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RATING STANDARD

for the

CERTIFICATION

of

FANS

RS/1/C/001-2017

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I. PURPOSE

The purpose of this Rating Standard is to establish definitions and specifications for testing and rating of FANS (FANS), for the related Eurovent Certified Performance (ECP) certification programme, in accordance with Operational Manual OM-22.

II. SCOPE

Please refer to related paragraph in the Operational Manual OM-22.

III. DEFINITIONS

For definitions regarding the certification scheme refer to Certification Manual.

III.1. Axial fan

A fan that propels gas in the direction axial to the rotational axis of one or more impeller(s) with a swirling tangential motion created by the rotating impeller(s) (refer to ISO 13349:2010 for illustration). The axial fan may or may not be equipped with a cylindrical housing, inlet or outlet guide vanes or an orifice panel or orifice ring.

For axial fans the fan flow angle, i.e the angle between incoming and outgoing gas flow directions, is lower than or equal to 20°.

III.2. Centrifugal fan

A fan in which the air enters the impeller(s) with an essentially axial direction and leaves it in a direction perpendicular to that axis. The impeller may have one or two inlets and may or may not have a housing (refer to ISO 13349:2010 for illustration).

For centrifugal fans the fan flow angle, i.e the angle between incoming and outgoing gas flow directions, is higher than or equal to 70°.

When fitted with a housing the fan is called a “housed centrifugal fan”. The housing is generally a scroll type casing (shroud) that includes supports for either Belt or Direct Drive.

When the centrifugal fan is unhoused it is called “plenum fan” (see §III.30).

III.3. Controller

A power electronic device that regulates the speed of a motor. Speed can be varied either continuously or in steps by a variable-speed motor, variable-speed coupling, convertors (inverters), voltage control or by use of electronically commutated or switched reluctance motors. The controller can notably be on/off, 2-speed, multi-speed drive (see §III.26) or variable speed drive (see §III.35).

III.4. Direct drive

Drive arrangement for a fan where the impeller is fixed to the motor shaft, either directly or with a co-axial coupling, and where the impeller speed is identical to the motor’s rotational speed.

III.5. Drive/control (electrical) input power

The drive/control (electrical) input power P_{ed} (W) is the electric power input measured at the main terminals of the controller (see §III.3).

III.6. Drive system

The drive system stand for the assembly that comprises the electric motor, the drive arrangement (see §III.4 and §III.34) and possibly a controller (see §III.3).

III.7. Dynamic pressure

The dynamic pressure is the pressure calculated from the mass flow rate, the average gas density at the outlet and the fan outlet area.

III.8. Fan

According to standard ISO 13349:2010, a fan is a rotary-bladed machine that receives mechanical energy and utilizes it by means of one or more impellers fitted with blades to maintain a continuous flow of air or other gas passing through it and whose work per unit mass does not normally exceed 25 kJ/kg.

III.9. Fan air power

Conventional output power P_u (W) which is the product of the mass flow-rate by the fan work per unit mass, or the product of the inlet volume flow, the compressibility coefficient and the fan pressure.

III.10. Fan housing

A casing around the impeller which guides the gas stream towards, through and from the impeller.

III.11. Fan impeller efficiency

The fan impeller efficiency η_r (%) is the fan air power P_u (see §III.9) divided by the impeller power P_r (see III.12).

III.12. Fan impeller power

The fan impeller power P_r (W), is the mechanical power supplied to the fan impeller.

III.13. Fan range

A family of fans of different sizes grouped under the same designation and using the same operating software/DLL.

The fan range characteristics can include the following:

- fan type : axial fan (see §III.1), unhoused fan (see §III.30 and §III.31) or housed centrifugal fan (see §III.2)
- support structure
- impeller arrangement (single-inlet or double-inlet)
- impeller blade geometry (see §III.22)
- impeller supplier
- impeller rotation direction (clockwise/anticlockwise)
- motor type
    - Alternating current (AC),
    - Electronically commutated (EC)
    - Permanent magnet (PM)
- motor rotor (external or internal)

- motor energy efficiency class (IE2, IE3 or IE4 as per standard IEC 60034-30-1:2014)
- motor frame size according to EN 50347:2001
- drive arrangement : direct-drive (see §III.4) or transmission (see §III.34)
- controller type (see §III.3)
- geometrical data :
  - impeller nominal tip diameter,
  - number of blades,
  - housing development radii, whenever applicable,
  - housing width, whenever applicable.

III.14. Fan static efficiency

The fan static efficiency is the energy efficiency of a fan based upon the measurement of the fan static pressure p_{sf} (see III.15).

III.15. Fan static pressure

The fan static pressure p_{sf} is the difference between the fan total pressure p_f and the fan dynamic pressure corrected by the Mach factor. It is also the difference between the static pressure at the fan outlet and the stagnation pressure p_{sg1} at the fan inlet.

III.16. Fan static pressure difference

Fan static pressure difference $\Delta p_{s\text{-}static}$: difference between the static pressure at the fan outlet and the total pressure at the fan inlet.

III.17. Fan total efficiency

The fan total efficiency is the energy efficiency of a fan based upon the measurement of the fan total pressure p_f (see III.18).

III.18. Fan total pressure

The fan total pressure p_f is the difference between the stagnation pressure p_{sg2} at the fan outlet and the stagnation pressure p_{sg1} at the fan inlet (see also stagnation pressure definition in §III.33).

III.19. Fan total pressure difference

The fan total pressure difference $\Delta p_{s\text{-}total}$ is the difference between total pressure at the fan outlet and total pressure at the fan inlet.

III.20. Impeller

The part of the fan that is imparting energy into the gas flow and is also known as the fan wheel.

III.21. Impeller arrangement

Is referred to as “impeller arrangement” the fact that the impeller is fed through one inlet (single inlet) or two inlets (double inlet).

III.22. Impeller blade geometry

For centrifugal fans the blade angle, i.e the inclination of the impeller blade towards or away from its rotation direction, leads to several blade types (refer to ISO 13349:2010 for illustration):

- Backward-curved (BC) when the blade angle is higher than or equal to 1°
- Forward-curved (FC) when that the blade angle is lower than or equal to -1°
- Radial-bladed, including radial-tipped and radial shrouded configurations, when the blade angle is strictly higher than -1° and strictly lower than 1°

The following blade types exist too:

- Backward-inclined (BI)
- Aerofoil (AF)

As they are sub-types of backward-curved (BC) type they will be considered as covered by the statements related to the BC type in this document.

In conjunction to the blade type, the blade angle value completes the blade geometry description.

III.23. Maximum fan speed

Maximum rotational speed N_{max} in rotations per minute [rpm] for which there is no risk of blade damage.

III.24. Measurement / Installation categories:

The categories of measurement/installation used with fans are the following:

- A: free inlet, free outlet and a partition between inlet and outlet zone
- B: free inlet, ducted outlet and a partition between inlet and outlet zone
- C: ducted inlet, free outlet and a partition between inlet and outlet zone
- D: ducted inlet, ducted outlet and a partition between inlet and outlet zone
- E: ducted inlet, ducted outlet without partition between inlet and outlet zone

III.25. Motor (electrical) input power

The motor (electrical) input power P_e (W) is the electric power input measured at the main terminals of the motor.

III.26. Multi-speed drive

A multi-speed driven motor is a fan motor can be operated at three or more speeds plus zero (“off”).

III.27. Octave band sound power level

Sound power level in an octave band with a defined centre frequency, noted LW_{fc}, expressed in [dB] and defined as 10 times the logarithm to the base 10 of the ratio of the sound power in watts to a reference value of 1 picowatt (10^{-12} W).

III.28. Operation point

Relative position on the fan characteristic curve corresponding to a particular airflow rate.

III.29. Overall efficiency for driven fans with/without variable speed

The overall efficiency for driven fans with variable speed is noted η_{ed} (%).

The overall efficiency for driven fans without variable speed is noted η_e (%).

The overall efficiency stands for static efficiency (see §III.14) when the fan is tested in the measurement/installation category A (see §III.24).

III.30. Plenum fan

Fan having an unhoused centrifugal impeller which draws air into the impeller through an inlet located in a barrier wall, and having a driver located on the same side of the barrier as the impeller (refer to ISO 13349:2010 for illustration).

III.31. Plug fan

Fan having an unhoused impeller arranged such that the system into which it is inserted acts as a housing, allowing air to be drawn into the impeller inlet (refer to ISO 13349:2010 for illustration).

III.32. Shaft power

The fan shaft power P_a (W), is the mechanical power supplied to the fan shaft, including bearings.

III.33. Stagnation pressure

The stagnation pressure is the pressure measured at a point in a flowing gas if it were brought to rest via an isentropic process.

III.34. Transmission

Drive arrangement for a fan which is not “direct drive” (see §III.4). Such driving arrangements may include transmissions using:

- an in-line direct coupling: the drive shaft and the impeller shaft are each fixed on a part of the in-line direct coupling and rotate at the same speed.
- an in-line slipping coupling: the drive shaft is fixed to the primary part of the coupling and the impeller shaft to the secondary part of the coupling, enabling them to rotate at different speeds, the relative difference of which (i.e. the slip) depends upon the speed, the torque to be transmitted and, when appropriate, the degree of control applied to the coupling.
- a gear box: drive and impeller shafts are not necessarily coaxial; they may be parallel or at an angle, their speeds being in one or more given ratio(s).
- a belt-drive: the drive shaft and the impeller shaft are not in-line, but parallel, the drive between the two being by means of flat, toothed or V-belts (or belts of some other section) and suitable pulleys. Their speeds are in a given ratio subject to a small amount of slip, except in the case of the toothed belt.

III.35. Variable speed drive

The Variable speed drive (VSD) is an electronic controller, integrated or functioning as one system or as a separate delivery with the motor and the fan, which continuously adapts the electrical power supplied to the motor in order to control its mechanical power output according to the torque-speed characteristic of the load being driven.

This designation includes electronically commutated (EC) motors with an internal control but excludes variable voltage controllers where only the supply voltage for the motor is varied.

III.36. Wire-to-air approach

The Wire-to-Air approach consists in assessing the fan performance from the electric wire to the air discharge, accounting for all the components involved in the air stream generation that affect the performance data.

All the components listed in §II of OM-22 that appear in the applicant/participant product catalogue have to be included in the tested fan assembly.

Whenever a given component (see components list in §II of OM-22) is not included in the applicant/participant catalogue, a recommended component is to be specified in the declaration file and its influence on the certified performance values is to be accounted for in the DLL/software ratings in accordance with the rating requirements (see §V.4).

IV. TESTING REQUIREMENTS

IV.1. Test standards

The aerodynamic test shall be conducted in accordance with:

- ISO 5801:2007: Industrial fans. Performance testing using standardized airways.

The sound test shall be conducted in accordance with:

- ISO 13347-2:2004: Industrial fans. Determination of fan sound power levels under standardized laboratory conditions. Part 2: Reverberant room method.

IV.2. Particular specifications for testing

The following specifications are applicable for qualification tests and repetition tests.

a. <u>Test conditions</u>

The performance testing shall be made on the fan alone, without the AHU casing.

The measurement/installation category shall be “A”: free inlet, free outlet and a partition between inlet and outlet zone (see §III.24).

b. <u>Performance items to be tested</u>

The performances to be measured for the aerodynamic test are listed in Table 2 in and those to be measured for the sound test appear in Table 3.

c. <u>Operating points for testing</u>

The aerodynamic performances (see Table 2) shall be measured for 10 operation points chosen randomly by Eurovent Certita Certification in the fan operating area.

The sound performances (see Table 3) shall be measured for the nominal rotational speed of the fan.

V. RATING REQUIREMENTS

V.1. Test-check

Eurovent Certita Certification shall conduct a “test-check”, i.e. the performances will be recalculated at the test operating conditions using the selection software.

A performance item fails when the difference between the recalculated value recalculated and the test results differs by more than the allowable tolerance (see §VII).

A test fails when one or more performance items fail.

V.2. Air density

Standard air density is set at 1.20 kg/m^3. It is mandatory to display the certified performances items under the standard conditions in the software outputs. It is allowed to display any other values if accompanied by the underlying air density.

V.3. Maximum fan speed

It is considered that the applicant/participant cannot declare ratings for operation points that imply to exceed the declared maximum fan speed (see definition in §III.23).

V.4. Wire-to-air principle implementation in the software/DLL ratings

Whenever the certification is conducted for a fan which requires the addition of one or several recommended component(s) to comply with the "wire-to-air" approach (see §III.36), the output data provided by the software/DLL shall comply with the calculation principle specified in §3.2 of Annex II of regulation 327/2011 applied to the whole performance curve.

In particular the overall efficiency η_e of the fan shall be calculated from the recommended (if not certified) electrical input powers P_e and P_{ed} respectively for motor and drive, the impeller efficiency η_r (certified) and the shaft power P_a (certified) applying:

$$\eta_e = \eta_r \cdot \eta_m \cdot \eta_T \cdot C_m \cdot C_c$$

with (refer to §3.2 of Annex II of regulation 327/2011 for further details):

η_m : the motor efficiency

η_T : the efficiency of the driving arrangement

C_m : the compensation factor to account for the matching of components

C_C : the part load compensation factor

Also, if the inlet connection (cone, nozzle, etc.) cannot be included in the tested object, the related pressure drop shall be considered in the fan performance ratings as follows:

$$\Delta p_{s-static}' = \Delta p_{s-static\_uncorrected} - \Delta p_{inlet}$$

and

$$\Delta p_{inlet} = K_{inlet} \cdot \frac{\rho_{air} \cdot V^2}{2} = 0.06 \cdot \rho_{air} \cdot V^2$$

with:

$\Delta p_{s\text{-}static}'$: the static pressure difference accounting for inlet connection (Pa)

Δp_{inlet} : the inlet connection pressure drop (Pa)

K_{inlet} : the inlet connection pressure drop coefficient, considered equal to 0.12

ρ_{air} : the air density (kg/m^3)

V : the air stream velocity (m/s)

Besides, whenever the tested object does not comprise the protection guards, the static pressure difference shall be corrected using the downgrading factors displayed below (see Table 1):

$$\Delta p_{s-static}'' = f_{guard\_inlet} \cdot f_{guard\_outlet} \cdot \Delta p_{s-static}'$$

with:

$\Delta p_{s\text{-}static}''$: the static pressure difference accounting for protection guards (Pa)

f_{guard_inlet} : the inlet guard downgrading factor

f_{guard_outlet} : the outlet guard downgrading factor

Table 1 : Downgrading factors for inlet and outlet fan guards' consideration in the overall performance data

Missing component	***Downgrading factor f_{guard}***
Inlet guard (wire)	0.95
Inlet guard (other)	0.80
Outlet guard (wire)	0.95
Outlet guard (other)	0.80

VI. CERTIFIED PERFORMANCE ITEMS

The following performance characteristics, as defined in testing standards listed in §IV.1, declared by the applicant/participant shall be verified by tests:

Table 2 : Performance items to be tested during the aerodynamic test

Aerodynamic performance item	***FAN-C***	***FAN-I***
Static pressure difference	YES	YES
Shaft power, including bearings	*NO*	YES
Motor (electrical) input power	YES	*NO*
Drive/control (electrical) input power	YES	*NO*
Maximum fan speed	*NO*	YES
Impeller efficiency	*NO*	YES
Overall (static) efficiency	YES	*NO*

Table 3 : Performance items to be tested during the sound test

Sound performance item	***FAN-C***	***FAN-I***
Inlet and outlet sound power level L_{Wfc} by octave bands at 125 Hz	YES	*NO*
Inlet and outlet sound power level L_{Wfc} by octave bands between 250 Hz and 8000 Hz	YES	*NO*

VII. TOLERANCES

When tested in the laboratory the obtained performance data shall not differ from the recalculated values ("test-check") by more than the tolerance values displayed in the following tables:

Table 4 : Applicable tolerances for a complete assembly (FAN-C)

Performance item	***Tolerance value***
Static pressure difference	-4 % or -15 Pa
Motor (electrical) input power	+3 %
Drive/control (electrical) input power	+3 %
Overall (static) efficiency	-5 percentage points
Inlet and outlet sound power level L_{Wfc} by octave bands at 125 Hz	+5 dB
Inlet and outlet sound power level L_{Wfc} by octave bands between 250 Hz and 8000 Hz	+3 dB

Table 5 : Applicable tolerances for a basic assembly (FAN-I)

Performance item	***Tolerance value***
Static pressure difference	-4 % or -15 Pa
Shaft power, including bearings	+3 %
Impeller efficiency	-5 percentage points
Maximum fan speed	-5 %

The relative deviation (in %) between the measured value X_{meas} and the recalculated value X_{recal} is calculated as follows:

$\Delta_{rel} = (X_{meas} - X_{recal}) / X_{recal}$

The absolute deviation between the measured value X_{meas} and the recalculated value X_{recal} is calculated as follows:

$\Delta_{abs} = X_{meas} - X_{recal}$

If any of individual points of measurement shows a deviation larger than the acceptable tolerance, the failure shall be declared and the failure procedure applied.