BS EN 12101-3:2015

BSI Standards Publication

Smoke and heat control systems

Part 3: Specification for powered smoke and heat control ventilators (Fans)

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National foreword

This British Standard is the UK implementation of EN 12101-3:2015. It supersedes BS EN 12101-3:2002 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee FSH/25, Smoke, heat control systems and components.

A list of organizations represented on this committee can be obtained on request to its secretary.

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This European Standard was approved by CEN on 12 January 2015.

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European foreword

This document (EN 12101-3:2015) has been prepared by Technical Committee CEN/TC 191 “Fixed firefighting systems”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2016, and conflicting national standards shall be withdrawn at the latest by May 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12101-3:2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s) and/or EU Regulation(s).

For relationship with EU Regulation(s), see informative Annex ZA, which is an integral part of this document.

This European Standard is part of the package of the European Standards EN 12101 covering smoke and heat control systems.

EN 12101, *Smoke and heat control systems*, consists of the following parts:

— *Part 1: Specification for smoke barriers — Requirements and test methods*

— *Part 2: Specification for natural smoke and heat control ventilators*

— *Part 3: Specification for powered smoke and heat control ventilators*

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— *Part 4: Natural smoke and heat control ventilation systems — Installation and test methods* (published as CEN/TR 12101-4)

— *Part 5: Design and calculation for smoke and exhaust ventilation systems* (published as CEN/TR 12101-5)

— *Part 6: Specification for pressure differential systems- kits*

— *Part 7: Smoke duct sections*

— *Part 8: Smoke control dampers*

— *Part 10: Power supplies*

— *Part 11: Smoke control in car parks*

— *Part 12: SHEVS – Time dependent fires*

— *Part 13: Pressure differential systems (PDS) design and calculation methods, acceptance testing, maintenance and routine testing of installation*

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Smoke and heat control ventilation systems create a smoke free layer above the floor by removing smoke and thus improve the conditions for the safe escape and/or rescue of people and animals and the protection of property and permit the fire to be fought while still in its early stages. They also exhaust hot gases released by a fire in the developing stage.

In specific cases some fans are used to convey smoke (e.g. in tunnels or car parks). These fans, called jet fans or impulse fans are also within the scope of this standard.

The use of smoke and heat control ventilation systems to create smoke free areas beneath a buoyant smoke layer has become widespread. Their value in assisting in the evacuation of people from construction works, reducing fire damage and financial loss by preventing smoke logging, facilitating fire fighting, reducing roof temperatures and retarding the lateral spread of fire is firmly established. For these benefits to be obtained it is essential that smoke and heat control ventilators operate fully and reliably whenever called upon to do so during their installed life. A heat and smoke control ventilation system is a scheme of safety equipment intended to perform a positive role in a fire emergency.

Components for smoke and heat control systems should be installed as part of a properly designed smoke and heat control system.

Smoke and heat control ventilation systems help to:

— keep the escape and access routes free from smoke;

— facilitate fire fighting operations by creating a smoke free layer;

— delay and/or prevent flashover and thus full development of the fire;

— protect equipment and furnishings;

— reduce thermal effects on structural components during a fire;

— reduce damage caused by thermal decomposition products and hot gases.

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Depending on the design of the system and the ventilator, powered or natural smoke and heat ventilators can be used in a smoke and heat control system. Powered smoke and heat control ventilators (fans) can be installed in the roof or upper part of walls of building or in a ducted system with the ventilator inside or outside the smoke reservoir or in a plant room.

Powered smoke and heat control ventilation systems should operate based on powered ventilators (fans). The performance of the powered smoke and heat control system depends on:

— the temperature of the smoke;

— size, number and location of the exhaust openings;

— the wind influence;

— size, geometry and location of the inlet air openings;

— the time of actuation;

— the location and conditions of the system (for example arrangements and dimensions of the building).

Smoke and heat control ventilation systems are used in buildings or construction works where the particular (large) dimensions, shape or configuration make smoke control necessary.

Typical examples are:

— single and multi-storey shopping malls;

— single and multi-storey industrial buildings and warehouses;

— atria and complex buildings;

— enclosed car parks;

— stairways;

— tunnels;

— theatres.

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1 Scope

This European Standard specifies the products characteristics of powered smoke and heat control ventilators (fans) intended to be used as part of a powered smoke and heat control ventilation system in construction works.

It provides test and assessment methods of the characteristics and the compliance criteria of the test assessment results.

This European Standard applies to the following:

a) fans for smoke and heat control ventilation;

b) impulse/jet fans for smoke and heat control ventilation;

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1363 (all parts), *Fire resistance tests*

EN 13501-4, *Fire classification of construction products and building elements — Part 4: Classification using data from fire resistance tests on components of smoke control systems*

EN 60034-1, *Rotating electrical machines - Part 1: Rating and performance (IEC 60034-1)*

EN 60034-2-1, *Rotating electrical machines - Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles) (IEC 60034-2-1)*

EN 60034-18-41, *Rotating electrical machines - Part 18-41: Partial discharge free electrical insulation systems (Type I) used in rotating electrical machines fed from voltage converters - Qualification and quality control tests (IEC 60034-18-41)*

EN 60085, *Electrical insulation - Thermal evaluation and designation (IEC 60085)*

CLC/TS 60034-17, *Rotating electrical machines - Part 17: Cage induction motors when fed from converters - Application guide (IEC 60034-17)*

EN ISO 204, *Metallic materials - Uniaxial creep testing in tension - Method of test (ISO 204)*

EN ISO 5167 (all parts), *Measurement of fluid flow by means of pressure differential devices*

EN ISO 5801, *Industrial fans - Performance testing using standardized airways (ISO 5801*

EN ISO 6892-1, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1)*

EN ISO 6892-2, *Metallic materials - Tensile testing - Part 2: Method of test at elevated temperature (ISO 6892-2)*

ISO 281, *Rolling bearings — Dynamic load ratings and rating life*

ISO 834-1, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 1099, *Metallic materials — Fatigue testing — Axial force-controlled method*

3 Terms, definitions, symbols and abbreviations

For the purposes of this document, the following terms and definitions apply.

3.1
ventilator
term covering both natural or powered ventilators (fans)

3.2
powered smoke and heat control ventilator
PSHC ventilator
smoke-ventilating fan that is suitable for handling smoke and hot gases for a specified time/temperature profile

3.3
dual purpose PSHC ventilator
smoke-ventilating fan that has provision to allow its use for comfort (i.e. day to day) ventilation

3.4
emergency PSHC ventilator
smoke-ventilating fan that is not used for comfort (i.e. day to day) ventilation

3.5
smoke reservoir
region within a building limited or bordered by smoke curtains or structural elements and which will in the event of a fire retain a thermally buoyant smoke layer

3.6
powered roof ventilator
fan designed for mounting on a roof and having exterior weather protection

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3.7
thermal insulated ventilator
ventilator insulated to limit the external surface temperature to reduce the danger of injury to persons or damage to materials (see 5.3.1)

3.8
smoke reservoir ventilator
ventilator suitable for operation fully immersed in a smoke reservoir

3.9
non smoke reservoir ventilator
ventilator not suitable for operation fully immersed in a smoke reservoir

3.10
series-produced powered ventilator product family
physically similar fans using the same form of construction and materials throughout, with the same methods of impeller construction, motor mounting and construction, and electrical connection in which the following may vary across the range:

— overall dimensions of the fans; and/or

— the impeller diameter and width, hub size, blade length and number of blades of the impeller; and/or;

— the motor details, as per 3.12, 3.13, 3.14 and 3.15

3.11
impulse/jet fans for smoke and heat control ventilation
fan used for producing a jet of air in a space and unconnected to any ducting

Note 1 to entry The air jet may be used, for example, for adding momentum to the air within a duct, a tunnel or other space, or for intensifying the heat transfer in a determined zone.

3.12
non-series produced fans for smoke and heat control ventilation
fans that are:

— individually designed and manufactured, upon request and for specific purposes, needing to readjust the production machines for their manufacture in order to be used in the work concerned; or

— custom-made for a specific order to obtain one or several end use performances different from products manufactured in series, even if produced according to the same manufacturing process/system design.

Note 1 to entry These are products of individual design that are ordered for and installed in one and the same known work. They should neither be part of a range of equal products, which is manufactured in series of the same kind combining usual components in the same way, nor should they and their field of application (e.g. dimensions, weight) be offered on the general initiative of the manufacturer (e.g. by means of published catalogues or other ways of advertising).

3.13
three phase motor family
motors which are physically similar, using the same form of construction i.e. same materials and manufacturing method for carcase, cooling impeller, when fitted, and end covers; same insulation materials which includes sheet insulation used for coil separation and slot insulation, winding impregnation material (varnish or resin etc., lead insulation, terminal blocks and any other materials that could affect the integrity of the insulation); same bearing type, class of fit, lubricant and arrangement, with motor windings based on the same maximum winding temperature and class of insulation,; in which the following may vary across the range:

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— frame size;

— the rotational speed;

— the electrical windings, including multi-speed;

— the form of mounting, e.g. foot, flange, pad, clamp, etc.

3.14
single phase motor family
motors which are physically similar, using the same form of construction i.e. same materials and manufacturing method for carcase, cooling impeller, when fitted, and end covers; same insulation materials which includes sheet insulation used on for coil separation and slot insulation, winding impregnation material (varnish or resin etc., lead insulation, terminal blocks and any other materials that could affect the integrity of the insulation); same bearing type, class of fit, lubricant and arrangement, with motor windings based on the same maximum winding temperature and class of insulation, same capacitor type and same location of the capacitor; in which the following may vary across the range:

— the frame size;

— the rotational speed;

— the electrical windings, including multi-speed;

— the form of mounting, e.g. foot, flange, pad, clamp, etc.

3.15
motor rating
motor rating (rated power) is the maximum power that the motor will deliver continuously without exceeding the allowable temperature rise

3.16
fire open position
position of a component to be reached and maintained while venting smoke and heat

4 Requirements

4.1 Response delay (response time)

4.1.1 Opening under wind load within a given time

If the fan is designed to be installed at the atmospheric termination of a smoke control system (e.g. powered roof ventilator) and is fitted with a fan shutter flaps or louvers which project above the wind deflectors (cowl or wind shield), the shutter, flaps or louvers shall open in less than 30 s when tested in accordance with 5.2.1.

4.1.2 Opening under snow load within a given time

If the fan is designed to be installed at the atmospheric termination of a smoke control system (e.g. powered roof ventilator) and is fitted with a fan shutter flaps or louvers which project above the wind deflectors (cowl or wind shield), the shutter, flaps or louvers shall open in less than 30 s when tested in accordance with 5.2.2.

4.2 Operational reliability

4.2.1 General

Operational reliability of a PSHC ventilator (fan) shall be demonstrated by verification against application categories and by verification of motor ratings.

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4.2.2 Application categories

To demonstrate its operational reliability, a PSHC ventilator (fan) has to be verified against categories:

The following Table 1 shows the relevant method to allocate the results in the corresponding category:

Table 1 — Application categories

Clause of the test method	Application category	Compliance criteria
5.3.1	Thermally insulated	When tested in accordance with Annex C: — The outer surface temperature of a thermal insulated fan shall not increase by more than 180 K for any individual value. — The cooling air expelled from the unit shall not exhibit an increase of temperature of more than 180 K from the initial room temperature.
5.3.1	Thermally uninsulated	-
Annex C, C.3.3	Installation inside the smoke reservoir	-
Annex C, C.3.3	Installation outside the smoke reservoir	-
Annex A, A.1.i)	Horizontal direction of motor shaft	-
Annex A, A.1.i)	Vertical direction of motor shaft	-
Annex A, A.1.n)	Converter feed (driven by frequency converter)	-
Annex A, A.1.n)	Direct feed (no speed variation)	-
Annex C, C.4.2.1	Dual purpose use	-
Annex C, C.4.2.1, C.4.2.2	Emergency only use	-
Annex C, C.3.3	Ducted cooling air required	-

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4.2.3 Motor rating

Since the PSHC ventilator (fan) may be operated at different temperatures (current or emergency), motors shall be selected for operation at the power required for normal ambient temperature and not just for operation at high temperature.

Selection of the motors shall comply with the following requirements:

— Motors shall comply with the requirements of EN 60034-1.

— Motor ratings shall be limited by the temperature rise for one class lower than the insulation class of the motor, as defined in EN 60085.

— The fan tested in accordance with 5.3.2, shall comply with the stability requirement in Annex C, C.4.2.2.

4.3 Effectiveness of smoke / hot gas extraction

4.3.1 General

The effectiveness of smoke / hot gas extraction of the fan is the ability to continue to extract the required volume flow at high temperature.

4.3.2 Gas flow and pressure maintenance during smoke and heat extraction test

The effectiveness of smoke / hot gas extraction is demonstrated by compliance with the performance requirements in Annex C, C.5, when tested according to 5.4.

4.4 Resistance to fire

The fan is shown to be functioning satisfactorily by its continued ability to provide the initial volume or pressure within the defined limits in C.5, when tested according to 5.5.

The test result shall be classified in accordance with EN 13501-4.

4.5 Ability to open under environmental conditions

4.5.1 Opening under wind load within a given time

When the fan is fitted with shutter, louvers or dampers, their ability to open under environmental conditions shall be demonstrated by fulfilling the requirements in Annex E, E.5 when tested in accordance with 5.6.

4.5.2 Opening under snow load within a given time

When the fan is fitted with shutter, louvers or dampers, their ability to open under environmental conditions shall be demonstrated by fulfilling the requirements in Annex E, E.5 when tested in accordance with 5.6.

4.6 Durability of operational reliability

Durability of operational reliability is demonstrated by motor rating according to 4.2.3 when tested according to 5.7.

5 Testing, assessment and sampling methods

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5.1 General

PSHC ventilator (fan), tests shall be carried out in accordance with Annexes A, B, C, E.

For each test, a test report shall be prepared in accordance with Annex C.

A fan can be tested completely assembled with ancillaries, for example:

— flexible connection elements;

— anchors (fastenings for mounting to external structure);

— airflow operated dampers or external powered dampers;

— shock absorber (anti-vibration mount);

— sound absorber (silencer or acoustic attenuator);

— support construction (e.g. for powered roof or partition fans);

— thermal protection (e.g. PTC thermistor, Thermocouple, Pt100…);

— ON-OFF switch and other electrical ancillaries (e.g. electrical safety box) which are directly mounted on the fan;

— guide vanes;

— flow deflectors;

— a jet fan shall be tested completely assembled and suspended from a supporting construction in accordance with the manufacturer's installation instruction.

For testing of motors alone, tests shall be carried out and test reports prepared in accordance with Annex D.

5.2 Test of response delay (response time) opening under wind, snow load within a given time

5.2.1 Wind load

The fan shutter, flaps or louvers shall open in less than 30 s against a horizontally applied load of 200 Pa, simulated by means of an additional fan blowing on the flap at a suitable velocity, or by any suitable mechanical means when the fan is tested in accordance with annex E and / or C.

Warning: For fans which use the air pressure from the fan to open flaps or louvers:

Due to the temperature rise the density of air decreases, resulting in a corresponding decrease in the pressure developed. This pressure is needed to open the termination system (flaps or louvers).

In this case, the laboratory shall perform the wind load test also during the high temperature test.

If fans selected according to Annex A and tested according to Annex C are intended for use with external, air-pressure operated shutters, the combination shall also be tested with a wind load according to Annex E.

The operating position can be considered as reached if the volume flow exhausted by the fan working under wind loads did not decrease by more than 10 % of that exhausted by the fan working without these loads.

If a fan intended for mounting on an external wall is fitted with external shutters, flaps or louvers and/or is not protected from wind force acting against it by a deflector or cowl, it shall be tested in accordance with this clause. Otherwise, the manufacture shall include a statement in his instructions that suitable wind guarding shall be fitted by the installer.

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5.2.2 Snow load

The fan shutter, flaps or louvers shall open in less than 30 s against a vertically applied load shown in Table 2, simulated by any suitable mechanical means, when the fan is tested in accordance with Annex E, at ambient temperature only.

Table 2 — Snow load classes

Class	Load (Pa)
SL 0	0
SL 125	125
SL 250	250
SL 500	500
SL 1000	1000
SL A	A

NOTE The operating position can be considered as reached if the volume flow exhausted by the fan working under snow loads did not decrease by more than 10 % of that exhausted by the fan working without these loads.

Where the minimum angle of installation recommended by the supplier exceeds 45° from the horizontal, the fan takes the classification SL 1000 without a test; except where the snow will be prevented from slipping from the fan e.g. by wind deflectors, in which case the fan shall be tested for a snow load classification which shall not be less than $\mathrm{SL} = 2000.d$ where *d* is the depth of snow, in metres, which can be contained with the confines of the deflectors.

5.3 Operational reliability

5.3.1 Application categories

The relevant test methods are those indicated in Table 1 in 4.2.2.

5.3.2 Motor rating

The test method to be applied is in Annex C, C.4.2.

5.4 Effectiveness of smoke / hot gas extraction – Gas flow and pressure maintenance during smoke and heat extraction test

The test method is given in Annex C.

5.5 Resistance to fire

The test method is given in Annex C.

5.6 Ability to open under environmental conditions: opening under wind, snow load within a given time

The test method is given in Annex E.

5.7 Durability of operational reliability

Durability of operational reliability is demonstrated by the test method given in 5.3.2.

6 Assessment and verification of constancy of performance – AVCP

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6.1 General

The compliance of powered smoke and heat control ventilators (fans) with the requirements of this standard and with the performances declared by the manufacturer in the DoP shall be demonstrated by:

— determination of the product type;

— factory production control by the manufacturer, including product assessment.

The manufacturer shall always retain the overall control and shall have the necessary means to take responsibility for the conformity of the product with its declared performance(s).

6.2 Type Testing

6.2.1 General

All performances related to characteristics included in this standard shall be determined when the manufacturer intends to declare the respective performances unless the standard gives provisions for declaring them without performing tests. (e.g. use of previously existing data, classified without further testing (CWFT) and conventionally accepted performance).

Assessment previously performed in accordance with the provisions of this standard, may be taken into account provided that they were made to the same or a more rigorous test method, under the same AVCP system on the same product or products of similar design, construction and functionality, such that the results are applicable to the product in question.

NOTE Same AVCP system means testing by an independent third party, under the responsibility of a notified product certification body.

For the purposes of assessment, the manufacturer's products may be grouped into families, where it is considered that the results for one or more characteristics from any one product within the family are representative for that same characteristics for all products within that same family.

Products may be grouped in different families for different characteristics.

Reference to the assessment method standards should be made to allow the selection of a suitable representative sample.

In addition, the determination of the product type shall be performed for all characteristics included in the standard for which the manufacturer declares the performance:

— at the beginning of the production of a new or modified powered smoke and heat control ventilators (fans) (unless a member of the same product range), or

— at the beginning of a new or modified method of production (where this may affect the stated properties); or

they shall be repeated for the appropriate characteristic(s), whenever a change occurs in the powered smoke and heat control ventilators (fans) design, in the raw material or in the supplier of the components, or in the method of production (subject to the definition of a family), which would affect significantly one or more of the characteristics.

Where components are used whose characteristics have already been determined, by the component manufacturer, on the basis of assessment methods of other product standards, these characteristics need not be re-assessed. The specifications of these components shall be documented.

Products bearing regulatory marking in accordance with appropriate harmonized European specifications may be presumed to have the performances declared in the DoP, although this does not replace the responsibility on the powered smoke and heat control ventilators (fans) manufacturer to ensure that the powered smoke and heat control ventilators (fans) as a whole is correctly manufactured and its component products have the declared performance values.

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6.2.2 Test samples, testing and compliance criteria

The number of samples of powered smoke and heat control ventilators (fans) to be tested /assessed shall be in accordance with Table 3.

Table 3 — Number of samples to be tested and compliance criteria

Characteristic	Requirement	Assessment method	No. of samples	Compliance criteria
Response delay: - Opening under wind load within a given time; - Opening under snow load within a given time.	 4.1.1 4.1.2	Annex E	m	 4.1.1 4.1.2
Operational reliability: Application categories; Motor rating.	 4.2.2 4.2.3	 4.2.2 Table 1 Annex C	 n n	 4.2.2, Table 1 C.4.2.1 and C.4.2.2
Effectiveness of smoke / hot gas extraction: Gas flow and pressure maintenance during smoke and heat extraction test.	4.3	Annex C	n	C.5
Resistance to fire	4.4	Annex C	n	EN 13501-4
Ability to open under environmental conditions: - Opening under wind load within a given time, - Opening under snow load within a given time.	4.5.1 4.5.2	Annex E	n	E.5
Durability of operational reliability.	4.6	5.7	n	4.6
m is calculated in accordance with provisions of Annex E. n is calculated in accordance with provisions of Annex A.				

6.2.3 Test reports

The results of the determination of the product type shall be documented in test reports. All test reports shall be retained by the manufacturer for at least 10 years after the last date of production of the powered smoke and heat control ventilators (fans) to which they relate.

6.3 Factory production control (FPC)

6.3.1 General

The manufacturer shall establish, document and maintain an FPC system to ensure that the products placed on the market comply with the declared performance of the essential characteristics.

The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the production process and the product.

All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures.

This factory production control system documentation shall ensure a common understanding of the evaluation of the constancy of performance and enable the achievement of the required product performances and the effective operation of the production control system to be checked. Factory production control therefore brings together operational techniques and all measures allowing maintenance and control of the compliance of the product with the declared performances of the essential characteristics.

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In case the manufacturer has used shared or cascading product type results, the FPC shall also include the appropriate documentation as foreseen in 6.3.4 and 6.3.5.

6.3.2 Requirements

6.3.2.1 General

The manufacturer is responsible for organizing the effective implementation of the FPC system in line with the content of this product standard. Tasks and responsibilities in the production control organization shall be documented and this documentation shall be kept up-to-date.

The responsibility, authority and the relationship between personnel that manages, performs or verifies work affecting product constancy, shall be defined. This applies in particular to personnel that need to initiate actions preventing product non-constancies from occurring, actions in case of non-constancies and to identify and register product constancy problems.

Personnel performing work affecting the constancy of performance of the product shall be competent on the basis of appropriate education, training, skills and experience for which records shall be maintained.

In each factory the manufacturer may delegate the action to a person having the necessary authority to:

— identify procedures to demonstrate constancy of performance of the product at appropriate stages;

— identify and record any instance of non-constancy;

— identify procedures to correct instances of non-constancy.

The manufacturer shall draw up and keep up-to-date documents defining the factory production control. The manufacturer's documentation and procedures should be appropriate to the product and manufacturing process. The FPC system should achieve an appropriate level of confidence in the constancy of performance of the product. This involves:

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a) the preparation of documented procedures and instructions relating to factory production control operations, in accordance with the requirements of the technical specification to which reference is made;

b) the effective implementation of these procedures and instructions;

c) the recording of these operations and their results;

d) the use of these results to correct any deviations, repair the effects of such deviations, treat any resulting instances of non-conformity and, if necessary, revise the FPC to rectify the cause of non-constancy of performance.

Where subcontracting takes place, the manufacturer shall retain the overall control of the product and ensure that he receives all the information that is necessary to fulfil his responsibilities according to this European standard.

If the manufacturer has part of the product designed, manufactured, assembled, packed, processed and/or labelled by subcontracting, the FPC of the subcontractor may be taken into account, where appropriate for the product in question.

The manufacturer who subcontracts all of his activities may in no circumstances pass the above responsibilities on to a subcontractor.

NOTE Manufacturers having an FPC system, which complies with EN ISO 9001 standard and which addresses the provisions of the present European Standard are considered as satisfying the FPC requirements of the Regulation (EU) No 305/2011.

6.3.2.2 Equipment

6.3.2.2.1 Testing

All weighing, measuring and testing equipment shall be calibrated and regularly inspected according to documented procedures, frequencies and criteria.

6.3.2.2.2 Manufacturing

All equipment used in the manufacturing process shall be regularly inspected and maintained to ensure use, wear or failure does not cause inconsistency in the manufacturing process. Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer’s written procedures and the records retained for the period defined in the manufacturer's FPC procedures.

6.3.2.3 Raw materials and components

The specifications of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring their compliance. In case supplied kit components are used, the constancy of performance system of the component shall be that given in the appropriate harmonized technical specification for that component.

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Table 4

Acceptance check	Test/Assessment Method	Requirement	Recommended minimum frequency	Record
Raw material: Metal sheet for casing, motor mounting, flanges, steel mesh, mineral wool…(for silencer), metal blocks for impeller casting	Measurement and or raw material certificate	Conformity of delivery with order specification	Each reception	yes
Compulsory components: top cover, electric cable and terminal box if so, belt and pulleys, bearings and transmission shaft, motor, blades/hub/ impeller, fastenings (screws, bolts, rivets, nuts, weldings), flexible joint if so,	Visual / Data sheet/ motor rating plate	Conform with range report list of approved components	See manufacturer operating procedure	yes
Optional accessories: Isolator/ON-OFF switch, electrical safety box, converter, pressure controller, flaps, damper, silencer, shock absorber, protection grill, electrical cables associated, motor covering, inlet nozzle, flexible joints/sleeves, guide vanes, guide cone.	Visual / Data sheet	Conform with range report list of approved ancillaries	See manufacturer operating procedure	yes
Product control- impeller				
Main dimensions (at least these ones used for stress calculations in EN 12101-3:2015, Annex A)	Measurements	Reference conform with range report	See operating procedure	yes
Material (blades, hub and taper lock-bush)	Material test report		See operating procedure	yes
Fastening: material, size and number (rivets, nuts, welding, bolts, tabs,)	Measurements	Reference conform with range report	See operating procedure	yes
Balancing	Test report / or balancing operation	Reference conform with range report	See operating procedure	yes
Balancing loads fastening	Visual check	Reference conform with range report	See operating procedure	yes
Motor	Motor manufacturer declaration and/or inspection body report	Conformity of delivery with order specification and/or in case of changing of component inside the motor, inspection body report	Each reception	yes

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The on-going compliance of a motor for installation within a smoke control fan with the requirements of this European Standard can be demonstrated by a factory production control by the manufacturer evaluated by a body notified according to the following rules:

1) The motor manufacturer selects a body notified for inspection and a body notified for tests.

2) Only the selected inspection body performs the assessment of the factory product control by the motor manufacturer and writes an inspection report at least in English language.

3) The motor manufacturer can therefore transmit the inspection report to all this customers which are fan manufacturer or directly to the notified body of the customer for confidentiality reasons.

4) If the motor manufacturer shall change or wants to change some components, he shall inform the selected test laboratory so that it can assess or perform, if required by the rules indicated in the standard (see annex B), the additional test(s). Then the test report is also written in English language and provided by the motor manufacturer to the inspection body so that he reports these changes in the inspection report.

The factory product control done by motor manufacturer shall focus on components listed in Table 5:

Table 5

Section 1: Material control					
Ref.	**Material inspection or test**	**Recommended method**	**Requirement**	**Recommended minimum frequency**	**Record**
1.1	Incoming material				
1.1.1	Raw material: All components listed in Table B.1 or necessary to manufacture components of the list (e.g. aluminium for casting, metal sheets…etc.)	Measurement and or raw material certificate	Conform with range report drawing and/or material specification of tested samples available by the manufacturer	See manufacturer operating procedure	yes
1.1.2	Compulsory components: all components which are not manufactured on site (e.g. bearings, steel rod for shaft, casing if purchased, terminal board…etc.)	Visual / Data sheet/ motor rating plate	Conform with range report list of approved components	See manufacturer operating procedure	yes

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Ref.	Material inspection or test	Recommended method	Requirement	Recommended minimum frequency	Record
1.1.3	Rotor Balancing	Certificate/ or balancing operation	Reference conform with range report	See operating procedure	yes
1.1.4	Optional accessories: temperature sensors, anti-condensation heaters, terminal box, gland, cooling impeller, balancing disc…etc.	Visual / Data sheet	Conform with range report list of approved ancillaries	See manufacturer operating procedure	yes
Section 2: Production control					
2.1	Process control				
2.1.1	Production method (e.g. for casting or rolling or welding or impregnation method)	Control the used method	The same method as the method used for production of tested samples	See manufacturer operating procedure	yes
2.1.2	Components manufactured by the sponsor	Control dimension and assembly quality of each component	Conform with range report drawing and especially tolerances (see material specification of tested samples available by the manufacturer)	See manufacturer operating procedure	yes
2.1.3	Components assembling	Mounting gauges, torque requirements, tip clearance, balancing of rotor	Conform with range report drawing and especially tolerances see material specification of tested samples available by the manufacturer Test or balancing certificate	See manufacturer operating procedure	yes
2.1.4	Arrangements to distinguish standard production and fire protection purposes production	Depending on each manufacturer	Avoid mixing	See manufacturer operating procedure	Yes

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Ref.	Material inspection or test	Recommended method	Requirement	Recommended minimum frequency	Record
Section 3: Product control					
3.1	Product control				
3.1.1.	Fireproof Electrical cables and terminal board when mounted	Visual check	Reference conform with range report	See operating procedure	yes
3.1.2.	Material of capacitor when mounted	Visual check	Reference and location conform with range report	See operating procedure	yes
3.1.3.	Material of cooling impeller when mounted	Visual check	Reference and location conform with range report	See operating procedure	yes
3.1.4.	Protection sleeve/conduit when mounted	Visual check	Reference and location conform with range report	See operating procedure	yes
3.1.5	Marking	Visual check	Reference conform with range report	See operating procedure	yes

6.3.2.4 Traceability and marking

Individual power and heat control system ventilators (fans) shall be identifiable and traceable with regard to their production origin. The manufacturer shall have written procedures ensuring that processes related to affixing traceability codes and/or markings are inspected regularly.

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6.3.2.5 Controls during manufacturing process

The manufacturer shall plan and carry out production under controlled conditions.

Table 6

Process	Test/assessment method	Requirement	Frequency	Record
Production method (e.g. for casting or rolling or welding)	Control the used method	The same or equivalent method as the method used for production of tested samples	See manufacturer operating procedure	yes
Components manufactured by the manufacturer	Control dimension and assembly quality of each component	Conform with range report drawing and especially tolerances (see material specification of tested samples available by the manufacturer)	See manufacturer operating procedure	yes
Components assembling	Mounting gauges, torque requirements, tip clearance, balancing of impeller	Conform with range report drawing and especially tolerances see material specification of tested samples available by the manufacturer Test or balancing certificate	See manufacturer operating procedure	yes
Arrangements to distinguish standard production and fire protection purposes production	Depending on each manufacturer	Avoid mixing	See manufacturer operating procedure	yes

Table 7

Final product characteristic	Recommended method	Requirement	Recommended minimum frequency	Record
Working clearance(s)	Gauge or equivalent	conform with range report	See operating procedure	yes
Section of cooling air entry/exit	Measuring section	conform with range report	See operating procedure	yes
Electrical cables and connections which are part of the product	Visual check	Reference conform with range report	See operating procedure	yes
Approved accessories (switch, flexible joint…)	Visual check	Reference and location conform with range report	See operating procedure	yes
Mounted motor	Visual check/checking of plate if possible	Reference conform with approved motors in the range report	See operating procedure	yes
Arrangement (transmission) between motor and impeller	Pulley aligning, belt tension, visual check of belt nature and pulley dimensions/type	Aligning, tension, conformity of arrangement with range report	See operating procedure	yes
Marking	Visual check	Reference conform with range report	See operating procedure	yes

6.3.2.6 Product testing and evaluation

The manufacturer shall establish procedures to ensure that the stated values of the characteristics he declares are maintained. The characteristics, and the means of control, are:

— Response delay shall be subject to the test indicated in Annex E, done at ambient temperature;

— Motor rating shall be subject to the test indicated in Annex C (C.4.2);

— Ability to open under environmental conditions at ambient temperature shall be subject to the test indicated in Annex E.

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6.3.2.7 Non – complying products

The manufacturer shall have written procedures which specify how non-complying products shall be dealt with. Any such events shall be recorded as they occur and these records shall be kept for the period defined in the manufacturer's written procedures.

Where the product fails to satisfy the acceptance criteria, the provisions for non-complying products shall apply, the necessary corrective action(s) shall immediately be taken and the products or batches not complying shall be isolated and properly identified.

Once the fault has been corrected, the test or verification in question shall be repeated.

The results of controls and tests shall be properly recorded. The product description, date of manufacture, test method adopted, test results and acceptance criteria shall be entered in the records under the signature of the person responsible for the control/test.

With regard to any control result not meeting the requirements of this European standard, the corrective measures taken to rectify the situation (e.g. a further test carried out, modification of manufacturing process, throwing away or putting right of product) shall be indicated in the records.

6.3.2.8 Corrective action

The manufacturer shall have documented procedures that instigate action to eliminate the cause of non-conformities in order to prevent recurrence.

6.3.2.9 Handling, storage and packaging

The manufacturer shall have procedures providing methods of product handling and shall provide suitable storage areas preventing damage or deterioration.

6.3.3 Product specific requirements

The FPC system shall address this European Standard and ensure that the products placed on the market comply with the declaration of performance.

The FPC system shall include a product specific FPC, which identifies procedures to demonstrate compliance of the product at appropriate stages, i.e.:

a) the controls and tests to be carried out prior to and/or during manufacture according to a frequency laid down in the FPC test plan,

and/or

b) the verifications and tests to be carried out on finished products according to a frequency laid down in the FPC test plan

If the manufacturer uses only finished products, the operations under b) shall lead to an equivalent level of compliance of the product as if FPC had been carried out during the production.

If the manufacturer carries out parts of the production himself, the operations under b) may be reduced and partly replaced by operations under a). Generally, the more parts of the production that are carried out by the manufacturer, the more operations under b) may be replaced by operations under a).

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In any case the operation shall lead to an equivalent level of compliance of the product as if FPC had been carried out during the production.

NOTE Depending on the specific case, it can be necessary to carry out the operations referred to under a) and b), only the operations under a) or only those under b).

The operations under a) refer to the intermediate states of the product as on manufacturing machines and their adjustment, and measuring equipment etc. These controls and tests and their frequency shall be chosen based on product type and composition, the manufacturing process and its complexity, the sensitivity of product features to variations in manufacturing parameters etc.

The manufacturer shall establish and maintain records that provide evidence that the production has been sampled and tested. These records shall show clearly whether the production has satisfied the defined acceptance criteria and shall be available for at least three years.

6.3.4 Initial inspection of factory and of FPC

Initial inspection of factory and of FPC shall be carried out when the production process has been finalized and in operation. The factory and FPC documentation shall be assessed to verify that the requirements of 6.3.2 and 6.3.3 are fulfilled.

During the inspection it shall be verified:

a) that all resources necessary for the achievement of the product characteristics included in this European standard are in place and correctly implemented, and

b) that the FPC-procedures in accordance with the FPC documentation are followed in practice,

and

c) that the product complies with the product type samples, for which compliance of the product performance to the DoP has been verified.

All locations where final assembly or at least final testing of the relevant product is performed shall be assessed to verify that the above conditions a) to c) are in place and implemented. If the FPC system covers more than one product, production line or production process, and it is verified that the general requirements are fulfilled when assessing one product, production line or production process, then the assessment of the general requirements does not need to be repeated when assessing the FPC for another product, production line or production process.

All assessments and their results shall be documented in the initial inspection report.

6.3.5 Continuous surveillance of FPC

Surveillance of the FPC shall be undertaken once per year. However, if after 2 years from the date of the first surveillance there is no evidence of non-compliancy, further surveillances shall be undertaken once every 2 years. The surveillance of the FPC shall include a review of the FPC test plan(s) and production processes(s) for each product to determine if any changes have been made since the last assessment or surveillance. The significance of any changes shall be assessed.

Checks shall be made to ensure that the test plans are still correctly implemented and that the production equipment is still correctly maintained and calibrated at appropriate time intervals.

The records of tests and measurement made during the production process and to finished products shall be reviewed to ensure that the values obtained still correspond with those values for the samples submitted to the determination of the product type and that the correct actions have been taken for non-compliant products.

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6.3.6 Procedure for modifications

If modifications are made to the product, production process or FPC system that could affect any of the product characteristics declared according to this standard, then all the characteristics for which the manufacturer declares performance, which may be affected by the modification, shall be subject to the determination of the product type, as described in 6.2.1.

Where relevant, a re-assessment of the factory and of the FPC system shall be performed for those aspects, which may be affected by the modification.

All assessments and their results shall be documented in a report.

6.3.7 One-off products, pre-production products (e.g. prototypes) and products produced in very low quantity

The powered smoke and heat control ventilators (fans) produced as a one-off, prototypes assessed before full production is established, and products produced in very low quantities (less than 10 per year) shall be assessed as follows.

For type assessment, the provisions of 6.2.1, apply, together with the following additional provisions:

— in case of prototypes, the test samples shall be representative of the intended future production and shall be selected by the manufacturer;

— on request of the manufacturer, the results of the assessment of prototype samples may be included in a certificate or in test reports issued by the involved third party.

The FPC system of one-off products and products produced in very low quantities shall ensure that raw materials and/or components are sufficient for production of the product. The provisions on raw materials and/or components shall apply only where appropriate. The manufacturer shall maintain records allowing traceability of the product.

For prototypes, where the intention is to move to series production, the initial inspection of the factory and FPC shall be carried out before the production is already running and/or before the FPC is already in practice. The following shall be assessed:

— the FPC-documentation; and

— the factory.

In the initial assessment of the factory and FPC it shall be verified:

a) that all resources necessary for the achievement of the product characteristics included in this European standard will be available, and

b) that the FPC-procedures in accordance with the FPC-documentation will be implemented and followed in practice, and

c) that procedures are in place to demonstrate that the factory production processes can produce a product complying with the requirements of this European standard and that the product will be the same as the samples used for the determination of the product type, for which compliance with this European standard has been verified.

Once series production is fully established, the provisions of 6.3 shall apply.

7 Marking, labelling and packaging

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The PSHC ventilator (fan) shall be marked as follows:

— with the manufacturer’s name or trademark;

— with the resistance to fire classification;

— with the number of this European Standard and the year of its publication (i.e. EN 12101-3:2015), followed by the generic name of the product "Powered Smoke and Heat Control ventilator";

— with the model/type;

— with power requirements, e.g. power, current, voltage and rotational speed; the snow load class where applicable;

— with the flow direction inside the fan (motor upstream, downstream or both);

— with direction of motor shaft (vertical, horizontal or both);

— with minimum flow and maximum temperature of cooling air where applicable;

— with information about electrical connections of motor (e.g. Y or Δ);

— with the text "This Powered Smoke and Heat Control ventilator shall be installed as per the manufacturer's instruction";

— with the manufacturer's installation instructions or a reference to a document held by the manufacturer giving these instructions;

— with the date of manufacture (month and year).

Where regulatory marking provisions require information on some or all items listed in this clause, the requirements of this clause concerning those common items are deemed to be met.

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Annex A
(normative)

Criteria to determine family of fans in order to select the sizes to be tested

A.1 Reduction of numbers of tests for PSHC ventilators forming a product range

It is not usually considered necessary to test every size of ventilator in a family of fans provided that the following are tested and the family complies with the rules given in A.3, A.4 and Annex B:

a) the fan with the most highly stressed impeller, and the ventilators with impellers in which the individual stress in any component, weld or fastening is the highest, as appropriate, if not the same(see A.4);

b) for fans with motors mounted in an enclosure which restricts the cooling, the worst case shall be tested; this is the smallest free area of the motor enclosure or the smallest section of exit or entry airway for cooling air;

c) at least two sizes of fans are tested at their highest rotational speed;

d) the fan with the smallest motor frame size to be used, except for fans where the impeller is not mounted on the motor shaft and the motors are out of the airstream in ambient air and the cooling of the motor is not affected by heat transfer from the ventilator or the ventilator construction;

e) if the highest impeller stress levels are determined by geometric similarity conditions from A.4.1, sufficient sizes of fans to ensure that the impeller diameters of the range are from 0,8 to 1,27 of those tested;

f) if the highest impeller stress levels are determined by the calculation methods in A.4.2, sufficient sizes of fans to ensure that the impeller diameters of the range are from 0,63 to 1,27 of those tested;

NOTE The coefficients are coming from Renard Series R20 in accordance with several ISO standards. The aim of the coefficients 0,8 or 0,63 and 1,27 is to validate fans down to 2 or 4 sizes smaller and up to 2 sizes larger than the tested size. See Annex F for more information.

g) For a direct drive axial fan where the blade profile is not symmetrical and the fan may be supplied with motor upstream or motor downstream, the fan shall be tested with motor downstream, which is the worst case.

h) But if the fan range is intended to operate only with motor upstream, the tests can be performed in this configuration;

i) If a fan or range of fans is intended for installation in either vertical or horizontal or intermediate positions, a minimum of one fan shall be tested in each of vertical (shaft down and motor downstream or shaft up and motor upstream if the fan range is intended to work only with the motor upstream) and horizontal orientation;

j) If a family of axial fans is also intended to be used for jet fan application, a minimum of one size of fan shall be tested in the jet fan configuration;

k) A fan for use as a jet fan shall be tested completely assembled, with its ancillaries as listed in 4.1 if supplied with the jet fan. A test of the fan with only the inlet side silencer is allowed to qualify a jet fan, unless the jet fan is suspended by the silencers;

l) For a reversible fan or jet fan, equipped with a symmetrical impeller (symmetrical blade profile or impeller with alternate blades) the test shall be performed with motor downstream.

m) A fan shall be tested with any electrical device used in combination with the motor which could have a negative impact on the motor (e.g. change electrical signal, overheating, etc.).

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n) Fan driven by PWM frequency converter at ambient and at high temperature.

The currently well-known impacts of a PWM frequency converter driving on an electric three-phase motor are the following:

— creation of partial discharges through the air voids located inside motor insulation. These discharges are in proportion with the temperature;

— creation of voltage peaks higher than those obtained from direct online supply;

— damage in the windings due to these voltage peaks and voltage gradient (du/dt)

— influence of the cable type/ length;

— stray bearing currents.

In order to estimate the final impact of the combination of converter and cable on the motor, it is necessary to measure directly at the motor terminals by means of a suitable instrument (e.g. an oscilloscope), only at ambient temperature for 10 minutes before the warm up period of the test:

— the maximum peak voltage value Up or peak to peak Upk/pk as well as;

— the maximum rate of voltage rise du/dt of the voltage fluctuations as indicated in Figure A.1 and formula:

$du/dt = (0,9\ Up - 0,1Up)/(t90 - t10))$

Refer to EN 60034-18-41 for more details.

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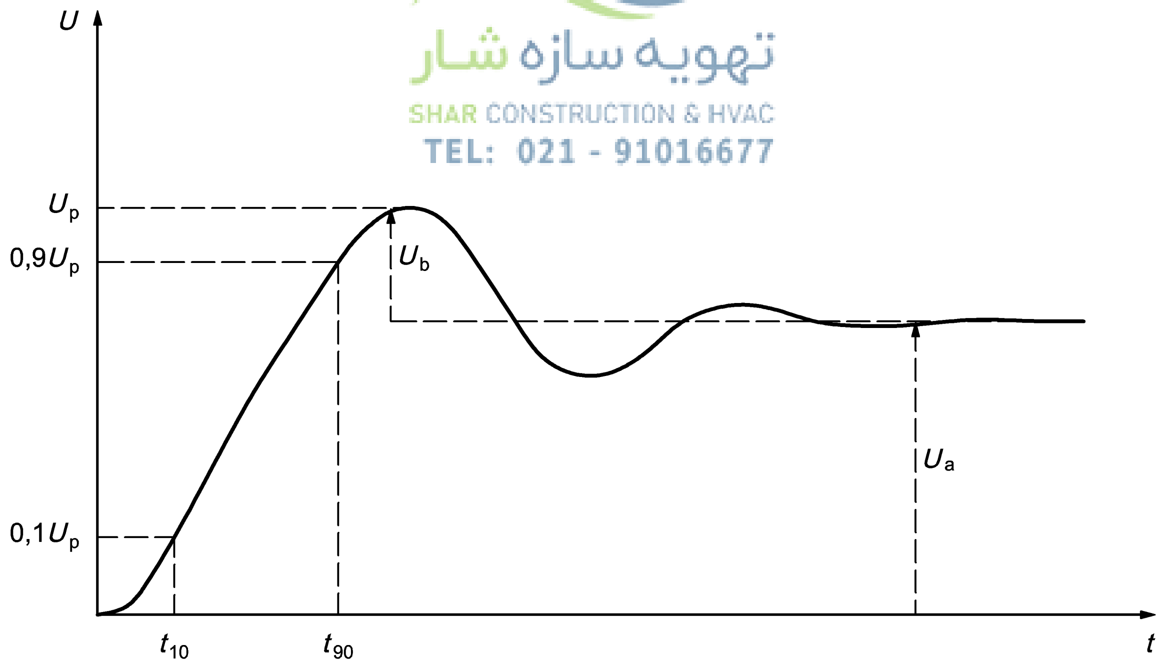


Figure A.1 — Voltage curve

Application of the test results:

The fan unit may be assumed to be able to withstand the same maximum peak to peak voltage values and rate of voltage rise at the motor terminals in an installation as during the test, independent of the Pulse Width Modulation (PWM) frequency converter.

a) Fan driven by PWM frequency converter only at ambient temperature

Fan tested direct on line can be installed with a frequency converter, provided the converter is by-passed during smoke and heat exhausting operation, without additional testing.

b) Fan driven by voltage converter (but switched off during smoke exhausting).

A motor which is supplied from a voltage converter may experience an increased temperature rise when run at a reduced voltage.

Because of this effect on the temperature rise inside the motor, the warm-up period of the test shall be performed with the output of the voltage converter set to run the motor at 70 % of nominal speed.

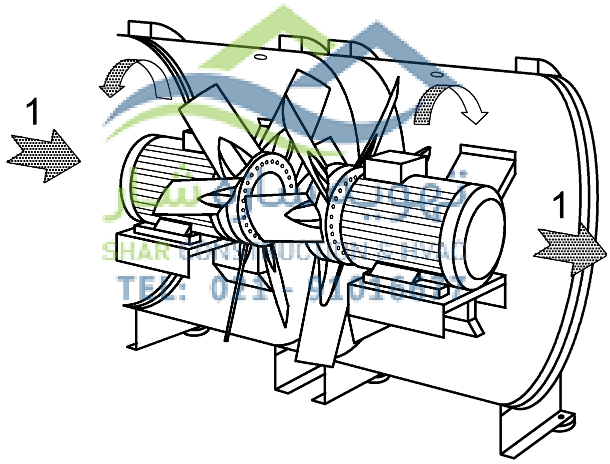
The temperature rise of the motor during this warm up period shall not be greater than one class lower than the insulation class of motor.

c) Fan started by soft starter.

Since the soft starter is bypassed just after the motor starting, it is not obligatory to test it, especially if the fan manufacturer wants to get both applications (with and without soft starter).

d) Contra-rotating installation

Such installation does not require any additional test provided the fan range was tested individually with motor downstream (see Figure A.2).



Key

1 air flow

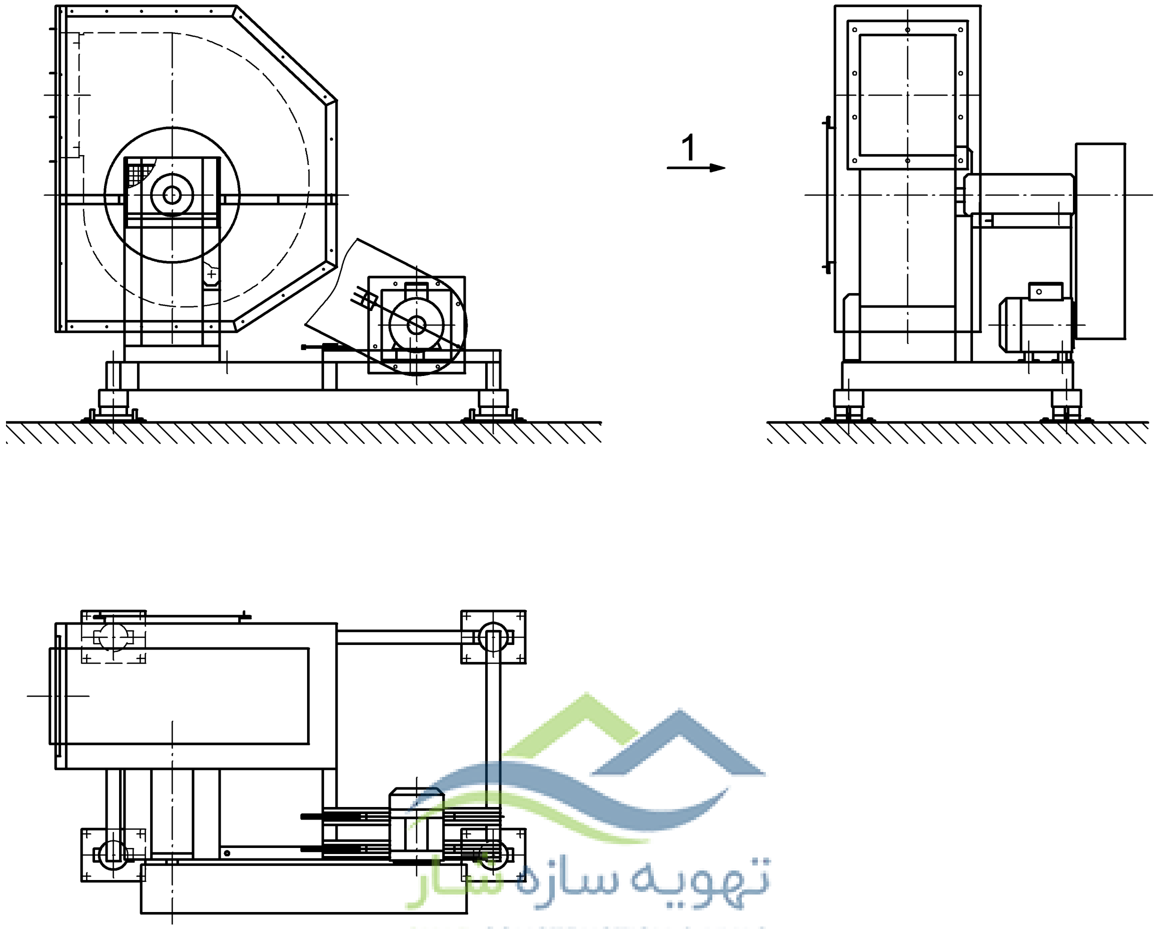
Figure A.2 — Contra-rotating installation

A.2 Motors

A.2.1 General

A family of motors shall only be assessed if the smallest and largest frame size motors used in the family are tested within the fans, at their highest ratings (voltage, power, rotational speed…), except when the impeller is not mounted on the motor shaft and the motors are out of the air stream in ambient air and the cooling of the motor is not affected by heat transfer from the ventilator or the ventilator construction(type 1) .When the motor is out of the air stream and the impeller is mounted on the motor shaft (type 2), motors from a different supplier to the one used in the ventilator test may be used, provided that the tested and alternative motors are of the same construction, i.e. same class of insulation and bearing type and class of fit and same synchronous speed and rating.

A.2.2 Motor Type 1: Motor out of airstream and Impeller not mounted on shaft



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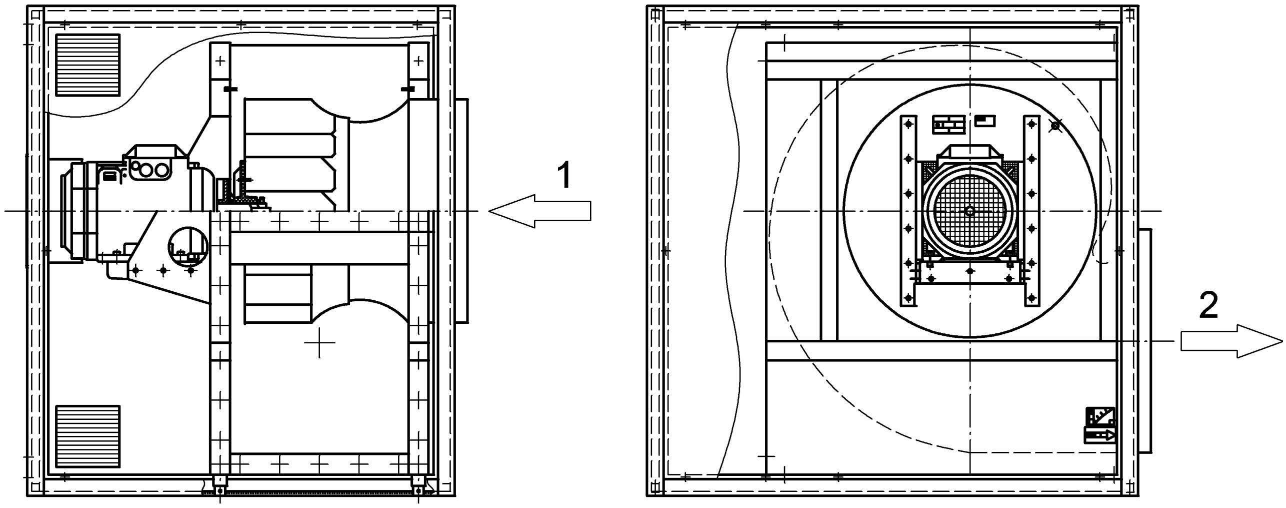
Key

1 air flow

Figure A.3 — Motor Type 1

In this case, motors Type 1 do not need to be approved and there are no requirements, except those described in 4.2.3.

A.2.3 Motor Type 2: Centrifugal fans with impeller mounted on the motor shaft



Key

1 air flow (inlet)

2 air flow (outlet)

Figure A.4 — Motor Type 2

Motors Type 2 shall be tested.

For interchange-ability, the motor winding temperature shall be measured just after the test (according to the resistance measurement method of EN 60034-1) to ensure that the temperature rise inside the motor is equal to or lower than that permitted for the insulation class. For example, with a standard class F motor, the motor winding temperature rise at the end of the high temperature test shall not exceed the class F requirement, i.e. 105 K.

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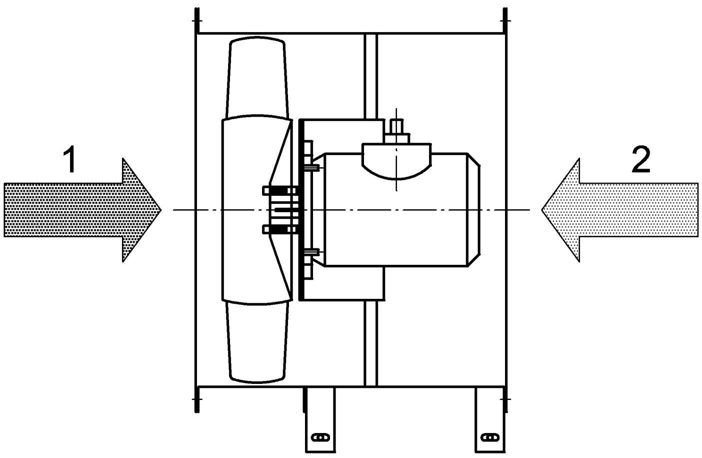
Where single-phase motors were tested, the above rule for motor interchange-ability will apply, provided that the alternative capacitor is located at the same place (a plastic capacitor can be replaced by an aluminium capacitor but not vice-versa).

Otherwise a motor cannot be changed without a new test. If new tests are required, see A.3.

A.2.4 Motor Type 3: Fans with motor inside the airstream without cooling



Key

1 air 1
2 air 2

Figure A.5 — Motor Type 3

Motors Type 3 shall be tested and interchange-ability is only possible with other motors already tested under specific conditions, see A.3.

A.2.5 Motor Type 4: Motors out of airstream but within fan casing

A.2.5.1 General

Motor Type 4: Fans with insulation class F (temperature rise B) or class H (temperature rise F) standard motors for F_{400} and lower temperature/times classes and motors affected by thermal transfer.

See examples in A.2.5.2 and A.2.5.3.

A.2.5.2 Motor Type 4.1

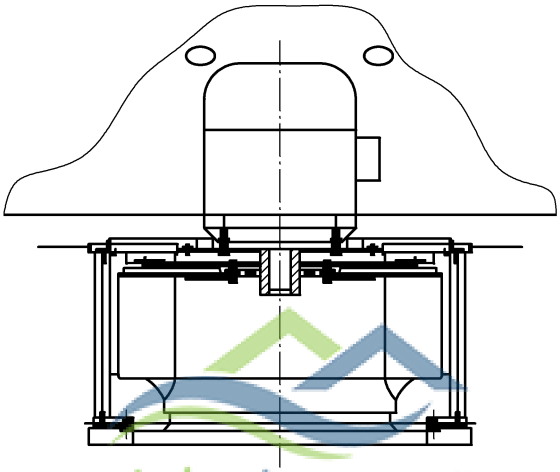


Figure A.6 — Motor Type 4.1

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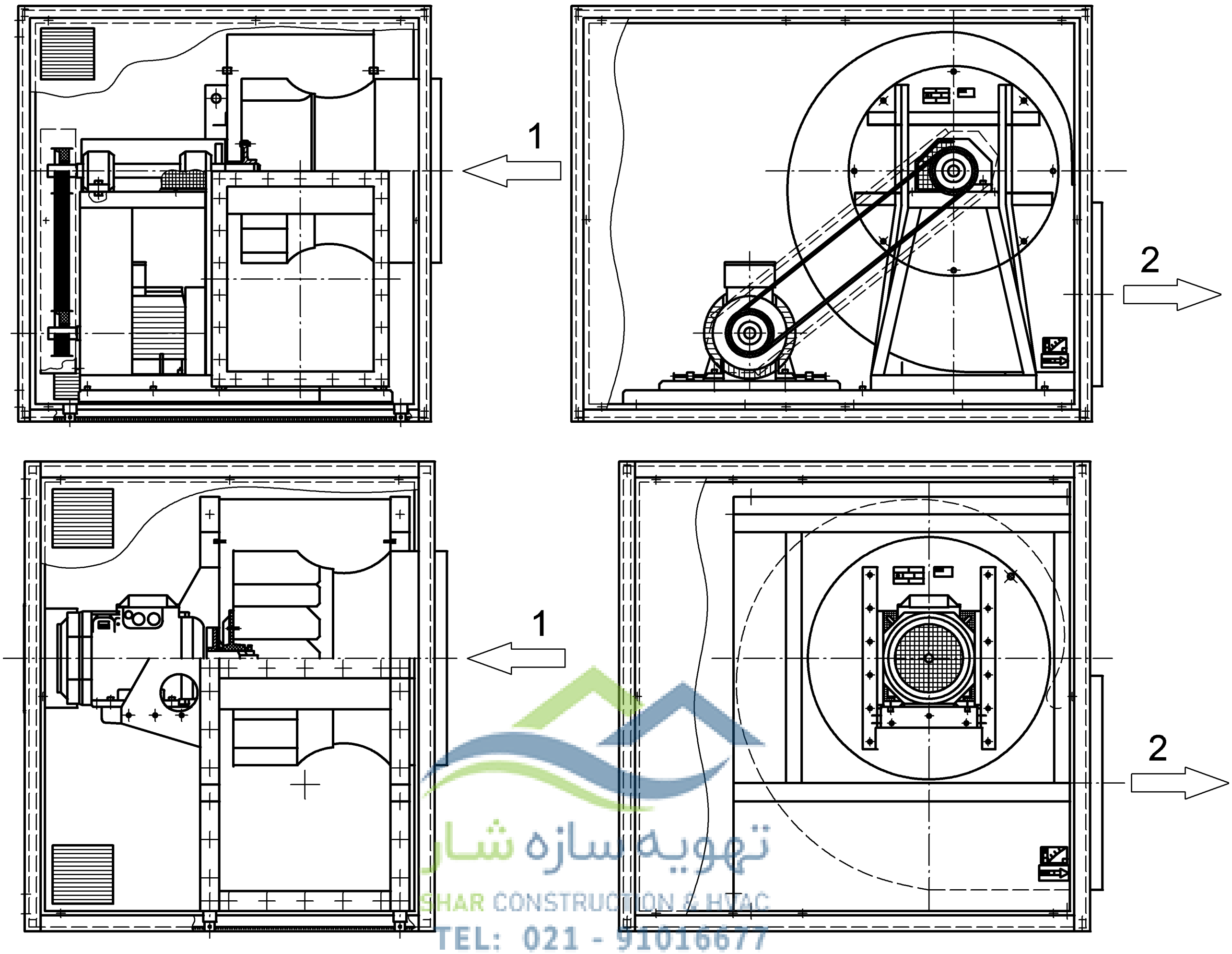
Motors of type 4.1 shall be tested.

For interchange-ability, the motor winding temperature shall be measured just after the test (according to the resistance measurement method of EN 60034-1) to ensure that temperature rise inside the motor is equal to or lower than that permitted for the insulation class. For example with a standard class F motor, the motor winding temperature rise at the end of the high temperature test shall not exceed the class F requirement, i.e. 105 K.

Where single-phase motors were tested, the above rule for motor interchange-ability will apply, provided that the alternative capacitor is located at the same place (a plastic capacitor can be replaced by an aluminium capacitor but not vice-versa).

Otherwise the motor cannot be changed without new test. If new tests are required, see A.3.

A.2.5.3 Motor Type 4.2



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Key

1 INPUT

2 OUTPUT

Figure A.7 — Motor Type 4.2

Motors of type 4.2 shall be tested.

For interchange-ability, the motor winding temperature shall be measured just after the test (according to the resistance measurement method of EN 60034-1) to ensure that temperature rise inside the motor is equal to or lower than that permitted for the insulation class. For example with a standard class F motor, the motor winding temperature rise at the end of the high temperature test shall not exceed the class F requirement, i.e. 105 K.

Where single-phase motors were tested, the above rule for motor interchange-ability is the same, provided that the alternative capacitor is located at the same place (a plastic capacitor can be replaced by an aluminium capacitor but not vice-versa).

Otherwise the motor cannot be changed without new test. If new tests are required, see A.3.

A.3 Combined testing

A.3.1 General rule

To allow the mounting of a new family of motors inside an already tested family of fans:

— test the smallest and largest frame motors sizes at their highest ratings within fans provided that the motors are part of the same homogeneous range (according to 3.13 and 3.14 definition).

A.3.2 Specific rule for an axial fan

When the family of fans is large, the motor family may consist of two or more homogeneous ranges. This means that for each homogeneous family, both smallest and largest frame sizes shall be tested (i.e. 4 or more tests).

However if the alternative motor family was already successfully tested according to annex D, or within another family of fans, in accordance with the same criteria listed in A.1 and for the same temperature-time classification, only the smallest and largest frame size of the complete motor family shall be retested within the fans (only 2 tests).

An example is following:

Fan family A tested with motor range X consisting of 2 homogeneous families

X1: Frame sizes 80 to 132

X2: Frame sizes 160 to 250

According to Annex B the frame sizes 80, 132, 160 and 250 were tested during the initial assessment.

Fan manufacturer wants to mount motor family Y consisting of 2 homogeneous families:

Y1: Frame sizes 90 to 112

Y2: Frame sizes 132 to 225

If Y motors were never tested, tests of 90, 112, 132 and 225 frame sizes motors shall be carried out.

If Y motors (at least the 90 up to 225 frame sizes range) were successfully tested with a load (acc. to annex D) or within a fan family B with the same criteria in accordance with A.1 and for the same temperature-time classification, then re-test only 90 and 225 frame sizes.

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A.4 Determination of highest stresses in impellers

A.4.1 PSHC Ventilators with geometrically similar impellers

For geometrically similar impellers the impeller with the highest peripheral speed is the most highly stressed.

Impellers are geometrically similar if all dimensions, excluding thickness of materials, are within 5 % of the values scaled by the ratio of the impeller diameters, and the numbers of blades and fastenings are identical. The centre boss is excluded from the geometric similarity requirements.

Table A.1

A fan family is geometrically similar if the fans of that family are manufactured according to standard series numbers R10, R20, R40 or according to self-defined design size increments (following a fixed size ratio), assuming similarity of the following component dimensions:			
Axial fans			
Geometrical parameters		Geometrical similarity	
Impeller diameter	D	e.g., R10, R20; R30 or self-defined design size increments	Dimensions according to drawing - check
Hub diameter	d	e.g., R10, R20; R30 or self-defined design size increments	Dimensions according to drawing - check
Number of blades	z	Testing is carried out with the maximum number of blades, i.e., max. load on the hub	Number of blades may be reduced after testing since hub load will thus be reduced.
Blade width at D (external diameter)	B_D		Dimensions according to drawing - check
Blade width at d (internal diameter)	B_d		Dimensions according to drawing - check
Blade length	l	$\frac{D-d}{2}$ Max. blade length is tested at max. load	Dimensions according to drawing - check Blade length may be reduced, with simultaneous reduction in casing diameter, taking into account the load.
Blade profile shape		Linear form factor	Dimensions according to drawing - check
Hub width	w	e.g., R10, R20; R30 or self-defined design size increments	Dimensions according to drawing - check

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Table A.2

Design characteristics			
If the fan and casing are built from sheet metal, geometrical incrementing of the sheet metal thickness is not necessary.			
Fastening method		Geometrically uniform fastening method (welding, screws or riveting) across the entire series	Change of fastening method within the series is not possible without testing. Welding: Execution of welds shall be identical, i.e., continuous weld seams, weld shape (fillet weld, square/bevel groove weld), length of weld shall be geometrically similar Rivet and screw joining methods: If, for instance, 5 rivets are used on small impellers, at least 5 rivets shall likewise be used on all fans in the series according to the calculation method.
Material		Identical material, no mixing	Uniform materials and uniform material combinations to be used across the entire series
Hub section		1. Geometrical similarity 2. Hub supports (connection piece between hub and motor shaft) may differ as appropriate	2. With externally sourced hub supports, geometrical similarity cannot be maintained. Calculated proof of screw attachment is required.
Motor mounting type		Motor mounting type shall be the same for the entire series	
		Motor mounting type shall be the same for the entire series	
		Geometrically similar	For motor supports: S= Material thickness G= Motor weight e.g.,. $\frac{s}{G}$ Least favourable conditions, related to design size, shall be tested.
Centrifugal fans			
Blade outlet diameter	D	e.g., R10, R20; R30 or self-defined design size increments	Dimensions according to drawing - check
Blade inlet diameter	d	e.g., R10, R20; R30 or self-defined design size increments	Dimensions according to drawing - check
Blade radius	r	e.g., R10, R20; R30 or self-defined design size increments	Dimensions according to drawing - check

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A.4.2 Fans with impellers that are not geometrically similar

NOTE The method given for calculating stresses is for comparative purposes only and is not suitable for design assessment. It only takes into account centrifugally induced stresses as aerodynamically induced stresses are of less importance.

A.4.2.1 Axial impellers

A.4.2.1.1 Centrifugal force

Divide the blade into four parts using five sections as shown in Figure A.8.

Calculate the centrifugal force for each part as follows

$$F_{n,n+1} = \rho \times \frac{A_n + A_{n+1}}{2} \times (R_{n+1} - R_n) \times \frac{(R_{n+1} + R_n)}{2} \times \omega^{2}$$

where

$F_{n,n+1}$	is the centrifugal force in Newton of the part of the blade between sections n and n+1;
ρ	is the density in kg/m^3;
A_n	is the area of section n in m^2;
R_n	is the radius of section n in m;
ω	is the angular velocity in radians/s.

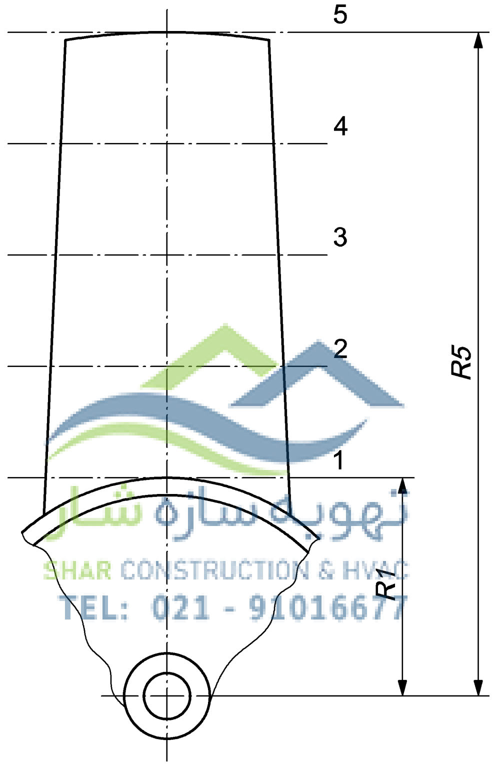

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Figure A.8 — Axial impeller, blade divided into four parts using five sections

Calculate the tensile stress as follows, see Figure A.9.

$$\sigma_{Tn} = \frac{F_n}{A_n} \times 10^{-6}$$

NOTE 10^{-6} is calculation factor to have A_n in mm²

where

σ_{Tn}	is the tensile stress in N/mm^2;
n	is the number of the section.

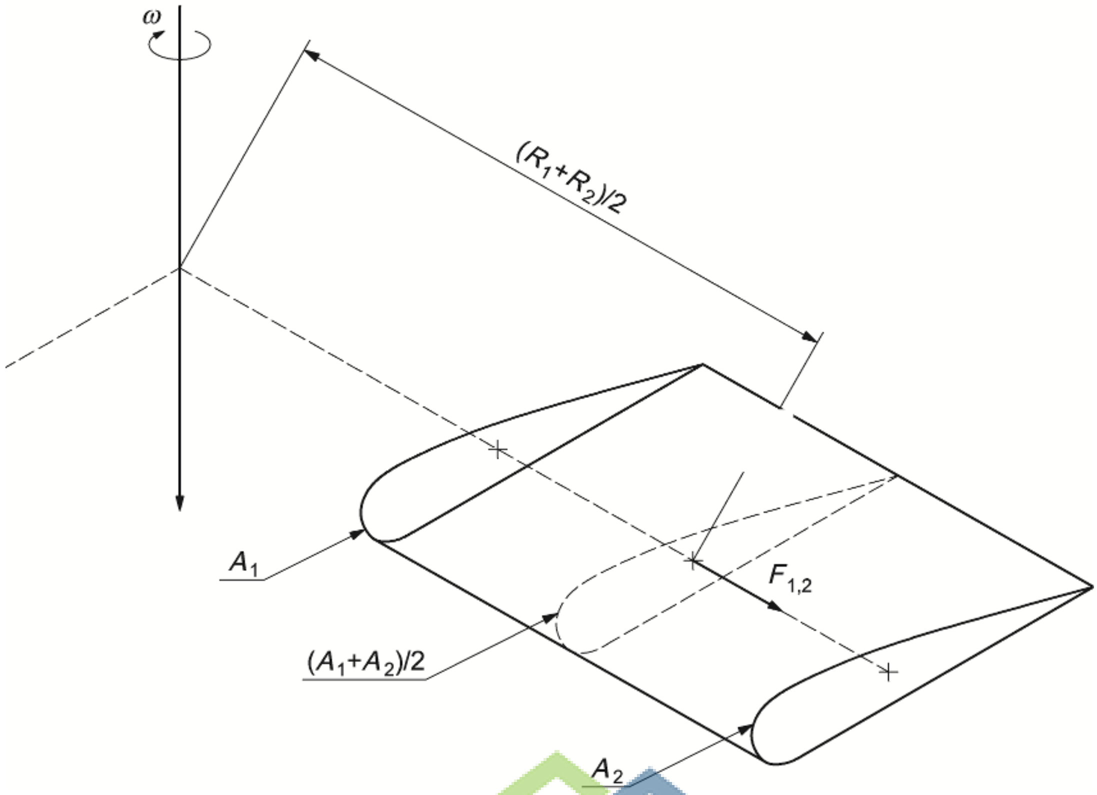

Figure A.9 — Axial impeller, application of centrifugal force $F_{1,2}$

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A.4.2.1.2 Fastenings or welds

Treat fastenings or welds as the inboard end of the blade section with the cross section area calculated from the weld or fastener area.

To simplify the calculation the stress to be calculated shall be the Force due to the blade divided by the cross section of the studs

Case of stud fixed blades

Sigma = F_1 / (N' x A)

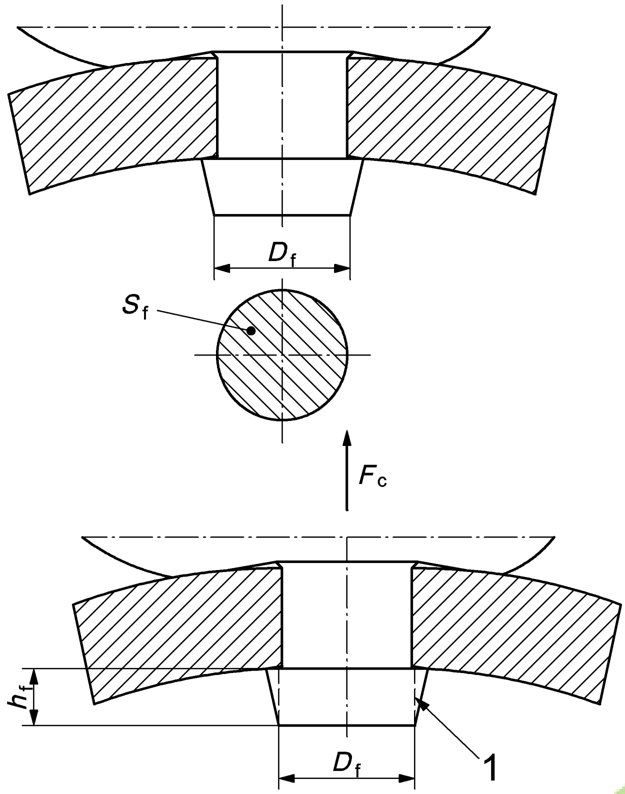
$$\sigma_f = \frac{F_1}{N'.A}$$

where

- N' is the number of studs
- A is the resistant cross section of a stud

Fastenings or welds

Treat fastenings or welds as the inboard end of the blade section with the cross section area calculated from the weld or fastener area.



$$\sigma_1 = \frac{F_1}{S_f} = \frac{F_1}{\pi \times \frac{D_f^2}{4}}$$

$$\sigma_2 = \frac{F_1}{\pi . D_f \times h_f}$$

Key

1 Shearing according to Fc

Figure A.10 — Blades with a shank

Then the fastening stress is σf = Max (σ1, σ2)

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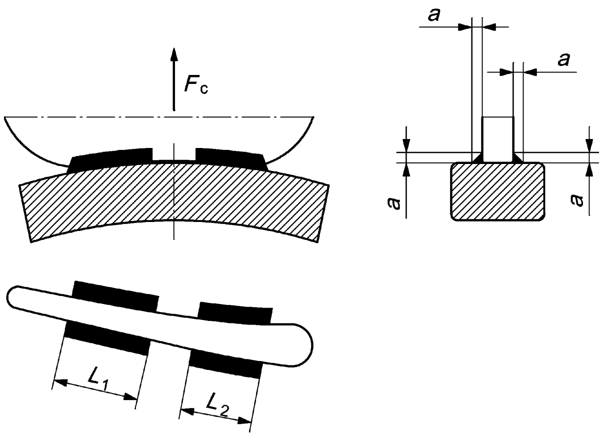

$$\sigma_2 = \frac{F_1}{2 \times a \times (L_1 + L_2)}$$

Figure A.11 — Welded blades

A.4.2.1.3 Hub/back-plate/shroud stresses

Consider only forces due to centrifugal effects. The stresses on the hub are a combination of the self-induced stress due to the rotation of the hub, the hoop stress due to the loads imposed by the blades, and the bending stress due to the point loads of the blades.

$$\sigma_{si} = \frac{\rho \times R_h{}^2 \times \omega^2}{10^6}$$

where

- σ_{si} is the self-induced stress in N/mm^2;
- R_h is the maximum hub radius in m;
- ω is the angular velocity in radians/s;
- ρ is the density in kg/m^3.

Assume that only the section of the hub/back-plate/shroud approximately symmetrical about the plane of rotation through the centre of the blade fixing is supporting the blades, see Figure A.12, then calculate the hoop stress,

$$\sigma_h = N \times F_1 \; / \; (2 \times \pi \times A_{csm})$$

where

- σ_h is the hoop stress in N/mm^2;
- N is the number of blades;
- F_1 is the total blade centrifugal force in Newton;
- A_{csm} is the cross sectional area of the hub in mm^2.

Calculate the section modulus Ix/v about an axis through the section centre of area, parallel to the axis of rotation, where v is the distance from this axis to the outside of the hub/back-plate/shroud supporting the blade. Then calculate the bending stress.

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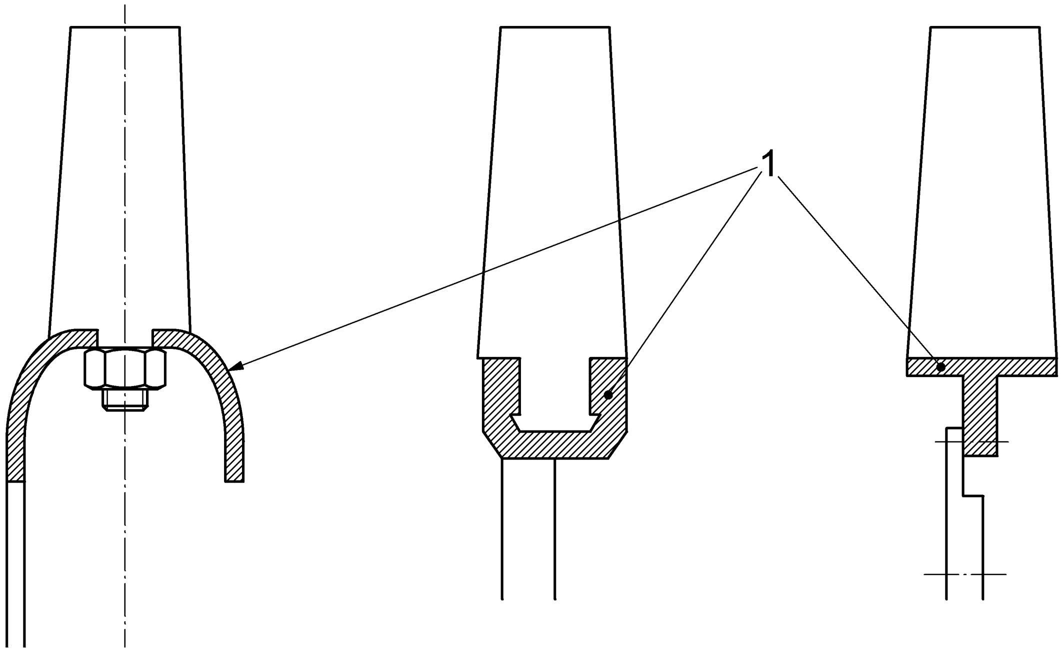
$$\sigma_b = F_1 \times 2\pi \times R_h \times 10^3 \; / (N \times 12 \times \frac{Ix}{v})$$

where

- σ_b is the bending stress in N/mm^2;
- Ix/v is the section modulus of A_{csm} section in mm^3;

Then using linear hypothesis:

Total stress = $\sigma_{si} + \sigma_h + \sigma_b$



Key

1 A_{csm}

Figure A.12 — Portion of hub to be used for calculation

NOTE Shaded parts show portion to be used for calculation.

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A.4.2.2 Centrifugal impellers

A.4.2.2.1 Centrifugal force

The centrifugal force is calculated by treating the blade as one piece, as follows:

$$F = \rho \times A_b \times L \times R \times \omega^2$$

where

- F is the centrifugal force in N;
- ρ is the density of blade material in kg/m^3;
- A_b is the cross section area of the blade at the centre of gravity, perpendicular to the axis of rotation in m^2;
- L is the distance between the back-plate and shroud, through the centre of gravity, parallel to the axis of rotation, in m;
- R is the radius of blade centre of gravity about the axis of rotation, in m;
- ω is the angular velocity of impeller in radians/s.

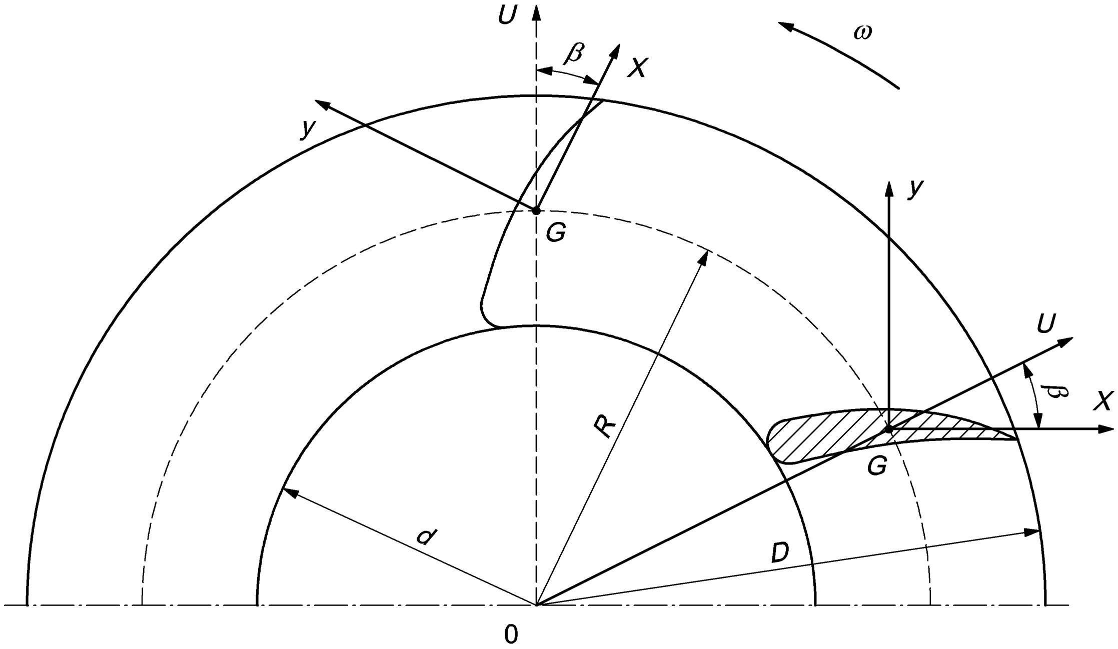

Figure A.13 — Centrifugal impeller, calculation of centrifugal forces about a principal axis

A.4.2.2.2 Blade bending moment

$M = F \times L / k$

where

- F is the centrifugal force defined in A.4.2.2.1;
- L is defined in A.4.2.2.1;
- M is the bending moment in *Nm*;
- k is a constant depending on the type of impeller construction (for comparative purposes use, it may be assumed that k = 1).

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A.4.2.2.3 Comparative blade stresses

To calculate comparative blade stresses resolve the bending moment about the principal axis and the stress calculated as follows:

$$\sigma_{Z1} = \frac{F \times \sin\beta \times L / k}{Z_{X\,\min}}$$ or $\sigma_{Z1} = 1\,000 \times M \times \sin\beta / Z_{X\,\min}$

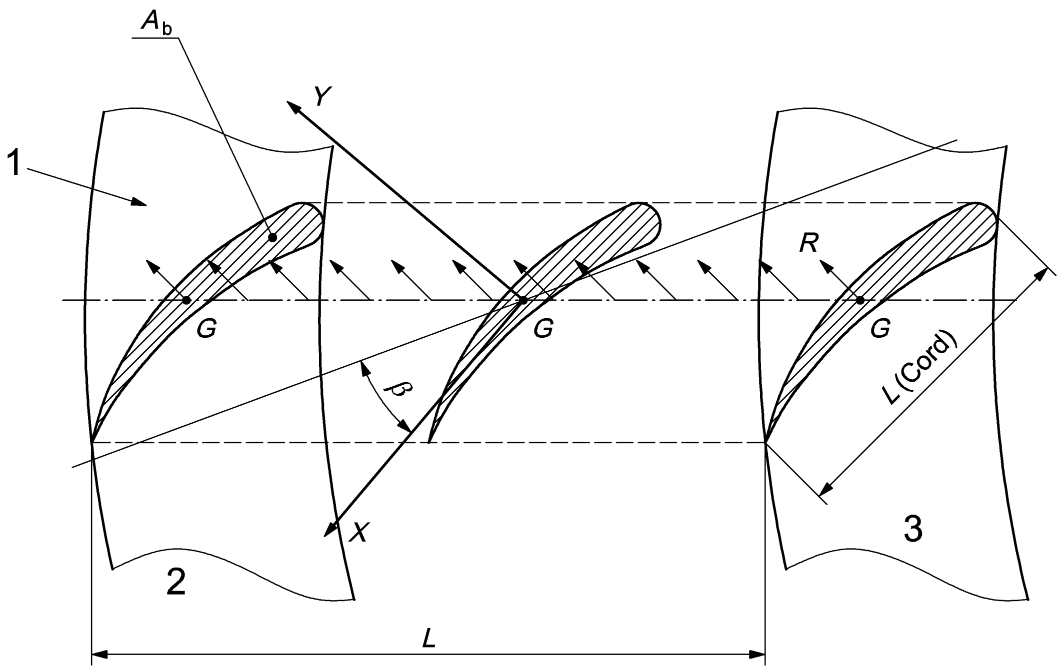
with M = F x L / k

$$\sigma_{Z2} = \frac{F \times \cos\beta \times L / k}{Z_{Y\,\min}}$$ or $\sigma_{Z2} = 1\,000 \times M \times \cos\beta / Z_{Y\,\min}$

with M = F x L / k

where

- σ_{Z1} and σ_{Z2} : Bending stresses about principal axis X and Y in N / mm² (most of the time, $\sigma_{Z2} < \sigma_{Z1}$)
- β angle between principle axis and the radial line of impeller
- $Z_{X\,\min}$ and _ $Z_{Y\,\min}$: Section modulus about principal axis X and Y in mm^3



Key

1 Centrifugal impeller
2 Back=plate
3 Shroud

Figure A.14 — Centrifugal impeller, calculation of σ_{Z1}

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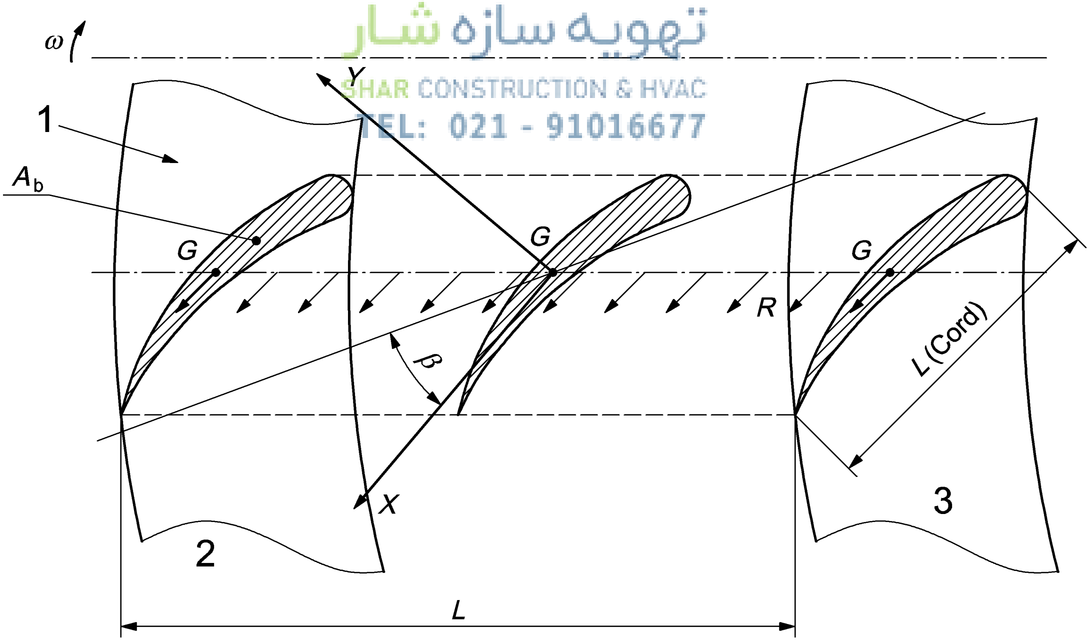


Key

1	Centrifugal impeller
2	Back=plate
3	Shroud

Figure A.15 — Centrifugal impeller, calculation of σ_{Z2}

A.4.2.2.4 Blade joint stress

Calculate the relative shear stresses at each blade joint as follows

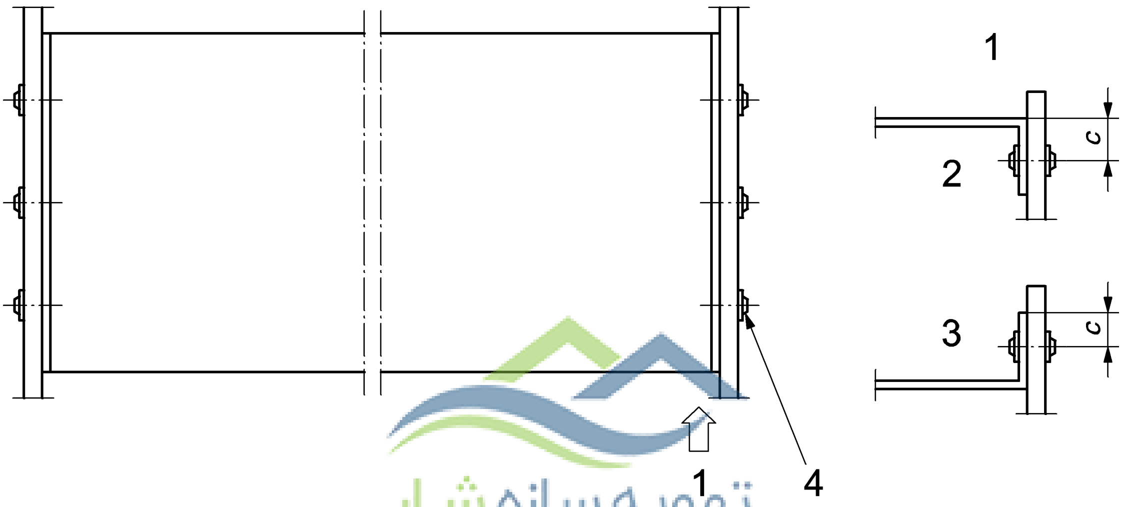
$$\sigma_s = F / A$$

where

σ_s is a shear stress in N/mm^2;

A is the area of cross section of fastening at joint in mm^2.

In specific cases the fastenings experience tensile stress and not shear stress; e.g.:



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Key

1 view X

2 Inner fastening

3 Outer fastening

4 Rivets or spot welding

Figure A.16 — Centrifugal impeller, calculation of blade joint stress

Calculate also the relative tensile stresses at each blade joint as follows

$$\sigma_t = F \times L / (A \times c)$$

where

σ_t is a tensile stress in N/mm^2;

A is the area of cross section of fastening at joint in mm^2;

c is a distance in mm, see the above scheme.

A.5 Assessment of changes in a fan family

A.5.1 Assessment of motor change

If motors of a different construction or from a different a supplier to the one that has been tested are used, the assessment shall be made, in accordance with Annex A, A.2.

A.5.2 Assessment of fan component change

The changes made to the fan family that has been tested shall be re-assessed as follows:

After the initial assessment of a fan family including blades made of material alloy A, the way to replace material A by material B (of the same main component) is as follows:

First option

Retest the fan including the most highly stressed impeller with material alloy B. The test duration of alternative impeller material shall be at least the duration of the initial assessment.

Second option

Comparison mechanical tests shall be performed on 5 blades samples (finished worked component in order to take into account the manufacturing process) made of both alloys.

This comparison tests shall be performed at the aimed classification temperature and during the whole test period (same heat up period time and temperature time period as in annex C).

1) If

$(R_{p02})_2 \geq (R_{p02})_1$

and

$(\text{Creep})_2 \geq (\text{Creep})_1$ (for the classification time, the classification temperature and the force applied to the blade in the fan) and the material has the same geometry, and the same or better surface roughness and the same or better grain size and

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$\rho_2 \leq \rho_1$

and

$\alpha_2 \leq \alpha_1$

and

$E_2 \geq E_1$

then, the new material is OK

2) If

$\alpha_2 > \alpha_1$

or

$E_2 < E_1$

the material is OK, but the new clearance shall be checked

3) If

$\rho_2 > \rho_1$

then it shall be checked that

$$(R_{p02} / \sigma_{cal})_2 \geq (R_{p02} / \sigma_{cal})_1$$

See Annex F for more explanation.

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Annex B
(normative)

Criteria to determine a family of motors in order to select the sizes to be tested

B.1 Reduction of numbers of tests for a motor family

It is not usually considered necessary to test every size and speed of motor to be used in a family of fans. Provided tests are carried out on the largest and smallest motor frame size at the highest ratings (i.e. highest voltage rotational speed and power) it is assumed that all the motors in a range will comply with the standard.

If the difference between two frame sizes is only the height of feet, (e.g. the frame size between sizes 80 and 90) a test performed on the 90 frame size is also valid for 80 frame size, provided the active parts are strictly the same.

When motors are direct on line (D.O.L.) tested at 50 Hz, the application at 60 Hz (D.O.L.) with the suitable voltage (keeping the voltage/frequency ratio) is also covered for motors of the same family including the same bearings and lubrication and having a higher pole number than the tested pole number, provided the rated power at 60 Hz, corresponding to maximum 1,15 times the power rated at 50 Hz, is covered by the family tested at 50 Hz.

Example: A test of 2 pole motors (frame size 80 at 1,1 kW + frame size 250 at 55 kW) tested direct on line on 400 V/ 50 Hz network will be valid for 4 poles motors supplied by D.O.L. network 440-480V / 60 Hz for frame sizes with a rated power corresponding to maximum 1,15 times the power rated at 50 Hz (frame sizes 80 to 225 in this case).

Tables B.1, B.2 and B.3 give the parameters to be taken into account to check if the motors are part of the same family, according to 3.14 and 3.15. This list of motor components shall be delivered by the motor manufacturer to the laboratory <u>**before**</u> selecting the specimen to be tested according to A.1.

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The preferred method to prove the resistance to temperature of electric motors for use in powered ventilators (fans) is to test the motor at elevated temperature in a powered ventilator (fan). The motor is shown to be functioning satisfactorily if the fan is continues to provide the required volume flow for the duration of the test, see C.5.

B.2 Assessment of changes in a motor family

B.2.1 Assessment for changing a family of motors in a family of fans

The assessment for changing a family of motors in a family of fans shall be in accordance with Annex A, A.2.

B.2.2 Assessment for changing components in a family of motors

The assessment for changing components in a family of motors shall be done in order to check if the changes do not worsen the performance of the family of fans. In that case, further specific tests are necessary to verify performance.

If more than one material of the insulation system within the production life time of the motor (line "wiring insulation" up to "winding impregnation") is changed, it shall be considered as a new family of motors and both smallest and largest frame sizes shall be retested.

The following Tables B.1, B.2, B.3 and B.4 specify the relevant components and the way to change them.

Table B.1 — Mechanical critical components in a motor

Elements	Security level	How to change
Housing(carcase) material	Critical	Test performed with cast iron / steel frame are not valid for aluminium frame. The smallest (thermally critical) and largest frame (mechanically critical) sizes of the whole range shall be re-tested. If the whole range consists of several previously evaluated smaller homogeneous ranges, the intermediate sizes need not be re-tested. Test performed with aluminium frame are not valid for cast iron / steel frame, except if additional technical evidence is available (e.g. calculations, temperature rise consideration …etc.). A successful re-test of the smallest motor frame size is sufficient to demonstrate.
Housing (carcase) design (e.g. ribs size, spacing and distribution but not method of mounting)	Critical	The design is directly linked to the rate of thermal exchange, so the change is not possible, except if additional technical evidence is available (e.g. calculations …etc.). Successful comparison tests according to B.2.3. between original and alternative design performed on a representative sample is sufficient to cover the change.
End Shields (Drive End and Non Drive End) material	Critical	Test performed with aluminium frame are valid for cast iron / steel frame but not vice versa.
Cooling impeller material	Critical	“No impeller” is considered as more critical than a plastic impeller, itself more critical than an aluminium impeller, itself more critical than a cast iron / steel impeller. This component is not critical for axial fans where the motor is in the airstream.
Fan cover	Critical	“No impeller casing” is considered as more critical than a plastic casing, itself more critical than an aluminium casing, itself more critical than a cast iron / steel casing. This component is not critical for axial fans where the motor is in the airstream
Bearing type (ball, rollers...)	Critical	In order to replace a ball bearing by an angular contact bearing for vertical application (including the same grease), then retest the smallest motor equipped with an angular contact bearing. The motor shall be tested with the highest axial load consistent with the specified expected bearing life for the motor range. This configuration is reached by weighting if necessary the hub of the impeller to increase the axial force. For a motor range approval made acc. to Annex D, the test for changing the ball bearing into an angular contact bearing shall be made with a test bench in vertical position, applying the highest permitted load on the bearing.
Class of fit / Bearing Clearance	Critical	C0 is considered as more critical than CN, itself more critical than C3, itself more critical than C4.
Arrangement (locked/floating)	Informative	Changes are allowed, provided that the axial clearance between end shield and bearing is the same or higher than tested. If test was performed on motor where both bearings are floating, it is not possible to mount any motor with one locked bearing.
Lubricant/grease	Critical	Only the tested grease can be used. A new test is required for a new grease. Test only the motor or the fan with the motor including the bearing which has the highest peripheral speed (i.e. rotation speed x medium diameter of the bearing).If several bearings sizes have the same highest peripheral speed, select from these the bearing which has the highest rotation speed

Table B.2 — Electrical and insulation critical components in a motor

Elements	Security level	How to change
Rotor (material of bars, end rings)	Critical	A range tested with copper bars is valid only for copper cage. A range tested with aluminium cage is valid for both, provided the full load power and temperature rise are not increased.
Lamination steel grade	Informative	This grade is usually changed to increase the efficiency. No extra test is required, provided the core length is not reduced.
Stator	Informative	Manufacturing and assembling method, motor outline range drawing showing the main dimensions of motor and a table with the dimensions for each size are required.
Internal cooling impeller	critical	If at least one motor was tested with an internal cooling impeller, an impeller made of the same material can be mounted in other motor sizes if required to meet requirement of temperature rise
Wiring insulation *	Critical	If the wire insulation change comes from a change of its material, there is a doubt concerning its association with other insulation materials of the stator. Retest the smallest motor / the fan with the smallest motor, because it includes the highest windings density and because it has the smallest thermal inertia
Slot insulation *	Critical	Suppliers' data sheets that show that the new insulation material is identical to the tested insulation material are acceptable (Identical means exactly the same material and not only the same thermal classification). Otherwise retest the smallest motor frame. An increase in the thickness of identical material is allowed without retesting.
Interlayer insulation(between windings inside a same slot, *	Critical	Idem
Slot wedge *	Critical	Idem
Phase insulation *	Critical	Idem
Lacing ribbon *	critical	Idem
Winding impregnation *	Critical	Only the resin tested or exactly the same material as tested is accepted. Otherwise retest the smallest frame size which is the most critical regarding the penetration of impregnation varnish.
Method of impregnation *	Critical	If the method of impregnation is changed retest the smallest motor frame size manufactured with the alternative method, except if the initial method was one dipping and the manufacturer decides to use two dipping.
Terminal box or flying leads	Critical	Test performed on a motor equipped with a terminal box is only valid to cover motors equipped with terminal boxes. Test performed on a motor equipped with flying leads only covers motors equipped with flying leads .A test of one example of the alternative configuration is sufficient to allow the change. Where the same type (insulation, manufacturer) of cables is used for both applications (same cable as flying leads is used to connect winding heads to the terminal board and also from terminal box to outside), the test with terminal box will cover the flying leads application.
Terminal board	Critical	Change of this element can be carried out if it is separately tested in its terminal box at equivalent voltage and at the specified classification temperature + 50°C inside the terminal box, using the same cables and way of fixing them. The change is acceptable if no short-circuit occurs during the specified classification time.
Terminal leads,	Critical	These leads are internal part of the motor and shall be tested with the smallest motor frame.
Gland and gland sealing, if fitted	critical	No gland (and no protection during the test) is considered as more critical than a plastic gland, itself more critical than metal gland.

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Insulation and type of connection between terminal leads and stator winding	critical	The method of connection (e. g. clamping or welding) and the material of the insulation sleeve protecting this connection are both critical. If one or other of these parameters is changed, retest the smallest motor frame size.

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Table B.3 — Variant acceptability

Elements	Security level	How to change
Application (Direct On Line, frequency converter)	critical	Tests made with a frequency converter are valid for DOL operation at the same voltage and frequency. When the initial assessment is performed direct on line (DOL), no further test is required for use with converter provided that: - any of the four filters described in Table B.4 is used with the converter; and - the power of the motor is de-rated by 20 %* or by a factor that will result in the DOL or lower temperature rise *based on CLC/TS 60034-17 If the initial assessment is performed in DOL application and the fan family needs to be installed with frequency converters without filters or de-rates, then retest both the smallest and largest frame motors at their highest powers and voltage, supplied from frequency converters in accordance with A.1.n)
Forms of running (horizontal, vertical)	critical	If a motor or family of motors is intended for installation in either vertical or horizontal or intermediate positions, a minimum of one motor shall be tested in each of vertical (shaft down and motor downstream or shaft up and motor upstream) and horizontal orientation
Air direction (motor upstream, motor downstream or both)	critical	Worst case valid for both. See A.1 g) and i)
Mounting feet or flange or foot and flange.	Informative	
second end shaft	Informative	
Protection IP56 and IP65	Informative	
Use grease nipples	critical	Tests done with grease nipples are valid with permanent grease bearings
Reinforced bearing series 63	critical	62 series is considered as more critical than 63 series.
Options		
Sensors	critical	It is only possible to use sensors PTC, Pt100 or bimetallic detectors if they are disconnected in case of a fire emergency, and if they were present during the tests. It is possible to install only one of these options for initial assessment, provided they are all installed inside the motor in the same way (same insulation sleeve)
Heating elements	critical	It is allowed to fit anti-condensation heating elements, but they shall not be in service during the normal motor operation or the emergency and should have been present during the test.
Supplying cable to motor (between terminal box and outside) or flying leads	critical	The cables can be replaced by other cables tested in the same conditions of temperature/time and connection on evaluation of the test laboratory
Capacitor	critical	The alternative capacitor shall be placed at the same location as for the tested one. Plastic capacitor may be replaced by aluminium capacitor but not vice-versa.

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Table B.4 — Filters for frequency converters

Ordered by best protection provided for motor (insulation and bearings)	Voltage drop	Losses to be added
VSD + sinusoidal filter	10 %	0 %
du/dt filter	negligible	0,1 to 1,5 % due to filter + 8-14 % due to VSD (PWM)
Motor termination unit	negligible	0,1 to 1,5 % due to filter + 8-14 % due to VSD (PWM)
Output reactor	negligible	0,1 to 1,5% + 8-14 % due to VSD (PWM)

B.2.3 Assessment of changes using Annex D

The annex D gives the possibility to perform test of motor independently of fan hazard and is helpful to control electrical, thermal and aerodynamic conditions on the motor.

A test of the initial version of the motor and a test of the alternative version are performed in the same conditions by recording the following parameters by means of type K thermocouples:

— Temperature in the winding heads

— Temperature in the bearings.

If the test of the initial version fails, no conclusion can be issued.

If the required temperature data from a test of the original motor is already available, only a test of the alternative version of motor is required.

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If both tests are successful **and** the temperatures measured in the alternative version are equal to or lower which can be up to 25 K higher to allow for tolerance in the measured furnace temperature) than the ones measured in the initial version of the motor **during the whole test period**, then the change is allowed without the need for any extra testing.

If the alternative version fails or if the above temperature comparison criterion is not matched, then there are doubts regarding the effect of the change on the emergency high temperature performance and:

— the change cannot be accepted,

— Or, if the motor manufacturer believes that the test failed due to the high stressing conditions of the test according to annex D, he can retest the alternative motor version in all fan ranges for which he wants to supply the alternative version of motor.

B.2.4 Normative list of motor components

The following tables indicate the list of information required by the test laboratory to evaluate changes and select motors that might need to be tested:

Figures B.1 and B.2 show the location of some of the referenced components.

— **General information:**

Motor Manufacturer

— **General data:**

Motors reference	
Lowest and highest frame sizes with their highest rated power	
Highest Voltage	
Highest frequency	
Highest and lowest poles number	
Insulation class	
Rise temperature class	

— **Mechanical data:**

Elements	Reference	Material and Characteristics
Frame material		
End Shields (DE and NDE) material		
Cooling impeller material		
Fan cover		
Bearing type (ball, rollers...)		
Class of fit (C3, C4) Bearing Clearance		
Arrangement (locked/floating)		
Lubricant/grease		

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— **Electrical and insulation data:**

Elements	Reference	Material and Characteristics
Rotor (material of bars...)		
Stator core		
Wiring insulation		
Slot insulation		
Interlayer insulation(between windings inside a same slot, if used		
Slot wedge		
Phase insulation		
Lacing ribbon, if used		
Winding impregnation		
Terminal board		
Terminal leads, if used		
Gland and gland sealing, if fitted		
Insulation and type of connexion between windings heads and terminal leads		

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What are the variant through the range concerning to:

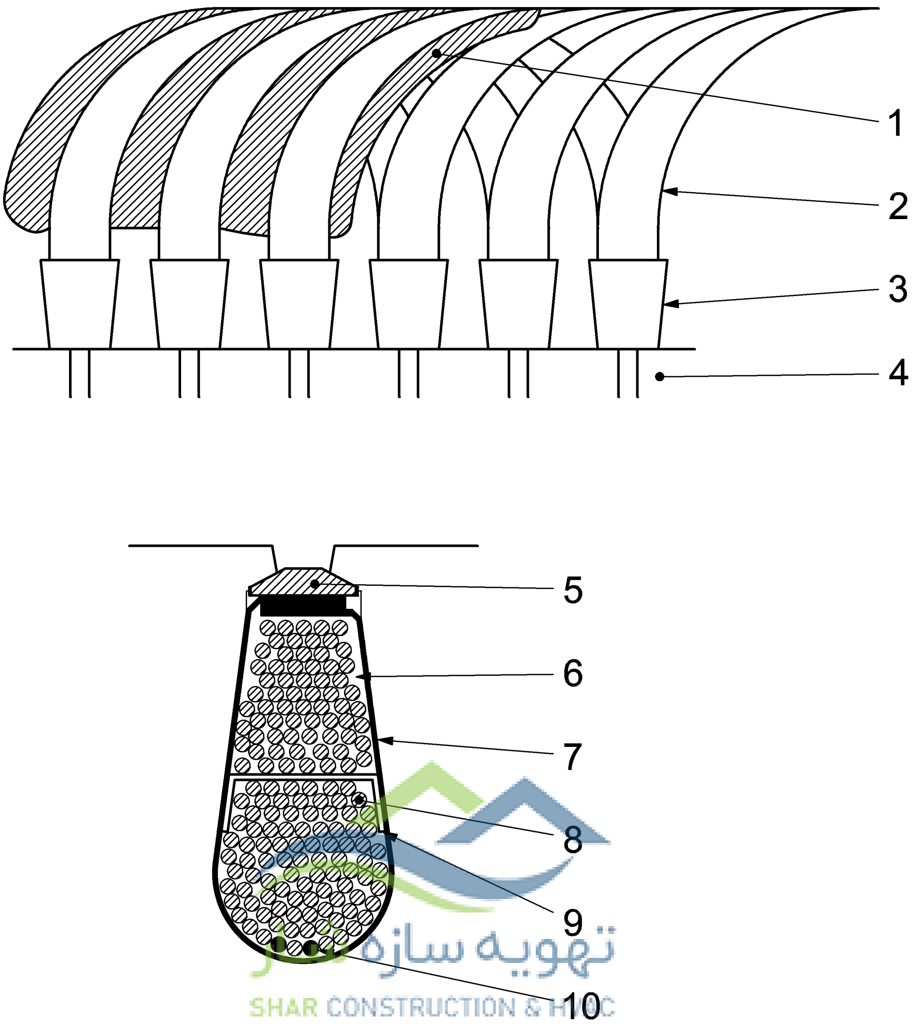
— cooling arrangements (IC 40, IC 41, IC 48, etc.)

— electrical connection (terminal box, or flying leads, etc..)

— the application (Direct On Line, frequency converter)

— forms of running (horizontal, vertical)

— air direction (motor upstream, motor downstream or both).



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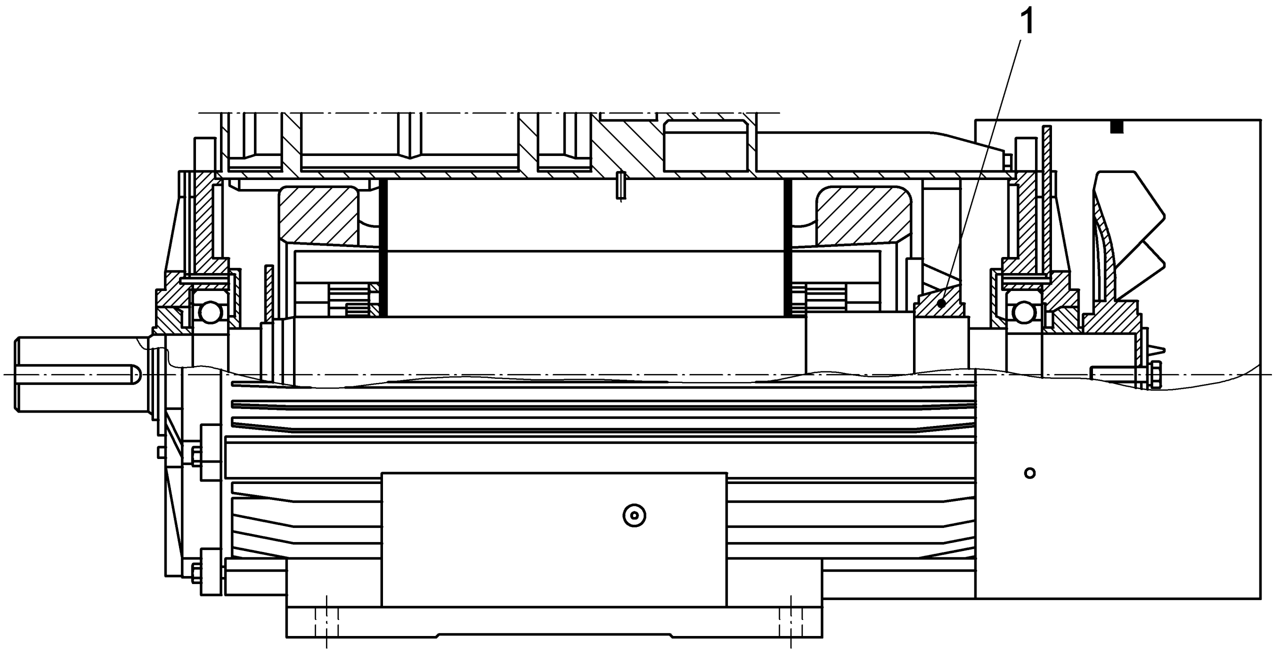
Key

1 Phase insulation
2 Coil
3 Slot insulation and slot wedge
4 Stator core
5 Slot wedge
6 Varnish
7 Slot insulation
8 Copper wires
9 Layer insulation
10 Leads of sensors and heaters

Figure B.1 — Details of stator



Key

1 Internal impeller

Figure B.2 — Example of motor with external and internal cooling impeller

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Annex C
(normative)

Test method for the determination of fire resistance of powered smoke and heat control ventilators (fans)

C.1 Principle

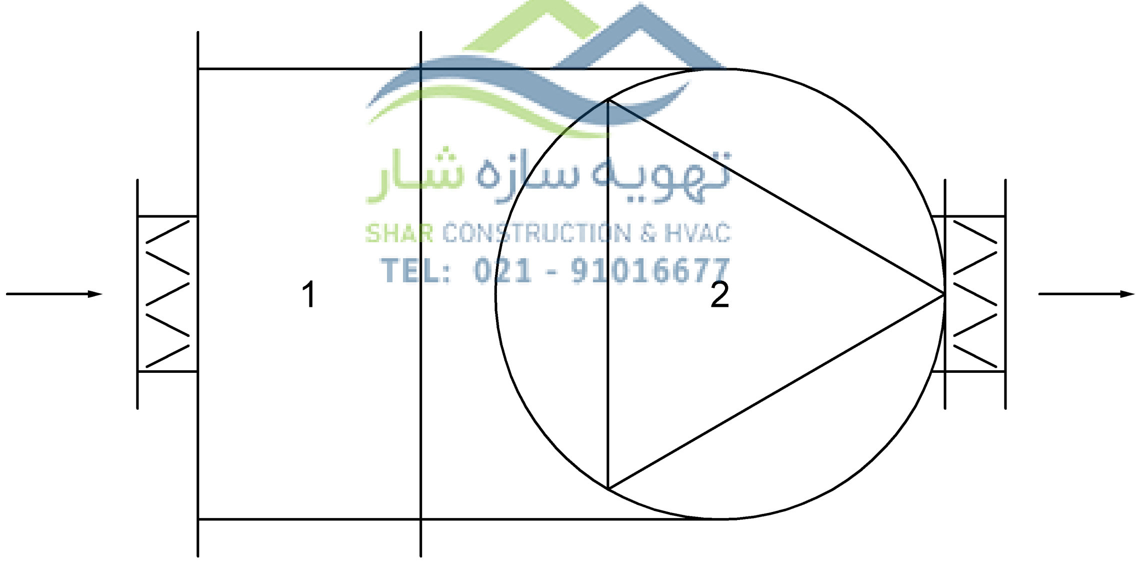
Fire resistance of powered smoke and heat ventilators (fans) is assessed with the fan set up in order to have, at normal ambient pressure and temperature (i.e. density 1,2 kg/m^3):

— the power output from the motor from 80 % to 100 % of the rated power of the motor;

— the fan operating anywhere on a stable part of its volume pressure curve.

C.2 Apparatus

C.2.1 Furnace, capable of heating the required air flow and raising the temperature of the system to the specified level in the specified time within the specified tolerances, either connected directly or through a system of ducting either to recirculate the hot gases or to discharge to atmosphere, see Figures C.1, C.2 and C.3.



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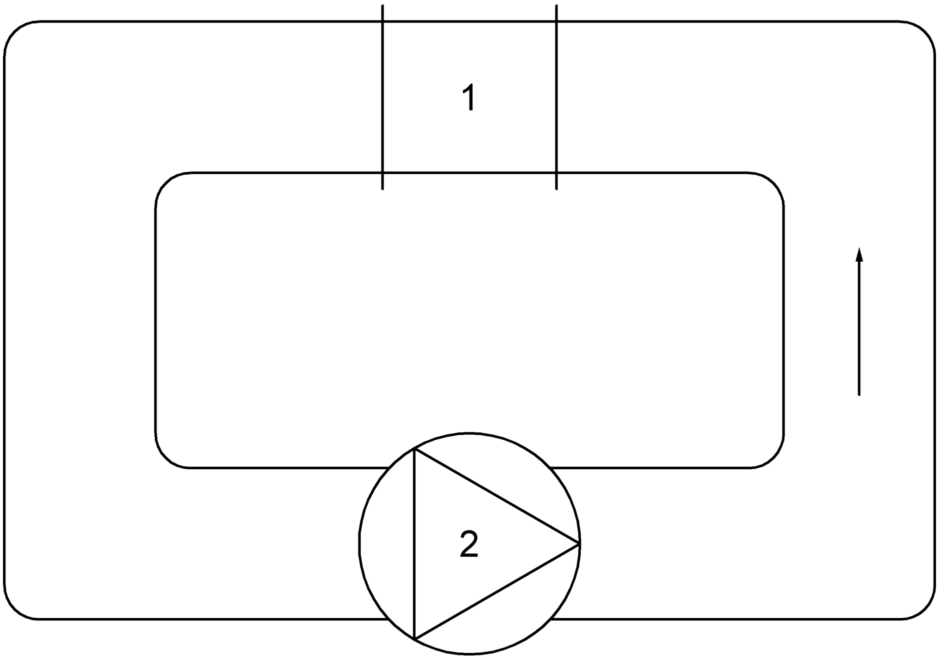
Key

1 Furnace

2 Fan

Figure C.1 — Fan connected directly to furnace

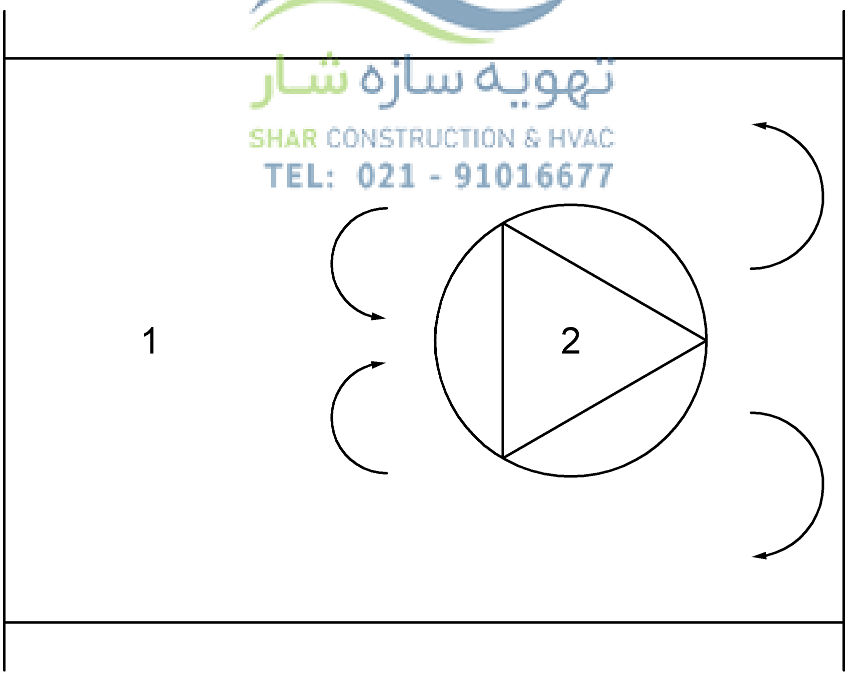


Key

1 Furnace

2 Fan

Figure C.2 — Fan connected to furnace by recirculating duct system



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Key

1 Furnace

2 Fan

Figure C.3 — Fan mounted inside furnace

C.2.2 Flow and/or pressure measuring equipment in accordance with EN ISO 5801, EN ISO 5167 (all parts)

C.2.3 Thermo-elements and thermocouples in accordance with EN 1363-1 .No plate thermometer (according to EN 1363-1) can be used; type K thermocouples shall be used to measure furnace temperature at 100 mm upstream of the fan, in accordance with EN 60584-1.

It is allowed to use shielded thermocouples for stability reasons.

C.3 Preparation

NOTE Some test furnaces are specified in ISO 834-1.

C.3.1 Axial Fan running (tip) clearance

A fan that is intended for installation outside of the smoke reservoir may be tested inside the furnace or outside the furnace with applied insulation. In these cases the test fan shall be provided with a tip clearance reduced in accordance with the following formula:

Reduced clearance = normal clearance – reduction of clearance

Reduction of clearance = $(D / 2).\ C.\ \Delta T$ mm

where

D	is the diameter at minimum clearance in millimetres;
C	is the coefficient of expansion for the material of the casing;
ΔT	is half the difference between the hot gas temperature and the ambient temperature.

NOTE 1 For this calculation the casing temperature is assumed to be the average between the hot gas temperature inside the fan and ambient temperature outside the fan.

Measure the minimum clearance between the impeller and the casing.

An example of procedure to measure the clearance is given in C.3.2.

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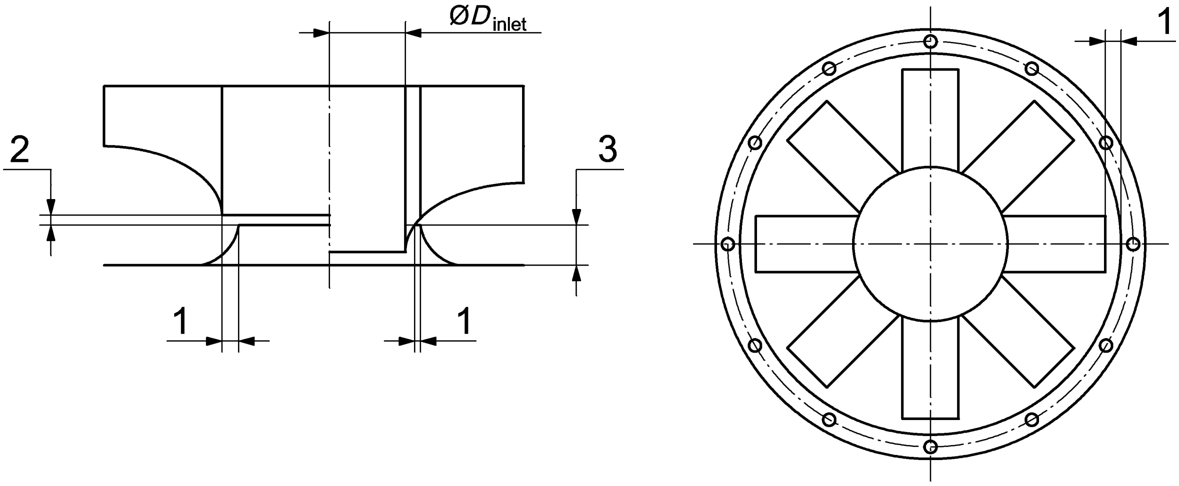
NOTE 2 A ventilator tested with insulation will have a higher casing temperature than one without insulation and consequently under test will have a larger tip clearance.

C.3.2 Measuring of running clearance

For an axial fan, the running clearance is the gap between the blade end and the fan case (tip clearance). For a centrifugal impeller, it is the clearance between the inlet nozzle and the impeller. Additionally there may be an overlap between the impeller and the inlet nozzle. The running clearance shall be measured before the test and may be measured for information when the fan has cooled after the high temperature test.

NOTE A measurement of the running clearance after the high temperature test can provide information on the elongation of an impeller blade and/or hub as a result of centrifugal force.



a) Centrifugal impeller running clearance and overlap

b) Axial impeller tip clearance

Key

1 running clearance

2 running clearance

3 overlap

Figure C.4 — Tip clearance

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Example of measurement procedure:

Step 1:

Fix a suitable measurement device, e.g. displacement transducer, to the impeller and rotate to find the minimum position of the casing / of the nozzle.

Step 2:

On the minimum position place a pin, e.g. drill bit, and rotate the impeller. If no impeller blades make contact with the pin, take the next largest size of pin. When an impeller blade is rubbing the pin, the tip clearance has been established.

Step 3:

If required, mark the impeller blade and the minimum position.

For accuracy drills bits with diameter step of 0,1 mm may be used.

C.3.3 Installation in furnace depending on the intended application categories

Set up the fan, following the supplier’s instructions, with its air-intake side connected to the furnace so that it represents as near as possible the conditions to which it will be exposed in service.

Test the fan by a method appropriate to the application category (ies) determined according to 4.2.2. Set up a smoke reservoir ventilator either surrounded by hot gases as indicated on Figure C.3, or, if the motor is inside the fan totally surrounded by the high temperature gas flow and not cooled by ambient air, set up the ventilator insulated so that the effect is the same as being surrounded by hot gases. Install a non-smoke reservoir ventilator connected to the hot gases either by partial insertion, e.g. for a roof extract unit, or in a ducted system surrounded by ambient air (see Figures C.1 to C.3). It may be necessary to make special duct connections when hot gas recirculation test systems are used. Install the duct connection so that it does not prevent heat recirculation to the motor if this could happen in practice. For the case of the roof fan such connection duct cannot be used to measure air flow rate, but the temperature of the incoming air can be measured for information.

A fan for use as a jet fan shall be tested completely assembled.

A jet fan can be tested according to Figure C.3 or mounted completely inside a recirculating duct (i.e. fan surrounded by hot gases) provided its working point is stable. If the ventilator discharges motor cooling air into the main airstream set up the ventilator so that the flow of cooling air is the minimum that will be achieved in practice.

NOTE 1 The flow rate will be affected by the operating point and the upstream and downstream loading.

Set up a flow or pressure measuring device in the system to measure the volume flow or pressure of the fan.

NOTE 2 The installation of flow measuring devices or pressure taps is not critical as the readings are for comparative purposes only and cannot be used to indicate actual performance.

Fit at least three furnace thermo-elements at approximately 100 mm upstream of the intake plate of the ventilator, positioned uniformly, to measure the temperature of the incoming gases.

Where the motor is mounted within the fan casing and is cooled by ambient air, fit flow measuring equipment taking care that it does not affect the flow rate of cooling air. Position the temperature sensors centrally at the inlet and outlet cross sections.

For insulated fan, install thermocouples at the critical position (e.g. thermal bridge, over a joint between two insulation boards), observing the following rules:

— thermocouples 50 mm away from the corner if applicable and at the centre of each face;

— thermocouples 15 mm away from the joint between faces;

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— thermocouples 25 mm away from critical point (e.g. penetrating screws where the diameter is less than 25 mm);

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— at least three surface temperature thermocouples for 1 m² side.

Fit electrical devices for the measurement of frequency, voltage, current, power and speed in accordance with EN 60034-2-1. A frequency measurement is not required if the main supply is of known frequency.

NOTE 3 Temperature rise could be measured by means of a thermocouple affixed into the winding head (but in no case inside the slot) and bearings at ambient and high temperature for information.

Additional precautions are needed when the power to the motor is being supplied from a frequency converter: if the output from the Frequency Converter is fed to the motor via sinusoidal filters, the voltage, current and electrical power may be measured with conventional instrumentation. However, it shall be taken into consideration that the use of sinusoidal filters can result in a voltage drop of 10 % from that of the fundamental wave root mean square (r.m.s) voltage at output of the Frequency Converter. Where sinusoidal filters are not used, conventional and wideband power analysers and digital voltmeters will measure the total r.m.s values including all harmonics generated by the Frequency Converter and may register voltages between 20 % and 30 % higher voltages than the fundamental wave r.m.s values. It is therefore necessary to use power analysers or voltmeters either able to get the complete spectrum in order to identify the fundamental wave or equipped with low pass line filters that will attenuate harmonics of the variable speed drive (VSD) output and enable accurate measurements to be recorded.

Care shall be taken with the test set-up to ensure that other instrumentation, transducers and sensors are not affected by Electromagnetic Interference. It may be necessary to use screened power cables and/or shielded sensor leads to guarantee the reliability of all other recorded measurements

C.4 Procedure

C.4.1 General conditions

Carry out the following tests, continuously in the order indicated, at an ambient temperature between 15°C and 40°C and in a location not affected by varying ambient conditions such as rain, snow, wind. Test insulated fans inside a building. Check that any cooling air is not below 15°C. Start test measurements prior to the test period. For all fan classes different from F_{842} test in accordance with C.4.2, C.4.3 and C.4.4. For fan Class F_{842} test in accordance with C.4.2 and C.4.5.

If a fan is tested at a higher temperature than, and for a time which is equal to or longer than that which is specified for a lower class or classes, then the fan shall also be approved for the lower class or classes.

C.4.2 Warm up period

C.4.2.1 Operate a dual purpose use fan at ambient temperature, at the maximum speed, for a warm up period until the motor frame or winding temperature increase is less than 2°C in 10 min, but for a minimum period of 60 min. Record voltage, current, power, flow or pressure and temperature measurements at intervals not exceeding 1 min. Ensure that the measurements are stable.

Do not operate a fan for emergency only use prior to test.

When a large fan is tested in a recirculating duct or inside a furnace, it may be difficult to achieve stabilisation of the motor temperature. When the temperature rise for the insulation class of the fan motor is reached, the heat up period can start provided that the fan volume flow or pressure is stabilized.

If bearing temperature measurements are required for information, monitor temperatures by means of thermocouples fitted as nearer as possible to the outer rings of both bearings.

C.4.2.2 Operate an emergency only use fan, at ambient temperature until the volume flow or pressure readings are stable.

A variation of +/- 2,5 % in volume flow or +/- 5 % in pressure, averaged over consecutive 2 min periods, may be considered stable.

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C.4.3 Heat up period

Increase the gas temperature at the intake plane of the fan to the appropriate value in a period of not more than 10 min. and not less than 5 min. Record voltage, current, power, temperature and flow and/or pressure measurements.

C.4.4 High temperature test

Carry out the test so that the average temperature upstream of the impeller is not less than the specified temperature and not more than the specified temperature + 25°C, maintained for the appropriate period of time. Record electrical, flow or pressure and temperature measurements at intervals not exceeding 1 min. Correct pressure measurements for the effects of density change due to temperature.

After 15 min, switch off the fan for 2 min, and then restart the fan. During this period the temperature variation may exceed the specified limits.

If the motor is driven by a frequency converter, the motor shall be stopped (power switched off) without any decelerating ramp set by the converter and then restarted after two minutes via the converter which is programmed with the shortest practical starting ramp (acceleration time).

Add the time the ventilator is switched off or is working below its target frequency to the specified period of the test.

C.4.5 High temperature test in accordance with temperature time curve

Increase the gas temperature at the intake plane of the ventilator in accordance with the standard time/temperature curve defined in ISO 834-1. Control the average temperature to a tolerance of 0 to + 25°C. Test the ventilator for a period of 30 min. Record electrical, flow and or pressure and temperature measurements at intervals not exceeding 1 min. Correct the pressure measurements for the effects of density change due to temperature.

During this period the temperature variation may exceed the specified limits.

C.5 Compliance criteria

The volume flow shall not decrease by more than 10 % and not increase by more than 25 %, or the static pressure difference (corrected for the effects of density due to temperature change) shall not decrease by more than 20 % and not increase by more than 50 % of that measured at the end of the warm up period of the test.

C.6 Test report

C.6.1 Prepare a test report after completion of each test including the following information:

a) name of the test laboratory;

b) name of the sponsor;

c) date of test;

d) name of supplier and trade name of the product;

e) the reference to the test methods;

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f) the catalogue description, size and speed of the ventilator tested;

g) the ancillaries tested including electric cables (type, size, supplier);

h) the temperature/time class (see 4.4) ;

i) the application categories (see 4.2.2);

j) snow load class;

k) details of the test arrangement including all equipment used for measurement of temperature, flow, pressure, current, voltage, electrical power and wind and snow load;

l) observations, measurements and calculated results made before during and after the tests in accordance with Annex C and E or D.

m) when the test is performed to assess the fan for installation with a frequency converter: record the model reference and type of converter (e.g. Pulse Width Modulation(PWM)), type, section and length of cable between converter and motor, switching frequency, start ramp time, type of filter if used and the frequency supplied by the converter. If the fan is intended for installation with different models or brands of frequency converter record the maximum voltage peak, peak to peak value and the maximum rate of voltage rise (du/dt) at which the motor has been tested.

C.6.2 Prepare an additional report providing details of a complete product family that may be covered by a number of tests including:

a) fan model reference or catalogue code;

b) the product range covered by the tests in accordance with Annex A;

c) fan speed;

d) impeller and hub diameter, tip clearance (see C.3) length and number of blades;

e) approximate blade cross sectional area;

f) approximate hub cross sectional area;

g) motor speed if different to c);

h) motor model reference or catalogue code;

i) motor rating;

j) bearing type, class of fit, lubricant and arrangement for motor, and for fan if fan is indirectly driven;

k) carcase, end cover and cooling impeller (if fitted) material;

l) insulation specification and Class;

m) which ancillaries are covered;

n) when the tests have been performed to allow use with frequency converters: type of converter (e.g. PWM), switching frequency, starting time ramp, filter to be used (if any) and allowed highest frequency for the converter application. If the fans are intended for installation with different models or brands of frequency converter, include information on maximum voltage peak, peak to peak value and the maximum rate of voltage rise (du/dt) at which a motor has been tested. (when many motors are tested to cover a range, the reference values for voltage peak and rate of voltage rise are the lowest values recorded among the different tests)

o) Recommendation about the supplying electric cable: "the fan shall be supplied by an electric cable which is suitable for smoke exhausting application and for the relevant temperature-time and installation classes".

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p) The following statement: "The tip/running clearances can have a large influence on the aerodynamic performance "

q) All information indicated in 6.3.2.6.

C.6.3 Evaluation of the minimum tip clearances for serial production of axial fans

The fan manufacturer will submit to the lab data regarding the minimum tip clearances (taken into consideration manufacturing tolerances) for the serial family of fans that he intends to produce.

a) For each submitted test specimen measure the actual minimum tip clearance for the impeller (see C.4),

b) Calculate for each test specimen the clearance safety factor

Definition of a safety factor:

Safety factor C: $C = J / Jth$

where

Jth	is the minimum tip clearance declared by the manufacturer
J	is the minimum tip clearance measured by the lab

C shall be greater than or equal to 1.

The safety factor to apply to the declared minimum tip clearances for non-tested fan sizes shall be:

— the safety factor of the smallest tested size for fans smaller than that which was tested;

— the safety factor of the largest tested size for fans larger than that which was tested;

— the highest safety factor of any two tested fans for sizes in between the two tested sizes,

EXAMPLE If, in order to cover a family of fans, you need to test 400, 710 and 1250 fan sizes, you will get three safety factors; C_{400}, C_{710} and C_{1250}.

For fan sizes smaller than 400, the accepted tip clearance is the declared minimum tip clearance (supplied by manufacturer) multiplied by C_{400} safety factor.

For fan sizes larger than 1250, the accepted tip clearance is the declared minimum tip clearance (supplied by manufacturer) multiplied by C_{1250} safety factor.

For fan sizes in between 400 and 710, the accepted tip clearance is the declared minimum tip clearance (supplied by manufacturer) multiplied by the maximum (C_{400} or C_{710}) safety factor.

For fan sizes in between 710 and 1250, the accepted tip clearance is the declared minimum tip clearance (supplied by manufacturer) multiplied by maximum (C_{710} or C_{1250}) safety factor.

a) Depending on the test configuration (within the furnace, with our without insulation…etc.) and the intended applications (smoke or non-smoke reservoir, insulated fan) the above clearances may have to be corrected in accordance with C.3.1 rule.

b) Two tables shall be supplied in the range report:

   — One table providing the minimal tip clearance for installation outside the smoke reservoir without insulation;

   — One table with the minimal tip clearance for installation inside the smoke reservoir or with insulation;

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Annex D
(normative)

Test methods for electric motors to determine the impact of the changes on the product characteristics

D.1 Principle

Another method to prove the resistance to temperature of electric motors for use in powered ventilators is by testing the motor at elevated temperature in conjunction with a generator or other method of providing the load. The motor is shown to be functioning satisfactorily by continuing to give the required output corresponding to the wished temperature / time category.

D.2 Tests in association with a generator or another load

D.2.1 Modulated Frequency Method (MFM)

Within EN 60034 range of Standards, different methods for loading a motor are approved as being equivalent and are well use by motor manufacturers.

— Either, loading motors with generator;

— Or, “electrically” loading the motor by using Modulated Frequency Method, described in EN 60034-29:2008, 6.2.2, which will give the same temperature rise in any active of motor as it will have if loaded mechanically by a generator as described in Annex D : Figure D.1.

EN 60034-29:2008, 6.2.2 describes the way to electrically load the motor by using a modulated frequency, which means the motor is accelerating and de-accelerating within a short time, resulting in the heat up of the motor with a temperature rise, stabilised by the setting of the current value during that period

The modulated frequency is generated with a frequency converter.

Concerning the Modulated Frequency Method (EN 60034-29:2008, 6.2.2), the input power cannot be easily measured, but normally it is possible to obtain values for the voltage, the current and power between motor and converter which will represent the losses of the motor tested.

Some preliminary tests shall be performed at ambient temperature by the motor manufacturer, in order to establish the same temperature rise as the rise measured when DOL or inverter running.

The settings of the converter to apply MFM method shall be adjusted so that:

— The current within the motor is at least the same as the current when the motor is loaded by a generator on a test bench;

— The temperature rise within the motor is the same or higher than the rise when the motor is loaded by a generator through an inverter on a test bench;

— The average frequency shall be the highest frequency required for the approval.

Since the measurement of power is not relevant, the lab shall measure the current and the average frequency.

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D.2.2 Apparatus for testing with a generator

D.2.2.1 Test installation

Mount the motor on a stable support in an enclosure that has a minimum radial dimension twice the maximum motor dimension.

Link it via a coupling and transmission shaft to an adjustable external load, such as a generator, which will absorb the power output of the motor.

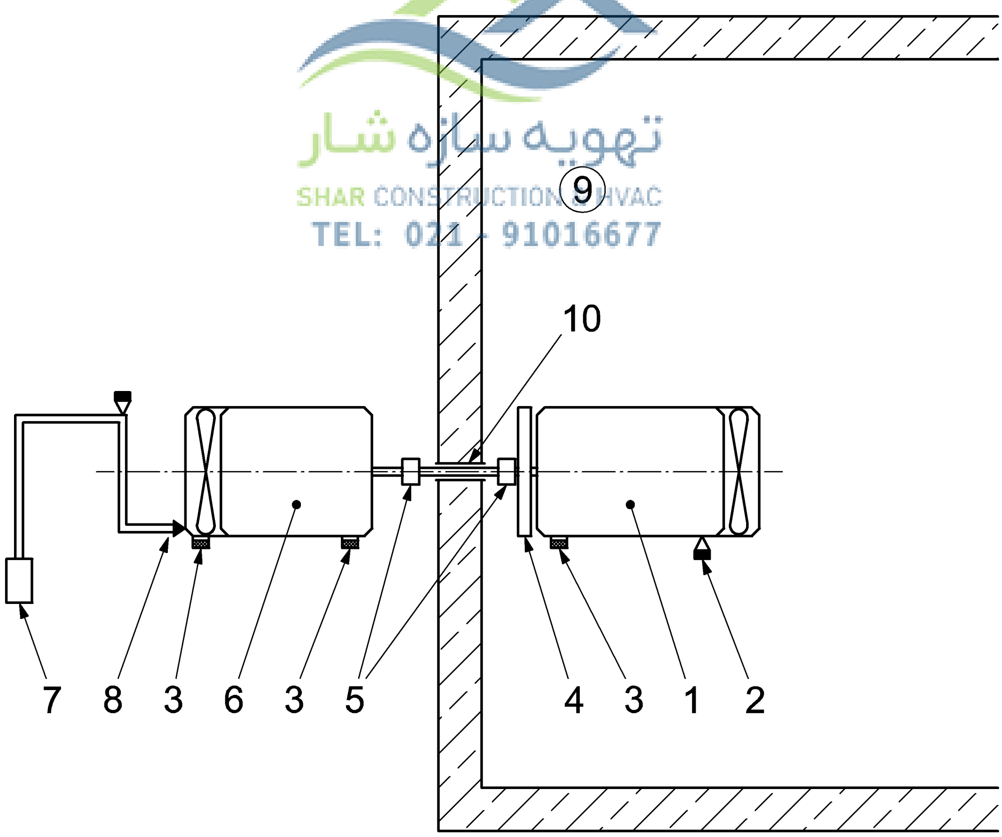
To circulate the hot gas past the carcase at the rated velocity fit either the normal integral cooling impeller or an external impeller if the motor is mounted within the fan airstream. Mount the external impeller either directly on the motor shaft or on the transmission shaft.

Air speed and air flow may be measured along the motor frame at ambient temperature for information.

D.2.2.2 Specifications for bearing load

Provide means of applying axial and/or radial load to the motor shaft corresponding to a certain capacity of bearing defined according to the rules stated in applicable standards (ISO 281) and corresponding to a life time L_{10h} as defined in the motor manufacturer documentation .For example, apply either a radial load and/or an axial load.

Provide means of applying axial and radial loads to the motor shaft. For example, apply the axial load by rigidly connecting the motor to an external load generator that is free to move axially and so can be used to convert a stationary axial load to one that rotates. See Figure D.1.



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Key

1 Motor to be tested
2 Fixed support
3 Sliding support
4 Radial load (e.g. steel disc)
5 Flexible couplings, torsionally rigid
6 Generator
7 Mass
8 Axial load, induced by mass (7)
9 Furnace
10 Penetration point

Figure D.1 — Typical method of applying radial and axial load to a motor

D.2.2.3 Temperature measurements

Fit one or more furnace thermocouples at a distance of approximately 100 mm from the motor frame to measure the temperature of the surrounding gases. Fit devices between the ribs of the motor for surface temperature measurement.

Fit also equipment in the windings to check temperature rise of motor.

No plate thermometer (according to EN 1363-1) can be used; type K shielded thermocouples with at least a 3 mm diameter lead shall be used around the motor to control furnace temperature.

D.2.2.4 Electrical measurements

Measure frequency, voltage, current, power and speed in accordance with EN 60034-2-1.

Additional precautions are needed when the power to the motor is being supplied from a frequency converter: if the output from the Frequency Converter is fed to the motor via sinusoidal filters, the voltage, current and electrical power may be measured with conventional instrumentation. However, it shall be taken into consideration that the use of sinusoidal filters can result in a voltage drop of 10 % from that of the fundamental wave r.m.s voltage at output of the Frequency Converter.

Where sinusoidal filters are not used, conventional and wideband power analysers and digital voltmeters will measure the total r.m.s values including all harmonics generated by the Frequency Converter and may register voltages between 20 % and 30 % higher voltages than the fundamental wave r.m.s values. It is therefore necessary to use power analysers or voltmeters able to get the complete spectrum in order to identify the fundamental wave to enable accurate measurements of voltage, current and r.m.s. input power to be recorded.

Care shall be taken with the test set-up to ensure that other instrumentation, transducers and sensors are not affected by Electromagnetic Interference. It may be necessary to use screened power cables and/or shielded sensor leads to guarantee the reliability of all other recorded measurements.

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D.2.3 Test specimens

Select test specimens in accordance with Annexes A and B.

D.2.4 Test procedure

D.2.4.1 General conditions

Carry out the tests at a starting ambient temperature between 15°C and 40°C.

D.2.4.2 Warm up period

Operate the motor at ambient temperature at its rated frequency and voltage, and at 100 % of the rated power.

Operate the motor at ambient temperature until the motor frame or winding temperature increase is less than 2°C in 10 min but for a minimum period of 60 min.

Record electrical and temperature measurements

If the temperature rise of the motor exceeds one class below the insulation class of the motor, the motor shall not be used for smoke vent application.

Measure the temperature of bearings by means of thermocouples fitted as nearer as possible to the outer rings of both bearings.

Increase the temperature at the air intake of or around the motor to that specified in Table 2 or Table 3 within a period of not more than 10 min or not less than 5 min. Record electrical and temperature measurements during this period. Adjust the load applied to the motor so that the motor output power is F times the rated power at a density of 1,2 kg/m^3, where *F* is as follows:

— 0,88 at a temperature of 200°C;

— 0,84 at a temperature of 250°C;

— 0,80 at a temperature of 300°C;

— 0,76 with at a temperature of 400°C;

— 0,60 at a temperature of 600°C.

D.2.4.3 High temperature test

Carry out the test at not less than the specified temperature, and not more than the specified temperature + 25°C and for the appropriate period of time. Record electrical and temperature measurements at intervals not exceeding 1 min.

After 15 min, switch off the motor for 2 min, and then restart the motor. During this period the temperature variation may exceed the specified limits.

If the motor is driven by a frequency converter, the motor shall be stopped (power switched off) without any decelerating ramp set by the converter and then restarted after two minutes via the converter which is programmed with the shortest practical starting ramp (acceleration time).

Add the time the motor is switched off or is working below its target frequency to the specified period of the test.

D.3 Test report

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D.3.1 Prepare a test report after completion of the tests including the following information:

a) name of the test laboratory;

b) name of the sponsor;

c) date of test;

d) name of supplier and trade name of the product;

e) the reference to the test method/s;

f) the catalogue description, frame size, class of insulation and speed of the motor tested;

g) the temperature time class (see 4.5);

h) the application classes (see 4.2.2);

i) the product range approved by the tests in accordance with Annex B;

j) details of the test arrangement including all equipment used for measurement of temperature, current, voltage, electrical power and (if required for information) air speed and air flow at ambient temperature;

k) observations, measurements and calculated results made before during and after the tests in accordance with Annex D.

l) when the test is required to qualify the fan for installation with a frequency converter: record the model reference and type of converter (e.g. PWM), type, section and length of cable between converter and motor, switching frequency, start ramp time, type of filter if used and the frequency supplied by the converter. If the fan is intended for installation with different models or brands of frequency converter record the maximum voltage peak, peak to peak value and the maximum rate of voltage rise (du/dt) at which the motor has been tested.

D.3.2 Prepare an additional report providing details of the complete product range approved including:

a) motor speed;

b) motor model number or catalogue code;

c) motor rating;

d) bearing type, class of fit, lubricant and arrangement;

e) carcase, end cover and cooling impeller (if fitted) material;

f) insulation specification and class.

g) when the tests have been performed to approve use with frequency converters: type of converter (e.g. PWM), switching frequency, starting time ramp, filter to be used (if any) and allowed highest frequency for the converter application. If the fans are intended for installation with different models or brands of frequency converter, include information on maximum voltage peak, peak to peak value and the maximum rate of voltage rise (du/dt) at which a motor has been tested. (when many motors are tested to approve a range, the reference values for voltage peak and rate of voltage rise are the lowest values recorded among the different tests)

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Annex E
(normative)

Test method for assessing the response delay and ability to open under environmental conditions

E.1 Objective of test

The objective of this test is to assess the response delay and ability to open under environmental conditions.

E.2 Test apparatus

Use a suitable test rig onto which the ventilator can be mounted and subjected to a test load equivalent to a wind pressure of 200 Pa. Apply the test load by one of the following methods:

a) plates;

b) bags containing up to 5 kg of solid particles or liquid.

Spread the loads over the whole of the external surface of the individual elements of the opening parts of the ventilator, to produce a uniformly distributed load.

E.3 Test specimen

See 5.2.1 for the wind load test.

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For the snow load test, the largest fan of the family shall be considered representative of all the fans in that family.

A test on the largest fan of the family shall be considered representative of all the fans in that family.

E.4 Test procedure

Mount the fan on the test rig in accordance with the supplier's recommendations. Apply the load using one of the methods given in E.2, increasing the load to the upper appropriate limit given in 5.2.1 and 5.2.2 and maintain the load for (10 ± 1) min.

Remove the load, actuate the ventilator and check that the dampers, flaps or louvers open to the design position.

Operate the ventilator against the design load three times, using the energy source as specified by the supplier and its fire activating mechanism. Determine if the fire operating position is reached each time.

E.5 Evaluation of test results

The ventilator meets the requirement of 4.1 if the test specimen achieves the operating position in each of the tests in less than 30 s. The test results may be applied to all the family of fans.

The operating position can be considered as reached if the volume flow exhausted by the fan working under snow and wind loads did not decrease by more than 10 % of that exhausted by the fan working without these loads.

Annex F
(informative)
Explanatory notes

F.1 General

The following explanatory notes are considered to be useful for a correct interpretation of some of the provisions included in this standard.

F.2 Explanation for A.4.4.3

To calculate comparative blade stresses resolve the bending moment about the principal axis and the stress calculated as follows:

$$\sigma_{Z1} = \frac{F \times \sin\beta \times L / k}{Z_{X\,\text{min}}} \text{ or } \sigma_{Z1} = 1000 \times M \times \sin\beta / Z_{X\,\text{min}} \text{ with } M = F \text{ x } L / k$$

$$\sigma_{Z2} = \frac{F \times \cos\beta \times L / k}{Z_{Y\,\text{min}}} \text{ or } \sigma_{Z2} = 1000 \times M \times \cos\beta / Z_{Y\,\text{min}} \text{ with } M = F \text{ x } L / k$$

Where

F and L	Are defined in A.4.2.2.1
σ_{Z1} and σ_{Z2} :	are the bending stresses about principal axis X and Y in newtons per square millimetre (most of the time, $\sigma_{Z2} < \sigma_{Z1}$);
β	is the angle between principal axis and the radial line of impeller:
$Z_{X\,\text{min}}$ and $Z_{Y\,\text{min}}$:	is the section modulus about principal axis X and Y in mm^3.

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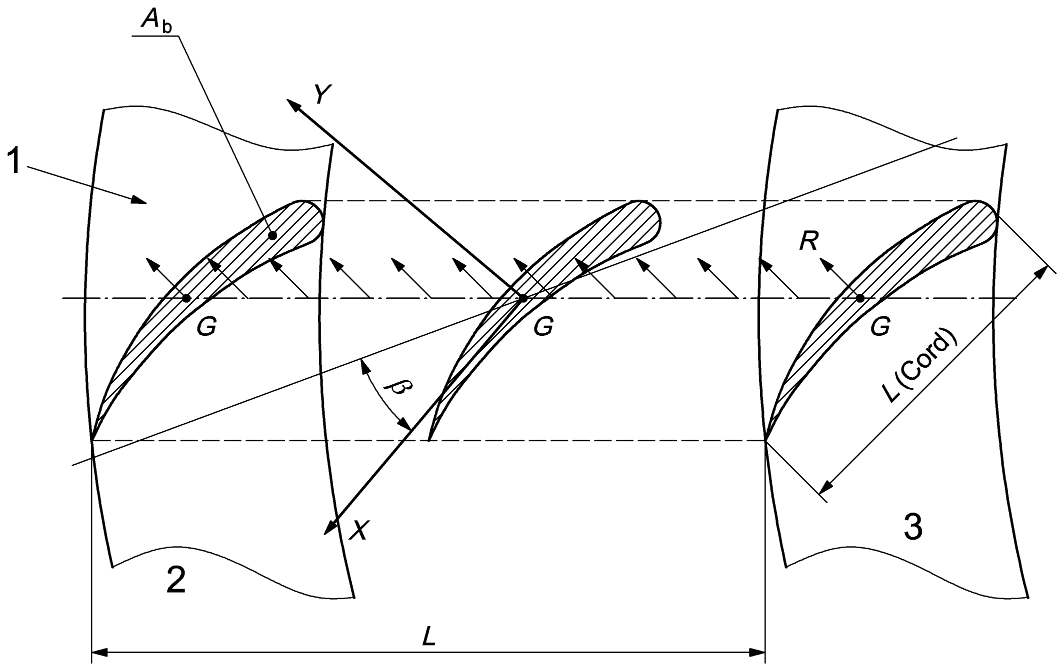

Key

1 Centrifugal impeller

2 Back plate

3 Shroud

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Figure F.1 — Centrifugal impeller, calculation of σ_{Z1}

— the centrifugal force about the principal axis GY is F x sin ß with F the centrifugal force calculated as in A 4.2.2.1

— the blade bending moment is M1 = F x sin ß x L / k (k = 12 if the blade is considered as fully embedded in back plate and shroud)

— the maximum blade stress is $\sigma_{Z1} = {}^{M1}/_{Z_{X\,\min}}$

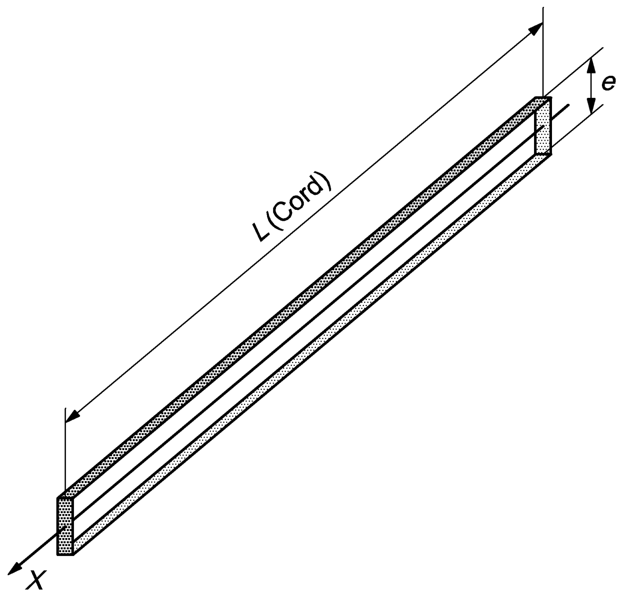


Figure F.2 — Example of calculation of $Z_{X\min}$ with a rectangular cross-section of blade

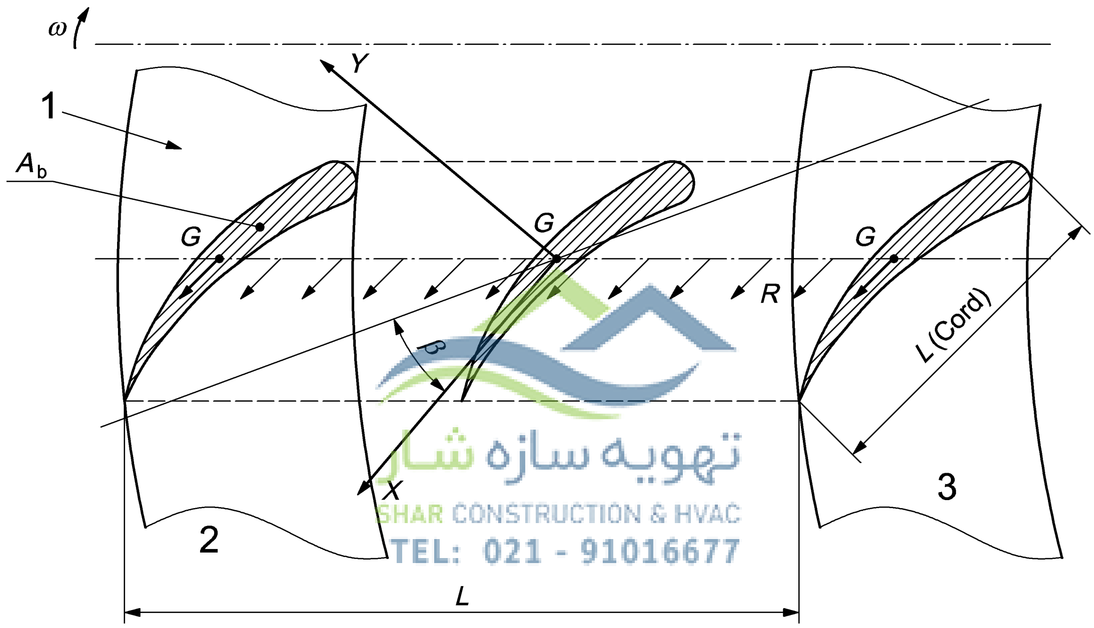
Here $Z_{Xmin} = \dfrac{\dfrac{L(cord)\times e^3}{12}}{\dfrac{e}{2}}$ or $Z_{Xmin} = \dfrac{L(cord)\times e^2}{6}$

and

$$\sigma_{Z1} = M1/Z_{X\,\min} \text{ with } \sigma_{Z1} = \frac{F\times \sin\beta \times L/k}{Z_{X\,\min}} \qquad (1)$$

EXAMPLE 1 Blade with L (cord) = 100 mm, e = 2 mm, ß = 25°

$$\sigma_{Z1} = F\times L/k \times 6{,}35\times 10^6$$



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Key

1 Centrifugal impeller

2 Back plate

3 Shroud

Figure F.3 — Centrifugal impeller, calculation of σ_{Z2}

— the centrifugal force about the principal axis GX is F x cos ß with F the centrifugal force calculated as in A.4.4.1

— the blade bending moment is $M2$ = F x cos ß x L / k (k = 12 if the blade is considered as fully embedded in back plate and shroud)

— the maximum blade stress is $\sigma_{Z2} = M2/Z_{Y\,\min}$

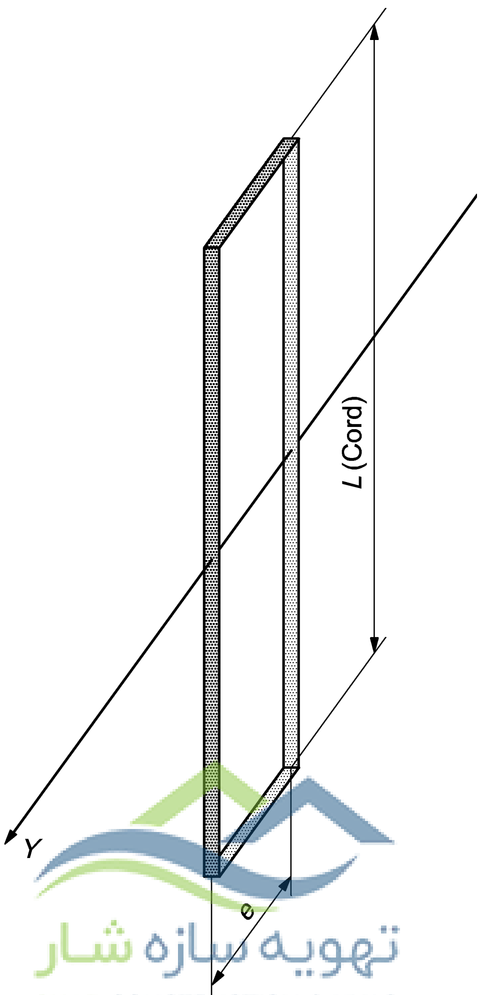

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Figure F.4 — Example of calculation of Z_{Ymin} with a rectangular cross-section of blade

Here $Z_{Ymin} = \dfrac{\dfrac{e \times L^3(cord)}{12}}{\dfrac{L}{2}}$ or $Z_{Ymin} = \dfrac{e \times L^2(cord)}{6}$

and

$$\sigma_{Z2} = M2 / Z_{Y\min} \text{ with } \sigma_{Z2} = \frac{F \times \cos\beta \times L / k}{Z_{Y\min}} \quad (2)$$

EXAMPLE 2 Blade with L (cord) = 100 mm, e = 2 mm, ß = 25°

$$\sigma_{Z2} = F \times L / k \times 0{,}27 \times 10^6$$

then

$$\sigma_{Z2} < \sigma_{Z1}$$

F.3 Origin of power coefficients in D.2.4.2

Historically, these coefficients were based on currents that were measured during fire tests. This explains why the coefficients are higher than coefficients derived from changes in air densities with temperature.

— Po output power;

— Pi input power;

— P400 power at high temperature;

— P20 power at ambient temperature.

For density decreasing due to temperature rise during a fire test, we can write for a motor:

$$\frac{Po400}{Po20} = \frac{\rho 400}{\rho 20}$$

Moreover Po = Pi.η and Pi = $U\,I$. cosφ.square root (3)

then

I = Po / (U.cosφ. η. square root (3))

then

$$\frac{I400}{I20} = \frac{Po400}{Po20} \times \frac{\eta 20}{\eta 400} \times \frac{U20}{U400} \times \frac{\cos\varphi 20}{\cos\varphi 400}$$

$$\frac{I400}{I20} = \frac{\rho 400}{\rho 20} \times \frac{\eta 20}{\eta 400} \times \frac{\cos\phi 20}{\cos\phi 400} \times \frac{U20}{U400}$$

Moreover $\eta 20$ / $\eta 400$ > 1 and cosφ 20/ cosφ 400 >1, which explains why the coefficients given in Annex D are greater than coefficients dependant only on the power.

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F.4 Consideration about frequency converter driving

The parameters to be taken into consideration are the peak line-to line voltages at the motor terminals generated by the drives as well as the voltage rise time and they can be influenced by the cable type and length.

The graphs (Figure F.5 and Figure F.6) show an example of voltage peak and du/dt versus cable length.

Rise time is calculated according to:

$$\Delta t = 0.8 \frac{\hat{U}_{LL}}{\frac{du}{dt}}$$

With:

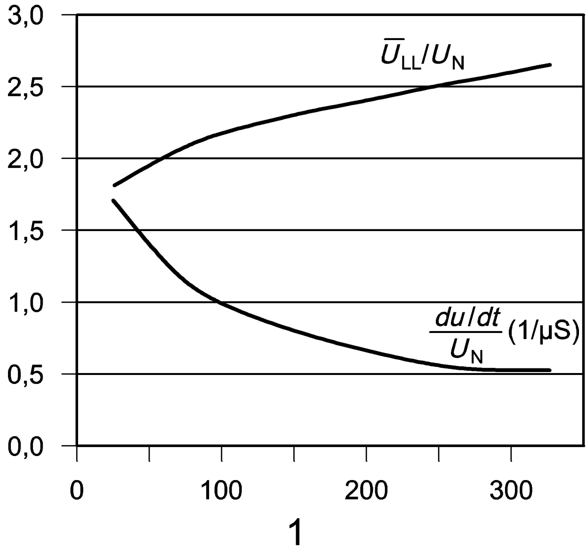
U_N rated voltage (V)

Δt rise time (µs)

$\hat{U}_{LL}$ line to line voltage peak (V)

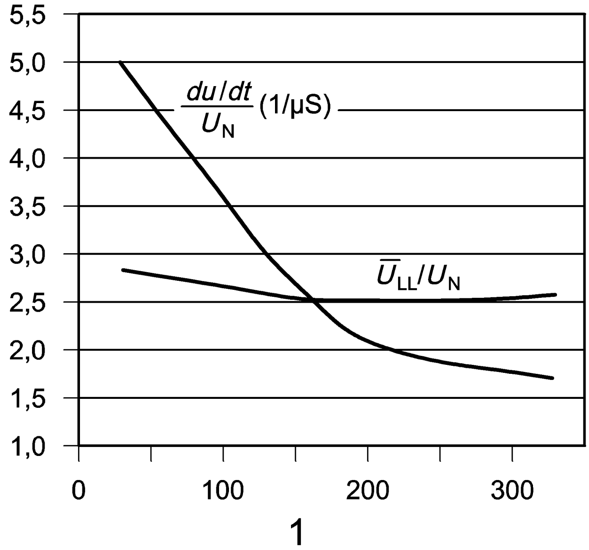
du/dt voltage rise time (V/µs)

Another important influencing factor can be the frequency converter switching frequency.



Key

1 Cable length (m)



Key

1 Cable length (m)

NOTE: The vertical axis of Figures F.5 and F.6 has either no unit (V/V) or (1/μs) depending on the considered graph.

Figure F.5 — Case with du/dt filter

Figure F.6 — Case without du/dt filter

The case without a du/dt filter is the worst case.

If a successful test is made without a filter, then approval can be given for:

— Installation with any cable length;

— Any converter with PULSE WIDTH MODULATION having a switching frequency equal to or below that which was used during the test;

— A PWM frequency converter used with or without filter.

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F.5Consideration regarding A.1, f) – scaling factors

	ISO 3:1973
Title:	Preferred numbers - Series of preferred numbers
Scope:	Preferred numbers are the conventionally rounded of term values of geometrical series, including the integral powers of 10 and having as ratios special factors in accordance with the specified tables. Basic, exceptional R 80 and derived series are designated.

	ISO 17:1973
Title:	Guide to the use of preferred numbers and of series of preferred numbers
Scope:	The best scale will be determined by taking into consideration, in particular, the two following contradictory tendencies: a scale with too wide steps involves a waste of materials and an increase in the cost of manufacture, whereas a too closely spaced scale leads to an increase in the cost of tooling and also in the value of stock inventories. In selecting a scale of numerical values, choose that series having the highest ratio consistent with the desiderata to be satisfied, in the order: R 5, R 10, etc.

	ISO 497:1973
Title:	Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers
Scope:	This is an additional guide to ISO 17 for selecting specified series with more rounded values. It shows the conditions for the use of these preferred numbers.

F.6 Consideration regarding B.2.2: change of type of bearing

F.6.1 General

The goal of this annex is a general guidance to select prototypes in horizontal and vertical position to validate bearings types

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F.6.2 Bearing ability to pass the smoke venting test

For all bearings: Ability of the bearing to keep the grease

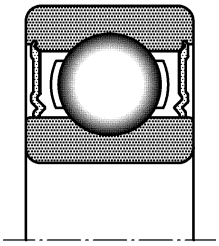

Figure F.7

Two types of bearings have to be considered:

— Deep groove ball bearing:

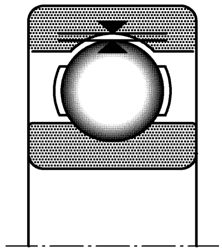

Figure F.8

— Internal clearance of the bearing allows temperature difference between inner and outer ring

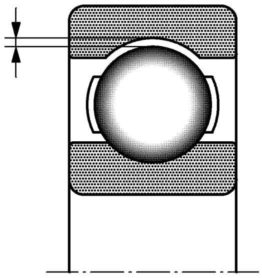

Figure F.9

— Angular contact bearing:

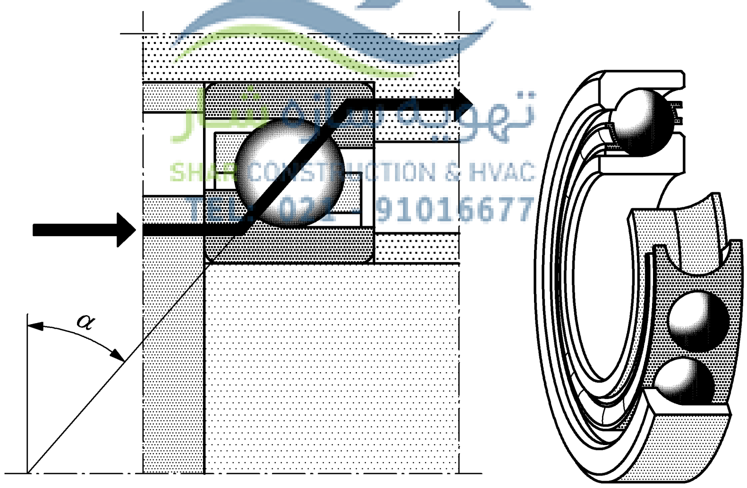

Figure 10

Due to design no clearances class are critical:

Versus temperature difference inner and outer ring contact angle will slightly change.

F.6.3 Parameters to consider during the heat up test

At the beginning of the high temperature test the outer diameter of the bearing may increase due to the increase in external temperature and the bearing clearance may initially increase. After some time, depending on temperature, iron and grease properties will change and the bearing will run dry. Metal parts in contact will become hotter and the clearance is compromised, resulting in premature failure of the bearing.

Consequently:

Deep groove bearing clearance has to be considered (e.g. C.4).

An angular contact bearing can tolerate a bigger temperature difference between inner and outer ring compared to a C4 deep groove ball bearing.

F.6.4 How to select motor sizes

The testing of motors, mounted horizontally and using deep groove ball bearings can be considered as the first step in certifying a motor range for smoke venting applications: tests of the smallest and largest motors shall be made according to the standard.

The bearings will be loaded with an equivalent load (combination of axial and radial load) as determined with ISO 281 (according to either Annex C or Annex D).

This test will qualify the bearing system with:

— deep groove ball bearing in horizontal position;

— angular contact bearing in horizontal position designed according to ISO 281 for the same life time criteria used for the test and respecting Faxial > Fradial;

— use of deep groove ball bearing in vertical position with same life time and design according to ISO 281 (contact ellipse will be checked) - it is supposed that the behaviour of grease in the vertical position has been tested.

NOTE It will also validate the insulation system (most critical is the smallest size).

F.6.5 How to select motor size in vertical position

The goal is to qualify angular contact bearings in vertical position in the same motor range that was tested in horizontal position. In this case, a test shall be performed to check the behaviour of the angular contact bearing configuration, selected according to ISO 281, and to check the behaviour of grease in the vertical position used with deep groove ball bearing or angular contact bearing.

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It is not necessary to test both the smallest and largest motors. The 'free' movement' in a small motor is 'limited' when compared to the largest size Motor and the small motor will heat up more rapidly in the hot air stream.

Consequently:

The worst case is the smallest motor size (with angular contact bearing) to be tested with the highest equivalent load and selected for the required life time calculated according to ISO 281.

This test will qualify:

— use of angular contact bearings in the motor range (smallest tested to largest);

— use of grease for deep groove ball bearing in vertical position using same grease.

NOTE 1 Test is on a fan fitted with a motor equipped with an angular contact bearing supporting the highest axial load for that bearing. This configuration can be achieved by weighting, if necessary, the hub of the impeller to increase the axial load (the required load is calculated according to ISO 281 for the specified bearing life).

NOTE 2 Compared with other bearing types such as deep groove ball bearings, a temperature difference between the outer and inner ring is not that harmful as long as the contact ellipse is not truncated (see Figure F.11).

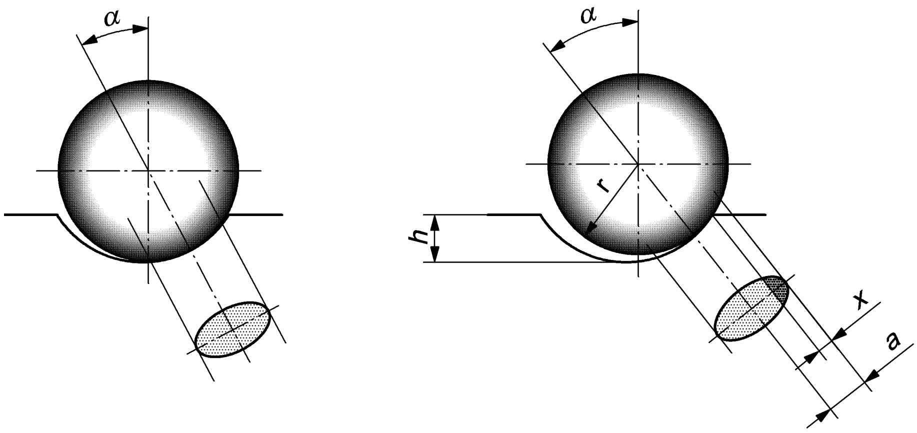

Figure F.11 — Example of the shape of the contact ellipse

In a smoke ventilation application, particularly if the motor is in the vertical position, an angular contact bearing may be required to cater for a high thrust axial load. If there is a temperature difference between the inner and outer ring the contact angle will slightly change but will not cause problems to the bearing as long as the non-locating bearing is free to move axially.

Lubrication properties become compromised at temperatures which are higher than the maximum specified for the normal working range of the grease. Depending on the bearing housing and seal arrangement, the effect of high temperature on some characteristics such as the dropping point of the grease, may prove more critical in vertical operation than horizontal operation...

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F.7 Consideration for changing material inside the fan

F.7.1 Material features

F.7.1.1 Mechanical properties

— Tensile strength;

— Compression strength, shear stress and twisting;

— Hardness;

— Creep;

— Behaviour at low temperatures;

— Fatigue.

F.7.1.2 Technological properties

— Abrasive resistance;

— Easy machining (formability).

F.7.1.3 Physical properties

— Density;

— Coefficient of thermal expansion;

— Thermal diffusivity;

— Elastic properties;

— Electrical conductivity;

— Behaviour in the magnetic field;

— Radioactive properties;

— Friction properties;

— Optical properties.

NOTE In the formulae,

Original material = $_1$

New material = $_2$

F.7.1.4 Tensile strength

Conventional elastic limit or Yield stress, R_{p02}

Breaking point, R_m

$(R_{p02})_2 \geq (R_{p02})_1$

F.7.1.5 Compression stress, shear stress and twisting

Not important while satisfying the previous point.

F.7.1.6 Hardness

Not important.

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F.7.1.7 Creep

It’s the material’s ability to resist to forces (comparable with centrifugal forces applied to blades when installed in the fan), depending on the time that it’s subjected to high temperature.

$(\text{Creep})_2 \leq (\text{Creep})_1$

F.7.1.8 Behaviour at low temperatures

Not important, but check that the characteristics of the new material are valid for a specific project temperature if this is below 0 °C.

F.7.1.9 Fatigue

If the R_{p02} is greater in the new material, the fatigue limit will be also greater if the following conditions are met:

— Same geometry (to avoid different notch effects),

— Less than or equal surface roughness,

— Less than or equal grain size.

If we meet the three conditions above, the behaviour of the new material to fatigue will be better than the original material, if $(R_{p02})_2 \geq (R_{p02})_1$.

F.7.2 Technological properties

F.7.2.1 Abrasive resistance

For 2 h maximum time at high temperature it is not important, but may need to be considered for dual purpose fans in some longer term day to day applications.

F.7.2.2 Formability

It is not important for the test. (It should be noted that the specimen selected for the tests shall be obtained from real pieces. In this way, the manufacturing process and its influence on the final properties of the material is taken into account.

F.7.3 Physical properties

F.7.3.1 Density

This is important for moving parts such as blades or rotors that are subject to stresses generated by centrifugal force. Therefore:

If $\rho_2 \leq \rho_1$ ➔ OK

If $\rho_2 > \rho_1$ ➔ shall be verified that $(R_{p02} / \sigma_{cal})_2 \geq (R_{p02} / \sigma_{cal})_1$, i.e. $(\text{Sec. Coef.})_2 \geq (\text{Sec. Coef.})_1$.

F.7.3.2 Coefficient of thermal expansion

If $\alpha_2 \leq \alpha_1$ ➔ OK

If $\alpha_2 > \alpha_1$ ➔ the new clearance between rotor and housing shall be evaluated in the fan.

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F.7.3.3 Thermal diffusivity

The thermal diffusivity is the rate of temperature change in a material.

$\delta = K / (\rho \cdot C)$, with K thermal conductivity, ρ density and C the specific heat of the material.

It is not important unless the thermal diffusivity of the new material is much higher than the thermal diffusivity of the original material.

F.7.3.4 Elastic properties

a) Stretch modulus, E

1) If $E_2 \geq E_1$ ➔ OK (higher stretch modulus less deformation);

2) If $E_2 < E_1$ ➔ Any change in clearance between rotor and housing shall be taken in account.

b) Damping, C

Does not affect:

1) Electrical conductivity;

2) Behaviour in the magnetic field;

3) Radioactive properties;

4) Friction properties;

5) Optical properties.

None of the above properties are critical to the operation of a PSHC Ventilator.

The following table specifies the reference standards

MECHANICAL CHARACTERIZATION		PHYSICAL CHARACTERIZATION	
Property	**Test**	**Property**	**Test**
Conventional elastic limit	EN ISO 6892-1	Density	UNE 400309
Tensile strength		Thermal Diffusivity	ASTM E1461
Breakage total extension		Thermal Expansion Coefficient	ASTM E228-11
Coefficient of necking			
Conventional elastic limit at high temperature	EN ISO 6892-2		
Tensile strength at high temperature			
Breakage total extension at high temperature			
Coefficient of necking at high temperature			
Fatigue Behaviour	ISO 1099		
Creep Behaviour	EN ISO 204		

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F.8 Complementary information on Installation / Application

It is considered advantageous to give information regarding product installation or application to the end user, in addition to that which is contained in the manufacturer's installation instructions , it may be included in a separate supplied document or appended to the Declaration of Performance: an example of a suitable format is given in Table F.8.

Table F.8

Mechanically driven exhaust appliances for smoke and heat control ventilators (fans)			
Classification			
	Class	**Temperature (°C)**	**Time (min)**
☒	F_{200}	200	120
☒	F_{300}	300	60
☒	F_{400}	400	120
☒	F_{400}	400	90
☒	F_{600}	600	60
☐	F_{842}	-	30
Free Classification for information only			
☒	Ff_{250}	250	120
☒	Ff_{300}	300	120
☒	Ff_{θ} (A)	θ	A
Motor Range	**FIREMOTOR ABC 123**		
1) Location of the fan and insulation if so [a]			
☒	outside the building without thermal insulation		
☒	outside the building including thermal insulation		
☐	inside the building but outside of the smoke reservoir without thermal insulation		
☒	inside the building but outside of the smoke reservoir including thermal insulation		
☒	inside the smoke reservoir		
2) Installation [a]			
☒	horizontal motor shaft, floor standing		
☐	horizontal motor shaft , wall mounted		
☒	horizontal motor shaft , suspended from ceiling		
☒	vertical motor shaft , impeller below the motor		
☒	vertical motor shaft , impeller above the motor		
☐	vertical motor shaft , mounted onto the face of wall		
☒	vertical motor shaft , suspended from ceiling		
☒	Motor upstream		
☒	Motor downstream		
Mechanically driven exhaust appliances for smoke and heat control ventilators (fans)			
3) Flexible connectors tested with the fan [a]: Connector abcVII			
☒	flexible connector inlet side		
☒	flexible connector outlet side		
☒	flexible connector inlet and outlet side		
☒	flexible connector for cooling air connection		
4) Cooling air [a]			
☒	$c_{Air,\theta}$ Cooling air volume flow Air = min. volume flow θ = max. cooling air temperature		
6) Snow load [a]			

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☐	SL0
☐	SL125
☐	SL250
☐	SL500
☐	SL1000
☐	SLA
7) Wind load [a]	
☐	200 Pa
Motor Range	**FIREMOTOR ABC 123**
8) Application	
☐	D.O.L. only
☐	with frequency converter under following conditions: – Peak to peak; – Filter, etc.
☐	Dual purpose
☐	Emergency only
☐	Thermally insulated
☐	Thermally uninsulated

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Annex G
(informative)

General guidance for installation and maintenance

G.1 Product, installation and maintenance information (documentation)

G.1.1 Product specification

The manufacturer shall provide, and retain a detailed description of the product including all the relevant components. This shall include a description of the materials used in the construction of the Powered Smoke and heat Control ventilator. It shall also include details of the method of installation, including fixing details.

G.1.2 Installation information

The manufacturer shall provide appropriate installation details that shall include at least information for:

— fixing and installation,

— connection to external services (e.g. electric installation),

— health and safety information to allow safe installation.

— When a frequency converter is used to drive the motor:

  — ,the maximum voltage peak and peak to peak value and the maximum rate of change of voltage with time (du/dt) that the motor has been tested and the following warning “If these values are exceeded on site voltage limiting filters shall be installed”.

  — The following warning/statement “It shall be proven that, in case of electrical power break the converter can restart itself and restart the motor in accordance with the emergency instruction on site and that the converter is able to drive the fan without any interruption due to electrical information (all electrical safety functions shall be inhibited in emergency operation) ”.

G.1.3 Maintenance information

The manufacturer shall provide appropriate maintenance information for the powered smoke and heat control ventilator that shall include at least:

— inspection and maintenance procedure,

— the recommended frequency of operational checks.

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Annex ZA
(informative)

Clauses of this European Standard addressing the provisions of the EU Construction Products Regulation

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under Mandate M 109 Fire alarm/detection, fixed fire-fighting, fire and smoke control and explosion suppression products given to CEN by the European Commission and the European Free Trade Association.

If this European standard is cited in the Official Journal of the European Union (OJEU), the clauses of this standard, shown in this annex, are considered to meet the provisions of the relevant mandate, under the Regulation (EU) No. 305/2011.

This annex deals with the CE marking of the powered heat and smoke control ventilators (fans) intended for the uses indicated in Table ZA.1 and shows the relevant clauses applicable.

This annex has the same scope as in Clause 1 of this standard related to the aspects covered by the mandate and is defined by Table ZA.1.

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Table ZA.1 — Relevant clauses for powered heat and smoke control ventilators (fans) and intended to be installed as part of a powered smoke and heat control ventilation system in construction works

Product: powered heat and smoke control ventilators (fans) **Intended use:** to be used as part of a powered smoke and heat control ventilation system in construction works			
Essential Characteristics	**Clauses in this and other European Standard(s) related to essential characteristics**	**Regulatory classes**	**Notes**
Response delay: - Opening under wind load within a given time; - Opening under snow load within a given time.	4.1.1 4.1.1		(s) Class
Operational reliability: - Application categories; - Motor rating.	4.2.2 4.2.3		Category Insulation class, ΔT
Effectiveness of smoke / hot gas extraction: - Gas flow and pressure maintenance during smoke and heat extraction test.	4.3.2		%
Resistance to fire	4.4		Class
Ability to open under environmental conditions - Opening under wind load within a given time; - Opening under snow load within a given time.	4.5		(s) class
Durability of operational reliability	4.6		Insulation class,ΔT

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The declaration of the product performance related to certain essential characteristics is not required in those Member States (MS) where there are no regulatory requirements on these essential characteristics for the intended use of the product.

In this case, manufacturers placing their products on the market of these MS are not obliged to determine nor declare the performance of their products with regard to these essential characteristics and the option “No performance determined” (NPD) in the information accompanying the CE marking and in the declaration of performance (see ZA.3) may be used for those essential characteristics.

ZA.2 Procedure for AVCP of the powered heat and smoke control ventilators (fans)

ZA.2.1 System(s) of AVCP

The AVCP system(s) of the powered heat and smoke control ventilators (fans) indicated in Table ZA.1, established by EC Decision 96/577/EC of 1996-06-24 (see OJEU L254 of 1996-10-08) as amended by EC Decision 2002/592/EC of 2002-07-15 (see OJEU L192, 2002-07-20) is shown in Table ZA.2 for the indicated intended use and relevant level(s) or class(es) of performance.

Table ZA.2 — System of AVCP

Products	Intended use	Level(s) or class(es) of performance	AVCP system
Powered ventilators	Fire safety		1
System 1: See Regulation (EU) No. 305/2011 (CPR) Annex V, 1.2			

The AVCP of the powered heat and smoke control ventilators (fans) in Table ZA.1 shall be according to the AVCP procedures indicated in Table ZA.3 resulting from application of the clauses of this or other European Standard indicated therein. The content of tasks of the notified body shall be limited to those essential characteristics as provided for, if any, in Annex III of the relevant mandate and to those that the manufacturer intends to declare.

Table ZA.3 — Assignment of AVCP tasks for the powered heat and smoke control ventilators (fans) under system 1

Tasks		Content of the task	AVCP clauses to apply
Tasks for the manufacturer	Factory production control (FPC)	Parameters related to essential characteristics of Table ZA.1 relevant for the intended use which are declared	6.3
	Further testing of samples taken at factory according to the prescribed test plan	Essential characteristics of Table ZA.1 relevant for the intended use which are declared	6.3.2.6
Tasks for the notified product certification body	Determination of the product type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product	Essential characteristics of Table ZA.1 relevant for the intended use which are declared	6.2
	Initial inspection of manufacturing plant and of FPC	Parameters related to essential characteristics of Table ZA.1, relevant for the intended use which is declared. Documentation of the FPC.	6.3.4
	Continuous surveillance, assessment and evaluation of FPC	Parameters related to essential characteristics of Table ZA.1, relevant for the intended use which is declared. Documentation of FPC	6.3.5

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ZA.2.2 Declaration of performance (DoP)

ZA.2.2.1 General

The manufacturer draws up the DoP and affixes the CE marking on the basis of the different AVCP systems set out in Annex V of the Regulation (EU) No 305/2011:

— the factory production control and further testing of samples taken at the factory according to the prescribed test plan, carried out by the manufacturer; and

— the certificate of constancy of performance issued by the notified product certification body on the basis of determination of the product type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product; initial inspection of the manufacturing plant and of factory production control and continuous surveillance, assessment and evaluation of factory production control.

ZA.2.2.2 Content

The model of the DoP is provided in Annex III of the Regulation (EU) No 305/2011.

According to this Regulation, the DoP shall contain, in particular, the following information:

— the reference of the product-type for which the declaration of performance has been drawn up;

— the AVCP system or systems of the construction product, as set out in Annex V of the CPR;

— the reference number and date of issue of the harmonised standard which has been used for the assessment of each essential characteristic;

— where applicable, the reference number of the Specific Technical Documentation used and the requirements with which the manufacturer claims the product complies.

The DoP shall in addition contain:

a) the intended use or uses for the construction product, in accordance with the applicable harmonised technical specification;

b) the list of essential characteristics, as determined in the harmonised technical specification for the declared intended use or uses;

c) the performance of at least one of the essential characteristics of the construction product, relevant for the declared intended use or uses;

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d) where applicable, the performance of the construction product, by levels or classes, or in a description, if necessary based on a calculation in relation to its essential characteristics determined in accordance with the Commission determination regarding those essential characteristics for which the manufacturer shall declare the performance of the product when it is placed on the market or the Commission determination regarding threshold levels for the performance in relation to the essential characteristics to be declared.

e) the performance of those essential characteristics of the construction product which are related to the intended use or uses, taking into consideration the provisions in relation to the intended use or uses where the manufacturer intends the product to be made available on the market;

f) for the listed essential characteristics for which no performance is declared, the letters "NPD" (No Performance Determined);

Regarding the supply of the DoP, article 7 of the Regulation (EU) No 305/2011 applies.

The information referred to in Article 31 or, as the case may be, in Article 33 of Regulation (EC) No 1907/2006, (REACH) shall be provided together with the DoP.

ZA.2.2.3 Example of DoP

The following gives an example of a filled-in DoP powered smoke and heat control ventilators (fans)

DECLARATION OF PERFORMANCE

No. 001CPR2013-07-14

1. Unique identification code of the product-type:

Powered smoke and heat control ventilator (fan)

A - X-T- FFF 21

2 Type, batch or serial number or any other element allowing identification of the construction product as required under Article 11(4):

Powered smoke and heat control ventilator (fan)

T120- P1- D-Vm-L40045- O50

3 Intended use or uses of the construction product, in accordance with the applicable harmonised technical specification, as foreseen by the manufacturer:

To be used as part of a powered smoke and heat control ventilation system in construction works.

4. Name, registered trade name or registered trade mark and contact address of the manufacturer as required under Article 11(5):

AnyCo SA,

PO Box 21

B-1050 Brussels, Belgium

Tel. +32987654321

Fax: +32123456789

Email: anyco.sa@provider.be

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5. Where applicable, name and contact address of the authorised representative whose mandate covers the tasks specified in Article 12(2):

Anyone Ltd

Flower Str. 24

West Hamfordshire

UK-589645 United Kingdom

Tel. +44987654321

Fax: +44123456789

e-mail: anyone.ltd@provider.uk

6. System or systems of assessment and verification of constancy of performance of the construction product as set out in CPR, Annex V:

System 1

7. In case of the declaration of performance concerning a construction product covered by a harmonised standard:

Notified product certification body No. 5678 determined the product type on the basis of type testing (including sampling); performed the initial inspection of the manufacturing plant and of factory production control and continuous surveillance, assessment and evaluation of factory production control and issued the certificate of constancy of performance.

8. Declared performance

Essential characteristics	**Performance**	**Harmonized technical specification**
Response delay: - opening under wind load within a given time - opening under snow load within a given time	20 s SL 500	EN 12101-3: 2015
Operational reliability : - Application categories - Motor rating	Dual purpose F, 80 K	
Effectiveness of smoke / hot gas extraction Gas flow and pressure maintenance during smoke and heat extraction test	±10 %	
Resistance to fire	F_{400} (120)	
Ability to open under environmental conditions - opening under wind load within a given time, - opening under snow load within a given time.	20 s SL 500	
Durability of operational reliability	F, 80 K	

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10. The performance of the product identified in points 1 and 2 is in conformity with the declared performance in point 8.

This declaration of performance is issued under the sole responsibility of the manufacturer identified in point 4.

Signed for and on behalf of the manufacturer by:

……

(name and function)

(place and date of issue) (signature)

ZA.3 CE marking and labelling

The CE marking symbol shall be in accordance with the general principles set out in Article 30 of Regulation (EC) No 765/2008 and shall be affixed visibly, legibly and indelibly to a label attached to the powered heat and smoke control ventilator (fan) together with the following information:

— the identification number of the notified product certification body;

— the name and the registered address of the manufacturer, or the identifying mark allowing identification of the name and address of the manufacturer easily and without any ambiguity;

— the last two digits of the year in which it was first affixed;

— the reference number of the declaration of performance;

— the dated reference to the this European standard applied;

— the unique identification code of the product-type;

— the intended use as laid down in this European standard applied.

— the level or class of the performance declared;

The CE marking shall be affixed before the construction product is placed on the market. It may be followed by a pictogram or any other mark notably indicating a special risk or use.

Figure ZA.1 gives example of the label attached to the powered heat and smoke control ventilator (fan).

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0123	*CE marking, consisting of the "CE"-symbol* *Identification number of the notified product certification body*
AnyCo Ltd, PO Box 21, B-1050, Brussels, Belgium **15** 00001-CPR-2013/05/12	*Name and the registered address of the manufacturer, or identifying mark* *Last two digits of the year in which the marking was first affixed* *Reference number of the DoP*
EN 12101-3:2015 Product A – X-T-FFF 21 intended to be installed as part of a powered smoke and heat control ventilation system in construction works **Response delay:** **- opening under wind load within a given time :** 20 s **- opening under snow load within a given time :** SL 500 **Operational reliability :** - **Application category:** Dual purpose - **Motor rating :** F, 80 K **Effectiveness of smoke / hot gas extraction** - **Gas flow and pressure maintenance during smoke and heat extraction test :** ±10 % **Resistance to fire:** F_{400} (120) **Ability to open under environmental conditions:** **- opening under wind load within a given time:** 20 s **- opening under snow load within a given time**: SL 500 **Durability of operational reliability:** F, 80 K	*No. of European standard applied, as referenced in OJEU* *Unique identification code of the product-type* *Intended use of the product as laid down in the European standard applied* *Level or class of the performance declared*

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Figure ZA.1 — Example of the label attached to the powered heat and smoke control ventilator (fan)

Bibliography

[1] EN 1366 (all parts), *Fire resistance tests for service installations*

[2] EN 12094 (all parts), *Fixed fire fighting systems — components for gas extinguishing systems*

[3] EN 12101-2:2003, *Smoke and heat control systems - Part 2: Specification for natural smoke and heat exhaust ventilators*

[4] EN ISO 9001, *Quality management systems - Requirements (ISO 9001)*

[5] ISO 3:1973, *Preferred numbers — Series of preferred numbers*

[6] ISO 14520-1, *Gaseous fire-extinguishing systems — Physical properties and system design — Part 1: General requirements*

[7] ASTM E1461-07:2011, *Standard test method for thermal diffusivity by the flash method*

[8] ASTM E228-11, *Standard test method for linear thermal expansion of solid materials with a Push-Rod Dilatometer*

[9] UNE 400309: *Febrero 1997, Pyknometers*

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