ducts, acoustic attenuators and other air system components. AMCA was founded in the United States, but they have expanded to be truly international. AMCA is now represented in several regions, with 350 member companies in 34 countries. Asia AMCA operates out of Malaysia and European AMCA operates out of Brussels. A Middle East AMCA is in the process of formation, and it will operate out of Dubai.

In 2010, AMCA published the first version of a fan efficiency-rating standard, AMCA 205 Energy Efficiency Classification for Fans. AMCA 205 has since become the reference standard for minimum fan efficiency requirements in

- ASHRAE 90.1-2013
- International Green Construction Code 2012
- International Energy Conservation Code 2015

AMCA 205 defines how to rate fan efficiency independent of motors and drives using a calculated index called a Fan Efficiency Grade (FEG).

AMCA 205 also prescribes that fans be sized and selected such that all operating points are within 15 percentage points of the fan's rated peak total efficiency. All model codes and standards referenced above prescribe minimum FEGs and sizing/selection windows.

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The AMCA 205 refers to a number of established test standards listed below:

- ANSI/AMCA 210 (ANSI/ASHRAE 51), Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
- ANSI/AMCA 230, Laboratory Methods of Testing Air Circulating Fans for Rating and Certification
- AMCA 260, Laboratory Methods of Testing Induced Flow Fans for Rating

AMCA 203-90 (R2011) - Field Performance Measurement of Fan Systems

Field Performance Measurements of Fan Systems reviews the various problems of making field measurements and calculating the actual performance of the fan and system.

AMCA 803-02 (R2008) - Industrial Process/Power Generation Fans: Site Performance Test Standard

This standard establishes uniform methods to be used in measuring the aerodynamic performance of industrial process or power generation fans under actual operating conditions on the site. The standard also defines rules for converting the measured performance to other specified operating conditions.

B3.6 ASHRAE standards

ASHRAE stands for the American Society of Heating, Refrigerating and Air-Conditioning Engineers. Founded in 1894, it is a global society advancing human well-being through sustainable technology for the built environment. The Society and its more than 50.000 members worldwide focus on building systems, energy efficiency, indoor air quality, refrigeration and sustainability.

ASHRAE publishes a well recognized series of standards and guidelines relating to HVAC systems and issues. These standards are often referenced in building codes, and are considered useful standards for use by consulting engineers, mechanical contractors, architects, and government agencies.

One of the standards is ASHRAE 90.1-2013. The purpose of this standard is to establish the minimum energy efficiency requirements of building design and construction, other than low-rise residential buildings.

In section 6.5.3.1.3 “Fan Efficiency” it is stated that fans shall have a fan efficiency grade (FEG) of 67 or higher based on manufacturers’ certified data, as defined by AMCA 205. The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan.

B3.7 SEAD standards

The Super-efficient Equipment and Appliance Deployment (SEAD) Initiative is a voluntary collaboration among governments working to promote the manufacture, purchase, and use of energy-efficient appliances, lighting, and equipment worldwide. SEAD is an initiative under the Clean Energy Ministerial (CEM) and a task of the International Partnership for Energy Efficiency Cooperation (IPEEC).

SEAD's 17 participating governments collaborate to accelerate and strengthen the design and implementation of appliance energy efficiency policies and related measures. The SEAD Initiative supports this effort by:

- Providing knowledge and tools that help impact policy change
- Raising awareness about the importance of increasing the efficiency of common appliances and equipment
- Identifying and highlighting technologies that will save energy
- Providing technical expertise and best practices to stakeholders

SEAD member governments include Australia, Brazil, Canada, Chile, the European Commission, Germany, India, Indonesia, Japan, Korea, Mexico, Russia, South Africa, Sweden, the United Arab Emirates, the United Kingdom and the United States.

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B4. Main standard contents

B4.1 ISO standards

B4.1.1 ISO 5801

Title - Industrial fans — Performance testing using standardized airways

This standard deals with the measurements of the performance of fans of all types except those designed solely for air circulation, for example, ceiling fans and table fans. Estimates of uncertainty of measurement are provided and rules for the conversion, within specified limits, of test results for changes in speed, produced gas and, in the case of model tests, size, are given.

Essential features of this standard are as follows:

a) Categories of installation. Since the connection of a duct to a fan outlet or inlet modifies its performance, it has been agreed that four standard installation categories should be recognized. A fan adaptable to more than one installation category will have more than one standardized performance characteristic. Users should select the installation category closest to their application.

b) Common parts. The differences obtained by testing the same fan according to various test codes depend chiefly on the flow pattern at the fan outlet and, while often minor, can be of substantial significance. There is general agreement that it is essential that all standardized test airways to be used with fans have common parts adjacent to the fan inlet and/or outlet sufficient to ensure consistent determination of fan pressure. Geometric variations of these common parts are strictly limited.

c) Calculations. Fan pressure is defined as the difference between the stagnation pressure at the outlet of the fan and the stagnation pressure at the inlet of the fan. The compressibility of air must be taken into account when high accuracy is required. However, simplified methods may be used when the reference Mach number does not exceed 0,15. A method for calculating the stagnation pressure and the fluid or static pressure in a reference section of the fan, which stemmed from the work of the ad hoc group of Subcommittee 1 of ISO/TC 117, is given in Annex C. Three methods are proposed for calculation of the fan power output and efficiency. All three calculation methods give very similar results (difference of a few parts per thousand for pressure ratios equal to 1,3)

d) Flow rate measurement. Determination of flow rate has been completely separated from the determination of fan pressure. A number of standardized methods may be used

B4.1.2 ISO 5802:2001

Title: Industrial fans — Performance testing in situ

Of special importance might be ISO 5802:2001 specifying tests for determining one or more performance characteristics of fans installed in an operational circuit when handling a monophase fluid.

The method for performance testing in situ is dealt with separately from the tests using standardized airways (see ISO 5801) in this independent document.

A detailed description of the velocity area methods for all commonly encountered airway cross-sections is provided. This standard also contains annexes describing the selection of suitable measuring stations and instrument calibration. It should be recognized that the performance of a fan measured under site conditions will not necessarily be the same as that determined from tests using standardized airways. The reasons for such differences are not only due to the inherently lower accuracy of a site test, but also due to the so-called "system effect factor" or "installation effect", where the ducting connections at fan inlet and/or outlet modify its performance. The need for good connections cannot be understated. The standard specifies the use of "common parts" immediately adjoining the fans and ensures that air/gas is presented to the fan as a symmetrical velocity profile free from swirl and undue distortion. Only if these conditions are met, will the performance under site conditions equate with those measured in standardized airways.

The standard specifies the positioning of velocity-area measuring points according to log-Tchebycheff or log-linear rules. Arithmetic spacing can lead to considerable error unless a very high number of point readings are taken. This standard does not cover the assessment of the additional uncertainty where the lengths of straight duct either side of the measuring station are less than those specified in Annex C. ISO 5168 and ISO 7194 contain methods from which it will be seen that where a significant radial component exists, uncertainties can considerably exceed the normally anticipated 4 % at 95 % confidence levels.

B4.1.3 ISO 12759:2010

Title: Fans — Efficiency classification for fans

ISO 12759:2010 specifies requirements for classification of fan efficiency for all fan types driven by motors with an electrical input power range from 0,125 kW to 500 kW. It is applicable to (bare shaft and driven) fans, as well as fans integrated into products. Fans integrated into products are measured as stand-alone fans.

ISO 12759:2010 is a standard, which in details describes the contents in the COMMISSION REGULATION (EU) No 327/2011 of 30 March 2011 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW.

B4.2 EN standards

B4.2.1 EN 13779:2007

Title: Ventilation for non-residential buildings – Performance requirements for ventilation and room-conditioning systems

EN 13779:2007 "Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems" provides design guidelines for ventilation and room-conditioning systems in non-residential buildings. Looks at the mechanical supply and exhaust ventilation systems and mechanical elements of hybrid ventilation systems, concentrating on principles, characteristics, requirements, operation and maintenance aspects.

B4.3 AMCA standards

B4.3.1 AMCA 205

Title: Energy Efficiency Classification for Fans

AMCA Standard 205, Energy Efficiency Rating for Fans, is a standard referenced by major energy efficiency and green construction codes and standards, such as 2012 International Green Construction Code (IgCC) and ANSI/ASHRAE/IES Standard 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings, etc.

AMCA 205 has two major parts. First, it defines a new fan efficiency metric - fan efficiency grade (FEG). It was realized by the industry that a fan energy efficiency threshold would be difficult to define as efficiency depends on fan diameter and other factors. For example, many types of fans with a diameter less than 20 inch cannot meet the 65% efficiency requirement. The new FEG metric is a dimensionless index calculated based on fan-rating test data.

Second, AMCA 205 stipulates that fans should be sized and selected to operate within 15% points of the fan's rated peak total efficiency. In order to reduce fan energy consumption, rightsizing fans is equally important as regulating the fan FEG level.

AMCA 205 helps regulators to develop enforceable fan requirements in the model codes and standards based on two-part fan-efficiency provisions: the minimum fan aerodynamic efficiency requirement and the sizing/selection window of the fan operating point relative to the fan's rated peak total efficiency.

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B4.4 ANSI/AMCA 210

Title - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating

This standard establishes uniform methods for laboratory testing of fans and other air moving devices to determine aerodynamic performance for rating or guarantee purposes in terms of airflow rate, pressure, power, air density, speed of rotation, and efficiency.

It is not the purpose of this standard to specify the testing procedures to be used for design, production, or field testing.

The standard may be used as the basis for testing fans, blowers, exhausters, compressors, or other air moving devices when air is used as the test gas.

B4.5 AMCA 203

Title - Field Performance Measurement of Fan Systems

AMCA Publication 203 is a general purpose guide for the measurement of fan performance. This guide is applicable to most air handling equipment installed in any system. It includes the calculation process for loss in performance due to system effects and methods for calculating test results and uncertainties. A wealth of reference material and examples of typical applications pointing out where difficulties may be encountered are included.

B4.6 AMCA 803-02 (R2008)

Title - Industrial Process/Power Generation Fans: Site Performance Test Standard

This standard was written specifically for fans in industrial processes or power generation. It is a bit more complicated and time consuming than the method in AMCA Publication 203, but it also yields results with lower uncertainties.

When testing any fan in the field, the overall system must be carefully taken into consideration to accurately determine where the measurements will be taken and if there are any system elements that may negatively affect the fan performance.

B4.7 IEC standards

B4.7.1 IEC 60034-30-1:2014

Title - Rotating electrical machines - Part 30-1: Efficiency classes of line operated AC motors (IE code)

The standard defines four IE (International Efficiency) efficiency classes for single speed electric motors that are rated according to IEC 60034-1 or IEC 60079-0 (explosive atmospheres) and designed for operation on sinusoidal voltage.

- Super-Premium efficiency, IE4
- Premium efficiency, IE3
- High efficiency, IE2
- Standard efficiency, IE1

An IE5 level is envisaged for a future revision, with the goal of further reducing losses by some 20% relative to IE4.

The new standard covers a wider scope of products. The power range has been expanded to cover motors from 120 W to 1000 kW. All technical constructions of electric motors are covered as long as they are rated for direct on-line operation. The coverage of the new standard includes:

- Single speed electric motors (single and three phase), 50 and 60 Hz
- 2, 4, 6 or 8 poles
- Rated output PN from 0.12 kW to 1000 kW
- Rated voltage UN above 50 V up to 1 kV
- Motors, capable of continuous operation at their rated power with a temperature rise within the specified insulation temperature class
- Motors, marked with any ambient temperature within the range of -20 °C to +60 °C
- Motors, marked with an altitude up to 4000 m above sea level

The efficiency levels defined in IEC 60034-30-1 are based on the low uncertainty test methods specified in IEC 60034-2-1, which has been updated to edition 2.0, 2014-06.

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B4.8 IEC 60034-2-1:2014

Title - Rotating electrical machines - Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)

The efficiency of a motor is defined as the ratio of output (mechanical) power to input (electrical) power. Determination can be done by using direct or indirect method.

Direct method simply requires a measurement of the input power by means of a power analyzer and the output power by means of the rotational speed and torque applied to a motor.

Indirect measurement is based on the loss segregation method leading to the sum of losses ie. total losses, calculated in each six load point as defined in the standard.

Total losses are then subtracted from the input power thus giving the output power used for the determination of the efficiency in each load point.

Motor losses can be divided in the following groups:

- Load losses that are of stator winding and rotor losses
- Iron losses
- Friction and windage losses
- Additional load losses (stray load losses)

Of these, the first four types of loss can be determined from input power, voltage, current, rotational speed and torque. Additional load losses are determined from the residual losses that are defined from the partial load tests.

The major changes in the edition 2.0 vs. edition 1.0 are related to improving the uncertainty and accuracy of testing. Major changes as below:

- Preferred testing methods defined for specific rating and type of machines
- Some refined requirement for the instrumentation and accuracy
- Specific test sequence for tests to be performed and introduced for the first time
- Small changes in the formulas for the loss calculations

As a whole these improvements do not make any big change in the loss calculation and efficiency determination when comparing edition 2.0 and edition 1.0, but the new edition makes testing more reliable and test results more comparable.

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B4.9 IEC TS 60034-31:2010

Title - Rotating electrical machines - Part 31: Selection of energy-efficient motors including variable speed applications - Application guide

The recognition that in a motor driven application inefficiencies are present throughout the entire system (power supply, electric motor, speed controls, mechanical transmission, end-use device, etc.), and are influenced by diverse factors, such as maintenance practices, load management, intensity of use, etc. led to this standard called "Selection of energy efficient motors including variable speed applications - Application guide, 2010".

The standard is intended to help manufactures, end-users, regulators, and other interested parties, with application issues regarding the use of energy-efficient motors and motor systems

B4.10 IEEE standards

B4.10.1 IEEE 112-2004

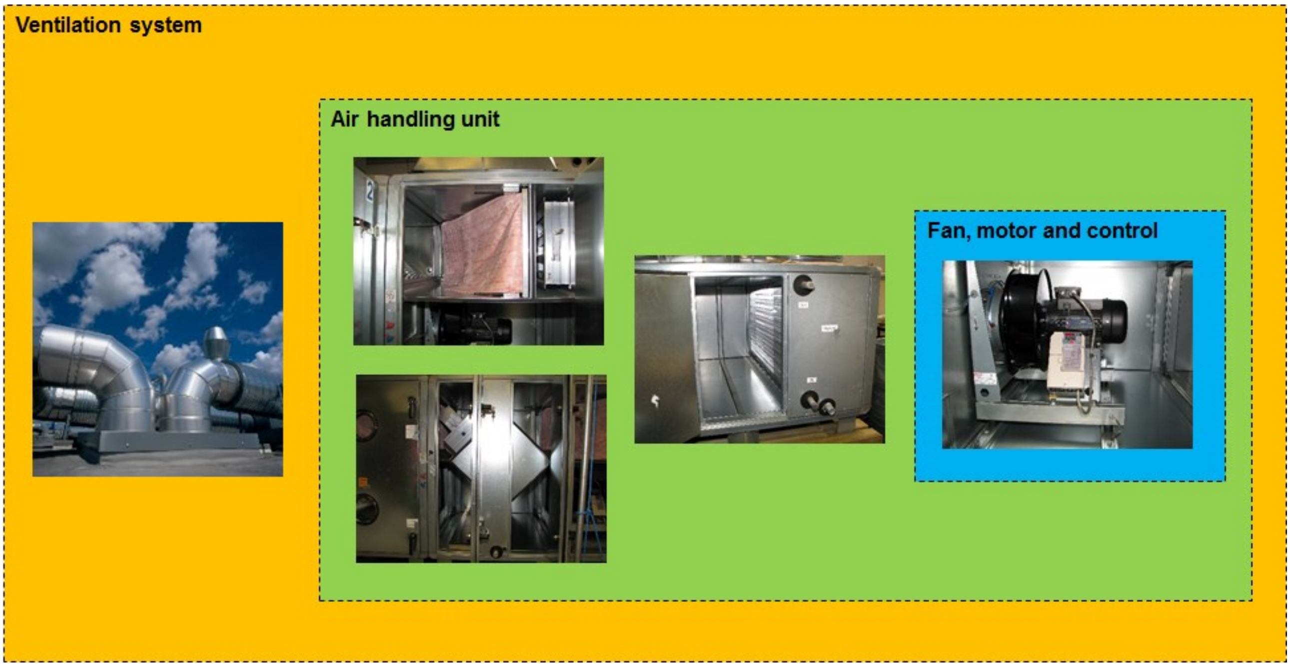
Title: Standard Test Procedure for Polyphase Induction Motors and Generators

This standard covers instructions for conducting and reporting the more generally applicable and acceptable tests of polyphase induction motors and generators. Many of the tests described may be applied to both motors and generators, as needed, and no attempt is made to partition the test procedure into clauses and subclauses that separately apply to motors or to generators. Whenever the term motor is used, it is to be understood that it may be replaced by the term generator, if applicable. Likewise, whenever machine is used, it may be replaced by either motor or generator, if applicable. Since polyphase power systems are almost universally three-phase systems, the equations in this standard have been written specifically for three phases. When the test is performed on other than three-phase power, the equations shall be modified appropriately.

B5. Legislative documents

B5.1 EU legislative documents

Several national EU legislative documents have an impact on the large fans including electric motors considered in this document. Some of the documents are dealing specifically with fan, motor and control while others are dealing with the air-handling unit. Furthermore, some of the documents are dealing with the whole ventilation system (fan, motor and control plus components and ducting system).



B5.1.1 Legislation and agreements at European community level

In December 2002, the Energy Performance of Buildings Directive (EPBD) was adopted by the European Parliament and the European Council with the aim to lay down more concrete actions and with a view to achieving the great unrealised potential for energy savings while reducing the large differences between Member States in this sector. The EPBD acts as the main legislative instrument to promote the improvement of the overall energy performance of buildings in the EU.

On 19 May 2010, the Council of the European Union and European Parliament adopted a recast of the Energy Performance of Buildings Directive in order to strengthen the energy performance requirements of buildings.

Under the Energy Performance of Buildings Directive:

- Energy performance certificates are to be included in all advertisements for the sale or rental of buildings
- EU countries must establish inspection schemes for heating and air conditioning systems or put in place measures with equivalent effect
- All new buildings must be nearly zero energy buildings by 31 December 2020 (public buildings by 31 December 2018)
- EU countries must set minimum energy performance requirements for new buildings, for the major renovation of buildings and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls, etc.)
- EU countries have to draw up lists of national financial measures to improve the energy efficiency of buildings

The second bullet above is interesting regarding testing of fans and ventilations units. In relation to the EBPD, the standards listed below are relevant.

Table 5 – Standards related to the EBPD

Ref.	Title
EN 13779	Ventilation for non-residential buildings – Performance requirements for ventilation and room-conditioning systems
EN 15239	Guidelines for inspection of ventilation systems
EN 15240	Ventilation for Buildings – Energy performance of buildings - Guidelines for inspection of air-conditioning systems

Table 6 – Legislation and agreements at European community level

Ref.	Title
Commission regulation (EU) No 327/2011 of 30 March 2011	Commission regulation implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW, OJ.L 90, 8. 6.4.2011
Ecodesign Fan Review	Review study of Commission Regulation (EU) No 327/2011. Final report. The purpose of the study was to provide background information to the Commission in relation to the revision of Commission Regulation 327/2011 with regard to ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW
Commission regulation (EU) No 1253/2014 of 7 July 2014	Commission regulation implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for ventilation units
Commission regulation (EC) No 640/2009 of 22 July 2009	Commission regulation implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors
Commission regulation (EU) No 4/2014 of 6 January 2014	Commission regulation amending Regulation (EC) No 640/2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors
Corrigendum to Commission Regulation (EC) No 640/2009 of 22 July 2009	Corrigendum implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors

B5.1.2 Legislation at member state level

In the Ecodesign Fan Review (10th of March 2015) it is stated that there virtually is no market surveillance by member states.

There has been no compliance testing on industrial fans by market surveillance authorities in the member states. Some countries like Denmark and Sweden are in preparation, but mainly the activity is limited to document inspection.

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In the Ecodesign Fan Review the Swedish Energy Agency, who is the surveillance authority in Sweden, reports that ‘the issue of responsibility of the fans is of outmost importance for market surveillance. Monitoring and verification of products under any ecodesign regulation, e.g. by testing products, is of very little use if the regulation is not enforceable. For the regulation to be enforceable, it must be perfectly clear in who to address in case on suspected non-compliance, i.e. which economic operator is legally responsible for the non-compliant fan. Document inspection is the only kind of market surveillance that has been performed.

According to the Ecodesign Fan Review, the fan industry signals and regrets the lack of market surveillance, but offers no real solution to the lack of funding at MS-level that most certainly is one of the causes. The associations are, however, resolute in their statement that third party certification (TPC) is not the answer. It would not, according to them, solve the problem of free-riders but instead would just create a lot of administrative burden.

Manufacturers think that for effective market surveillance also the availability of test facilities is problematic and suggested a collaboration, possibly perhaps the use of their certified laboratories.

B5.1.2.1 Denmark

In addition to the demands in the EU Directives, concerning fans and electric motors, Denmark has its own national Building Regulations. In the Building Regulations, there are demands for total system efficiency also named the specific fan power (SFP). The specific fan power gives the specific energy consumption of the fan per volume of air delivered. As pressure losses in the system and losses related to the motor or the control system are accounted for in the specific value, the SFP is a good energy indicator for the whole system but does not necessarily give an indication of the efficiency of the fan used.

The SFP can be expressed as:

$$SFP = \frac{P_{fan,in} + P_{fan,out}}{V_{total}} = \left[\frac{W}{m^3/s}\right]$$

Table 7 – Danish Building Regulations concerning ventilation systems

Ventilation system	SFP [W/m^3/s]
CAV (Constant Air Volume)	1.800
VAV (Variable Air Volume)	2.100
Only exhaust (without mechanical air supply)	800

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The provision does not apply to installations linked to industrial processes and installations whose annual electricity consumption for air transport is less than 400 kWh.

B5.1.2.2 UK

In the Non-Domestic Building Services Compliant Guide, there are demands for maximum specific fan powers (SFP) in air distribution systems in new and existing buildings. Relevant demands, in relation to large fans, are listed in table 1-7.

Table 8 – Non-Domestic Building Services Compliant Guide in the UK

Ventilation system	New buildings [W/l/s]	Existing buildings [W/l/s]
Central mechanical ventilation system including heating and cooling	1,8	2,2
Central mechanical ventilation system including heating only	1,6	1,8
All other mechanical ventilation systems	1,4	1,6

B5.1.2.3 Germany

The German EnEv [EnEv, 2013] also uses the SFP for supply and exhaust air plant without heating and cooling and for plants with controlled airconditioning.

Table 9 – German EnEv, 2013

Ventilation system	SFP [kW/m^3/s]
Supply air fan	1,5
Exhaust air fan	1,0

B5.1.2.4 Other countries

Other countries like Sweden and Finland also have their own national Building Regulations with demands for total system efficiency. These demands do not differ substantially from the demands shown above.

The demands in the various national Building Regulations is an effective mean towards the use of effective fans, but it cannot be used directly to evaluate the efficiency of fans. By measuring specific fan powers, it is only possible to estimate efficiencies of fans.

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Third country legislation

B5.1.3 United States

ASHRAE 90.1 has been a benchmark for commercial building energy codes in the United States for more than 35 years.

It is a standard that provides the minimum requirements for energy-efficient design of most buildings, except low-rise residential buildings. It offers, in detail, the minimum energy-efficient requirements for design and construction of new buildings and their systems, new portions of buildings and their systems, and new systems and equipment in existing buildings, as well as criteria for determining compliance with these requirements.

Many states apply ASHRAE 90.1 to buildings being constructed or under renovation. Most states apply the standard or equivalent standards for all commercial buildings. Others apply the standard or equivalent standards for all government buildings. There are some states that use other energy conservation standards for all commercial buildings and some other states that use a combination of the ASHRAE 90.1 standard for all government buildings and use other energy conservation standards for their commercial buildings. A few states do not apply any energy conservation standards for their government and commercial buildings.

Current status of adoption into energy codes is tracked by the Building Codes Assistance Project. As of January 2014, 6 states have codes which meet or exceed ASHRAE Standard 90.1-2010 (WA, MT, IL, MS, RI, MD). 36 states have codes which meet or exceed ASHRAE Standard 90.1-2004, and 9 states have either no code or a code which precedes 90.1-2004. California has an energy code (CCR Title 24 Part 6), which has a very similar structure and requirements.

ASHRAE 90.1 is also an industry standard referenced by the U.S. Green Building Council (USGBC) in the LEED building certification program (third-party verification system for sustainable structures around the world). It is frequently used as a baseline for comparison during energy retrofit projects or any project that employs building energy simulation.

Chapter 6.5.3.1.3 “Fan Efficiency” in the standard deals with fan efficiency. Fans shall have a fan efficiency grade (FEG) of 67 or higher based on manufacturers’ certified data, as defined by AMCA 205. The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan.

The U.S. Department of Energy (DOE) has completed a provisional analysis of the potential economic impacts and energy savings that could result from promulgating an energy conservation standard for commercial and industrial fans and blowers. This analysis incorporates information and comments received after the completion of an analysis presented in a notice of data availability (NODA) published in December 2014. At this time, DOE is not proposing an energy conservation standard for commercial and industrial fans and blowers. This analysis may be used in support of the Appliance Standards Federal Rulemaking Advisory Committee (ASRAC) commercial and industrial fans working group negotiations to develop a recommendation for regulating commercial and industrial fans. DOE encourages stakeholders to provide any additional data or information that may improve the analysis and to present comments submitted to this NODA and to the NODA published in December 2014 to the working group.

B5.1.4 Canada

Canada's Energy Efficiency Act provides for the making and enforcement of regulations concerning minimum energy performance levels for energy-using products, as well as the labelling of energy-using products and the collection of data on energy use.

The Energy Efficiency Regulations establish energy efficiency standards for a wide range of energy-using products, with the objective of eliminating the least energy-efficient products from the Canadian market.

Fans are not among the wide range of energy-using products regulated for energy efficiency in Canada.

B5.1.5 Australia and New Zealand

Fans are not currently regulated for energy efficiency in Australia and New Zealand.

A range of options for driving improvements to the energy efficiency of new fans sold, including possible regulations, are discussed in three Product Profiles which were released by the E3 Committee for public comment in 2012.

The Product Profiles cover both Non-Domestic Fans (driven by an electric motor with power input of 125 W to 500 kW) which are used in industrial and commercial applications, and Small Fan Units (driven by a motor with a power input less than 125 W)

This work on fans follows a Discussion Paper on Industrial Equipment which was released by the E3 Committee in 2010. It identified fans as one of the high priority products for further consideration. The draft 'In from the Cold Strategy' also proposed MEPS regulations for fan motors used in some refrigeration applications.

This work has also been prompted by developments in the European Union, where minimum energy performance regulations for fan units with an input power in the range of 125 W to 500 kW were introduced in 2013 and made more stringent in 2015.

Relevant documents include:

- Discussion Paper: Improving the Energy Efficiency of Industrial Equipment
- Report: In From the Cold – Strategies to Increase Energy Efficiency of Non-domestic Refrigeration in Australia
- Report: In from the Cold – Background Technical Report Volume 1

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- Report: In from the Cold – Background Technical Report Volume 2 »

A Regulation Impact Statement considering policy options for increasing the energy efficiency of new fan-units (fan plus electric motor combination) sold into the Australian and New Zealand markets, including regulatory options, is currently under preparation and is expected to be released for consultation around the middle of 2016.

http://www.energyrating.gov.au/products/fans

https://www.environment.gov.au/climate-change/emissions-reduction-fund/publications/factsheet-emissions-reduction-fund-helping-improve-energy-efficiency

https://www.legislation.gov.au/Details/F2015L01712

B5.1.6 Brazil

The technical standards
Within the Brazilian Association for Technical Standards – ABNT (www.abnt.org.br), there are two Committees addressing the standardization of ventilators: the Brazilian Committee for Machinery and Mechanic Equipment (ABNT/CB-004), and the Brazilian Committee for Cooling, Air Conditioning, Ventilation and Heating (ABNT/CB-055).

However, in the case of large ventilators and for standard testing purposes, the ISO and AMCA standards are adopted. Those standards are described elsewhere in this Deliverable D.2.1.

The scope of the ABNT/CB-004 is the following: Standardization in the field of machinery and mechanical equipment, including machine tools; tools and devices; mechanical parts; transmission movements; measuring systems and mechanical quality control ; compressors; hydraulics and pneumatics; refrigeration and industrial ventilation; valves and components; elevators and material handling equipment; thermodynamics; pumps and motor pumps; tools and modeling; machines for printers, wood, ceramics, plastics, food industry and leather and footwear; machinery and equipment for textile industry, basic and environmental sanitary equipment, and leisure parks; agricultural machinery; heavy machinery and equipment, and basic standards for mechanical design regarding namely terminology, and testing methods.

The scope of the ABNT/CB-055 is the following: Standardization in the field of refrigeration, air conditioning, ventilation and heating comprising commercial and industrial refrigeration, commercial and industrial air conditioning, commercial and industrial ventilation and conventional and solar heating; machinery, equipment and systems performance and testing; systems design, implementation and maintenance; preservation of perishable food; human comfort; air quality and energy conservation in commercial and industrial environments.

The IPT: Institute for the Technological Research (Instituto de Pesquisas Tecnológicas)

The IPT is a research Infrastructure attached to the Secretary of Economic Development, Science, Technology and Innovation at the Federal State of S. Paulo (www.ipt.br). It acts as an independent testing laboratory. Therein, two infrastructures have to be referred: the CTMetro, and the Testing Laboratories.

The ‘CTMetro’ – The Metrological Centre for Mechanics, Electricity and Fluids integrates the skills on metrology providing technological and R&D services ranging from meters calibration services and testing of equipment to providing solutions to complex metrological problems (www.ipt.br/centros_tecnologicos/CTMetro).

The ‘Testing Laboratories’ are a IPT service provider targeting at the flow equipment manufacturers and users, and involves testing laboratories to characterize the performance (pressure, flow, power, yield) of fans, pumps and compressors (www.ipt.br/solucoes/22.htm). In such infrastructure, testing conditions are the following:

a) Fans: up to 110 kW, and up to 45000 m^3/h

b) Hydraulic pumps: up to 2000 m^3/h, and up to 10 bar

c) Compressors: up to 3000 m^3/h

These ‘Testing Laboratories’ operate in cooperation with the IPT calibration facilities,which are part of the National Metrology Chain – RBC (Rede Brazileira de Calibração) due to its accreditation by CGCRE-Inmetro.

The Brazilian Ministry of Development, Industry and Trade

The Ministry of Development, Industry and Trade contributes to this legal framework through the following three formal bodies:

CONMETRO - the National Council of Metrology, Standardization and Industrial Quality, an inter-ministerial board that is responsible for establishing the national policies on metrology and quality and that coordinates the National System ‘Sinmetro’ with the assistance of Inmetro (www.inmetro.gov.br/inmetro/conmetro.asp).

INMETRO – The National Institute of Metrology, Quality and Technology (www.inmetro.gov.br/inmetro/), who includes in its mission to:

- Provide technical support to CONMETRO
- Implement the national policies on metrology and quality set by CONMETRO

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- Maintain the national measurement standards in the country; establish and maintain their metrological traceability to the units of the International System of Units (SI); and to extend the traceability chain to the standards of measurement in the country

- Development of conformity assessment programs, in the areas of products, processes, services and personnel, mandatory or voluntary, which involve the approval of regulations

- Plan and carry out the activities of accreditation of calibration and testing labs, of proficiency test suppliers, of certification bodies, of inspection, drilling and others, all of which are necessary for the development of the infrastructure of technological services in the country

- Carry out market surveillance of quality in certified and regulated products (textile, and low voltage goods) available in the consumer market.

Note: According to ABRAVA, the formal inspection activities focusing on fans are performed in agreement with the parties: user, designer, manufacturer, test team (test, adjustment and flow balancing) and the commissioned organization, by establishing in advance the responsibilities and the trials to be performed.

SINMETRO - The Brazilian System of Metrology, Standardization and Industrial Quality (www.inmetro.gov.br/inmetro/sinmetro.asp), which consists of public and private entities that perform activities related to metrology, standardization, industrial quality and certification of compliance. This system was established by Law 5966 of December 11, 1973 with the support of a technological service infrastructure able to evaluate and certify the quality of products, processes and services through certification bodies, network testing and calibration laboratories, training bodies, bodies of proficiency testing and inspection bodies, all accredited by INMETRO. Supporting this system are the Brazilian standardization bodies, the scientific and industrial metrology and the legal metrology laboratories states. This structure is formed to meet the needs of industry, commerce, government and consumers.

<u>ABNT – The Brazilian Association for Technical Standards</u>

ABNT is a non-profit private organization, and a founding member of ISO (International Organization for Standardization), of COPANT (Comisión Panamericana de Normas Técnicas), of AMN (Asociación Mercosur de Normalización), and of IEC (International Electrotechnical Commission). It is responsible for the preparation of the Brazilian Standards (NBR), arranged by his Brazilian Technical Committees (ABNT / CB), Sectorial Standardization Bodies (ABNT / ONS), Study Committees (CE) and commissions Special Studies (ABNT / CEE) (www.abnt.org.br).

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Testing facilities

The reference laboratory in Brazil is the IPT– Instituto de Pesquisas Tecnológicas, which - through the CTMetro and the 'Testing Laboratories' (described above), provides the testing conditions for fans up to 110kW and 45000m3/h.

Within the Testing Laboratories, the procedure for testing performance of industrial fans is done in the Flow Lab according to ISO 5801:2007 (www.ipt.br/ensaios/9340.htm)

In case the testing conditions are not met in the IPT Laboratory, in situ testing (at manufacturer's/ user's facilities) is an accepted practice, provided the accuracy and repeatability of the testing conditions are met.

Adding to that, there is also the option of using the fans affinity law when testing a lower scale model. In those cases, scientific and technical assistance is provided and the Polytechnic School attached to the University of S. Paulo is a reference for that purpose.

In the Electric and Optical Lab, fans are also tested within the following reference standards: IEC 60335-1; IEC 60335-2-80; ABNT NBR NM 60335-1; ABNT NBR 11829 (www.ipt.br/ensaios/4189.htm)

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B5.1.7 Japan

Japan's Top Runner Programme, is a set of energy efficiency standards for energy intensive products, such as home appliances and motor vehicles. As of 2014, the programme involved 23 product categories, but not fans. It is not possible, via the internet, to find any information about legislation concerning fans.

B6. Conclusions

The research carried out for the Industrial Fans product group (Group B) in the Task 2.1 „Worldwide and EU Technical standard and legislative framework into the WP2 - Landscape of testing avenues“ of the INTAS project shows that in the EU and in the major surveyed economies the main standards and legislative tools to help MSA in testing industrial fans are in general available.

For industrial fans there is one main standard, ISO 5801, for testing energy performance. However, two different practices are used in the industry – the European and the American. The fan efficiency can either be established including the electric power input of the motor as in Regulation (EU) No. 327/2011 or without the electric power input as according to AMCA (Air Movement & Control Association international Inc.), standard AMCA 205 Energy Efficiency Classification for Fans (defines the so-called Fan Efficiency Grade (FEG))/AMCA 210. ISO 5802 provides methods for in-situ testing, so do the publication/standards AMCA 203-90 (R2011)/AMCA 803-02 (R2008). Some of the measurement procedures for flow in-situ, are quiet time consuming and there is a lack in the standards for more operational methods for flow measurements based on e.g. tracer gas or ultra sound.

The electric motors of industrial fans are also subject to Ecodesign requirements according to Regulation (EC) No 640/2009, so electric motors may also be tested to secure the full product compliance. IEC-60034-series standards are available for testing of electric motors. Fans will also be part of ventilation units. Ecodesign requirements exist for ventilation units as well as specified in Regulation (EU) No 1253/2014, so in this case compliance of electric motor, fan and ventilation units may be subject to verification.

In Europe, national building codes may in accordance with the Energy Performance of Buildings Directive (EPBD), (2010/31/EU), also specify energy requirements for the overall ventilation system efficiency, the so-called Specific Fan Power (SFP). European standards exist to support the EPBD on this issue. In the USA, the construction standard ASHRAE 90.1 2013 sets requirements on the fan efficiency grade (FEG) based on manufacturers’ certified data as defined by AMCA 205.

The general worldwide picture is that Europe and USA are the front runners and that other countries are adapting to their standards. The data collected on standards and legislation will be used as input to the remaining WP 2 tasks as well as the INTAS-project in general.

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B7. Database

Annexed to this report is the database of the documents considered. The database is an Excel spreadsheet with the following fields and meanings.

B7.1 Relevance

This field contains the relevance of the record with the INTAS scope.

0. The document is focused on large fans no relevance with the scope of this report
1. The document is focused on large fans but it has a low relevance with the scope of this report
2. The document is focused on large fans and it has a low relevance with the scope of this report
3. The document is important for the scope of this report

B7.2 Mandatory

This field records if the document is mandatory or not.

YES – The document is mandatory
NO – The document is not mandatory

B7.3 Type

This field records the type of the document:

- Standard
- Technical report
- Legislative document

B7.4 Country

This field records the geographical scope of the document:

- Australia and New Zealand
- Brazil
- Canada
- China

- Europe
- European Union
- India
- Israel
- International
- Japan
- Korea
- Mexico
- United States of America
- Vietnam

B7.5 Organisation

This field records the name of the issuing organisation of the document.

B7.6 Organisation code

This field records the code of the issuing organisation of the document.

B7.7 Reference

This field records the code of the document.

B7.8 Title

This field records the title of the document.

B7.9 Original Title

This field records the original title of the document.

B7.10 Function

This field records the function of large fans covered by the document.

B7.11 Airflow

This field records the range of airflow of fans covered by the document.

B7.12 Pressure

This field records the range of rated pressures of fans covered by the document.

B7.13 Power input

This field records the range of power input of motors covered by the document.

B7.14 ISO/AMCA/IEC/EN/IEEE like

This field records if the document is coherent with ISO/AMCA/IEC/EN/IEEE practices or not.

- Identical – the document is identical to the corresponding ISO/AMCA/IEC/EN/IEEE one
- With deviations – the document is similar to the corresponding ISO/AMCA/ IEC/EN/IEEE one but with some deviations
- It is – the document is ISO/AMCA/IEC/EN/IEEE
- Aligned – the document is covering something not addressed in the ISO/AMCA/ IEC/EN/IEEE documents but it coherent with ISO/AMCA/IEC/EN/IEEE approach

B7.15 Test

This field records if the document deals with fans tests or not.

PTT - The document deals with fan tests
EPT- The document deals with energy performance tests for fans
NO - The document does not deal with fan tests

B7.16 MEPS

This field records if the document contains fan MEPS or not.

YES - The document contains fan MEPS
NO - The document does not contain fan MEPS

B7.17 MEPS type

This field records the type of MEPS adopted by the document.

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B7.18 Label

This field records if the document contains fan labelling system or not.

YES - The document contains a fan labelling system
NO - The document does not contain a fan labelling system

B7.19 Link

This field contains the internet link to the document.

B7.20 Notes

This field contains additional notes about the document.

List of Tables

More information

about the INTAS project activities
and all of its results
are published on:

www.INTAS-testing.eu

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