SLOVENSKI STANDARD
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Prezraļevanje stavb - Preskusi in merilne metode za predajo vgrajenih prezraļevalnih naprav in klimatizirnih sistemov

Ventilation for buildings - Test procedures and measuring methods for handing over installed ventilation and air conditioning systems

Lüftung von Gebäuden - Prüf- und Meßverfahren für die Übergabe eingebauter raumlufttechnischer Anlagen

Ventilation des bâtiments - Procédures d'essai et méthodes de mesure pour la réception des installations de ventilation et de climatisation installées

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Ventilation for buildings - Test procedures and measuring methods for handing over installed ventilation and air conditioning systems

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 156 "Ventilation for buildings", 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of an identical text or by endorsement, at the latest by September 2000, and conflicting national standards shall be withdrawn at the latest by September 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies checks, test methods and measuring instruments in order to verify the fitness for purpose of the installed systems at the stage of handing over.

The standard enables the choice between simple test methods, when sufficient, and extensive measurements, when necessary.

The standard applies to mechanically operated ventilation and air conditioning systems as specified in CR 12792 and comprising any of the following:

- Air terminal devices and units
- Air handling units
- Air distribution systems (supply, extract, exhaust)
- Fire protection devices
- Automatic control devices.

This standard does neither define the procedure by which the system is set, adjusted and balanced nor the procedure for internal quality control checks before handing over.

The standard does not apply to:

- Heat generating systems and their control
- Refrigerating systems and their control

- Distribution of heating and cooling medium to the air handling units
- Compressed air supplying systems
- Water conditioning systems
- Central steam generating systems for air humidifying
- Electric supply systems.

This standard applies to ventilation and air conditioning systems designed for the maintenance of comfort conditions for buildings excluding dwellings. It is not applicable in the case of systems for the control of industrial or other special process environments. In the latter case, however, it may be referred to if the system technology is similar to that of the above mentioned ventilation and air conditioning systems.

This standard does not include any requirements concerning the installation contract. However, in order to facilitate the application of this standard, the installation contract should refer to the provisions which are listed in annex H.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to apply (including amendments).

CR 1752
Ventilation for buildings – Design criteria for the indoor environment

CR 12792
Ventilation for buildings – Symbols and terminology

EN 1822-1
High efficiency particulate air filters (HEPA and VLPA) – Part 1: Classification, performance testing, marking

EN 60584-1
Thermocouples – Part 1: Reference tables (IEC 60584-1:1995)

EN 60584-2
Thermocouples – Part 2: Tolerances (IEC 60584-2:1982 + A1:1989)

EN 60651
Sound level meters (IEC 651:1993)

EN 60751
Industrial platinum resistance thermometer sensors (IEC 751:1983 + A1:1986)

ENV 12097
Ventilation for buildings – Ductwork – Requirements for ductwork components to facilitate maintenance of ductwork systems

3 Test and check procedure

The following steps shall be carried out in the given order:

a) Completeness checks

b) Functional checks

c) Functional measurements

Special measurements in accordance with clause 7 and Annex F shall only be carried out when required and especially agreed.

Functional checks and measurements on the system can be performed to a variable extent which is specified by means of 4 levels (see Annex D). The choice of a level should be agreed upon and be part of the installation contract.

A summary of the different tests and measurements is included in Figure 1.

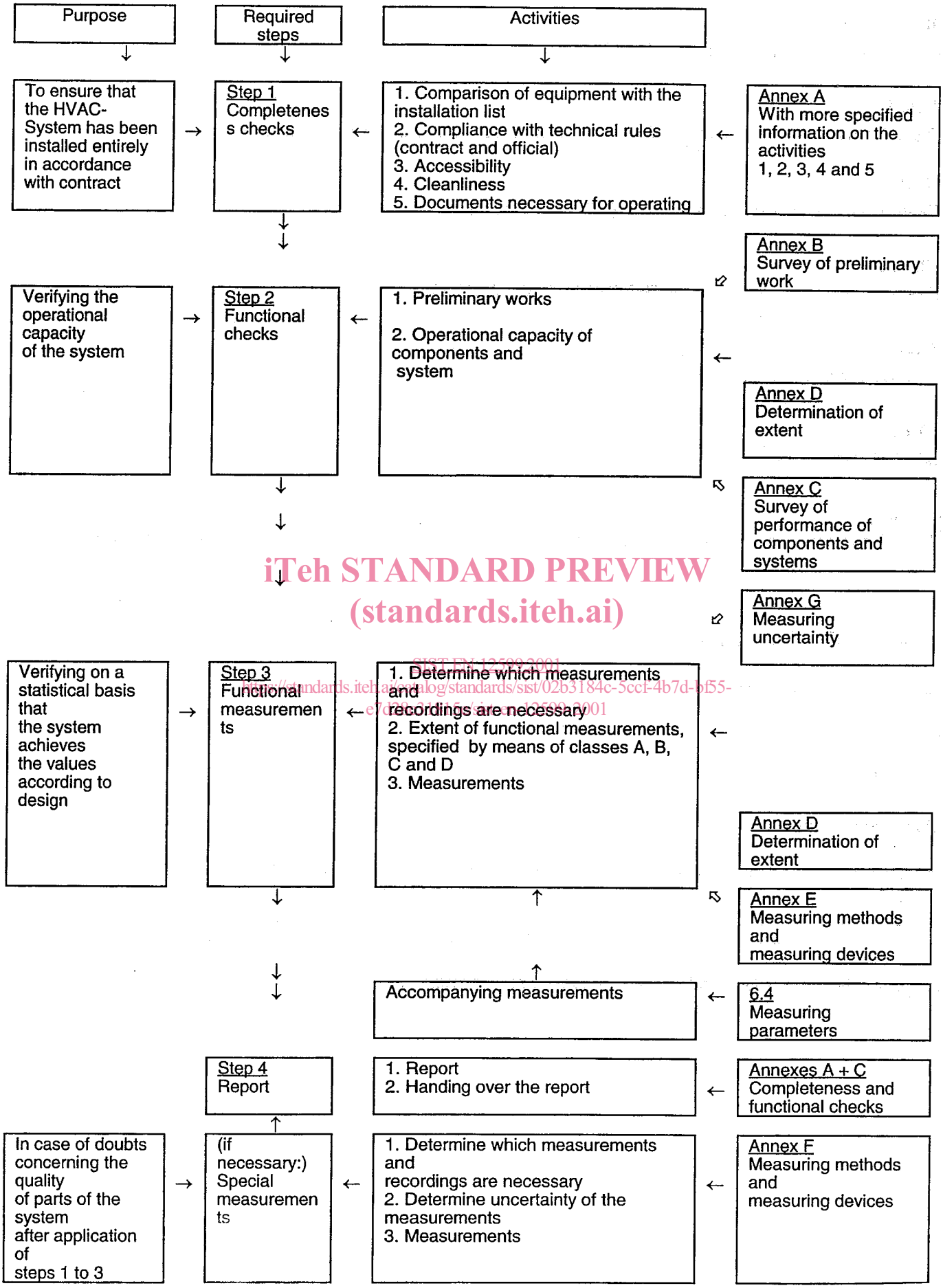

Figure 1 - Summary of tests and measurements to verify the quality of the systems

4 Completeness checks

The completeness check is intended to assure that the system has been installed completely and in compliance with the relevant technical rules.

The following checks are included:

– Comparison of the delivered system with the specification, both with regard to volume and material and, if necessary, also with regard to characteristics and spare parts.

– Check of compliance with technical and legal rules.

– Check of the accessibility of the system with regard to operation, cleaning and maintenance.

– Check of the cleanliness of the system as specified in ENV 12097.

– Check whether all documents necessary for operation are available.

A description of the completeness check is included in Annex A.

5 Functional checks

The purpose of the functional check is to prove the operational capacity of the system according to the specification. The test shows whether the particular elements of the system such as filters, fans, heat exchangers, coolers, humidifiers etc. have been properly installed and are effective.

5.1 Preliminary work

It is necessary that the installation work is completed and that the system is adjusted before starting the checks.

Annex B contains a survey of preliminary work.

5.2 Procedure

Functional checks shall be carried out on every kind of installed equipment.

Before starting the checks a checklist shall be drawn up.

The extent of functional checks is defined in Annex D.

The locations for the checks shall be the subject of prior agreement by the parties concerned.

Instruction for the procedure and a list of usual functional checks are given in Annex C.

6 Functional measurements

The purpose of the functional measurements is to give proper assurance that the system achieves the design conditions and set points as specified.

When judging the results of measurements in an air conditioned space the influence of physical characteristics of the building should be taken into account.

6.1 Range of functional measurements

Table 1 indicates which measurements and recordings are necessary for each type of ventilation and air conditioning system.

The extent of functional measurements is defined in Annex D.

Table 1 - Functional measurements

Measurement at		Central system/ Appliance				Room				
Parameters / Type of system/Functions		current drawn by the motor [E.6]	air flow *) [E.1]	air temperature *) [E.3]	pressure drop at filter [E.7]	supply and exhaust air flow [E.1]	supply air temperature **) and air temperature in the room [E.3]	air humidity [E.4]	sound pressure level [E.5]	indoor air velocity [E.2]
Ventilation system	(F) Z	1	1	0	1	2	0	0	2	0
	(F) H	1	1	1	1	2	2	0	2	2
	(F) C	1	1	1	1	2	2	2	2	2
	(F) M/D	1	1	1	1	2	2	1	2	2
Partial air conditioning system	(F) HC	1	1	1	1	2	1	2	2	2
	(F) HM /HD /CM /CD	1	1	1	1	2	1	1	2	2
	(F) MD	1	1	1	1	2	2	1	2	2
	(F)HCM/MCD/CHD/HMD	1	1	1	1	2	1	1	2	2
Air conditioning system	(F) HCMD	1	1	1	1	2	1	1	2	2

*) Outdoor air, supply and exhaust air
**) Depending on control principles, if relevant

Explanations for Table 1:

0 measurement not necessary
1 to carry out in all cases
2 to carry out only in the case of contracted agreement
C cool
D dehumidify
F filter
H heat
M humidify (moisture)
Z without any thermodynamic air handling functions (zero)

6.2 Procedure

Before starting the functional measurement, the measuring locations shall be specified and the procedures and measuring devices shall be agreed upon and given within the technical documents.

At least one measuring position is required for measurements in rooms of area up to 20 m²; larger rooms should be subvided accordingly. The measuring positions should be chosen within the occupied zone and where the worst conditions are expected.

With regard to the selection of the measuring instruments the uncertainty shall be taken into account (see Annex G). Calibrated devices shall be used.

The indoor climate factors and air flow rates, heating, cooling and humidifying performances, electrical characteristics and other design data shall be measured at the ventilation system design air flow rate. Tolerances of the measured values in respect of the selection of the measuring equipment are given in Table 2.

Table 2 - Permissible uncertainty for the measuring parameters

Parameter	Uncertainty*)
Air flow rate, each individual room	± 20 %
Air flow rate, each system	± 15 %
Supply air temperature	± 2 °C
Relative humidity [RH]	± 15 % RH
Air velocity in occupied zone	± 0,05 m/s
Air temperature in occupied zone	± 1,5 °C
A-weighted sound pressure level in the room	± 3 dBA
*) The uncertainties include the permitted deviations from the design values as well as any measuring error.	

If the performance of the system requires closer uncertainties, this shall be specially defined in the documentation of the system. If product standards, national or local regulations require closer uncertainties, this shall be adhered to. All temperatures and heating or cooling performances shall simultaneously comply with the given uncertainties.

6.3 Measuring methods and measuring devices

Annex E provides information concerning measuring methods and devices which are adequate for the functional measurement.

6.3.1 Measurement of the air flow rate

The air flow rate can be evaluated by different methods. Usually, it is calculated from the air velocity and the corresponding cross-section. The air velocity can be measured by means of an appropriate anemometer or a pressure drop across a throttling device.

Air flow rates should preferably be measured at an appropriate cross-section of a duct. As air velocity is seldom uniform, it should be measured at an appropriate number of locations in the cross-section and averaged for the mean velocity. A measurement of pressure drop across a throttling device may also be used.

If an appropriately located duct cross-section is not available, then cross- sections within the air handling unit or fan casing may be used in order to determine the mean air velocity. This measurement may be made provided that there is unidirectional flow and clearly corresponding cross-section.

For air terminal devices other methods (e. g. bag method) can be applied. The exhaust air terminal devices with a low pressure drop can be measured by means of the compensation method.

The different measuring methods and devices are described in E.1.

6.3.2 Measurement of the indoor air velocity

Indoor air flow is usually a turbulent flow. The air velocity varies from place to place within the room, the variations being random with regard to magnitude and direction. Therefore, an exact measurement of the air velocity is complicated. Generally, it is sufficient to measure the mean air velocity at selected positions (see E.2.1).

In rooms up to approximately 20 m² floor area, one measurement position is sufficient. Large rooms (e. g. landscaped offices) should be measured on the similar basis to the foregoing and positions in the occupied zone should be chosen where higher air velocities can be expected. Measurements should preferably be taken at positions intended for intensive occupancy, e. g. at the desk in an office.

The measuring methods and devices are described in E.2.

6.3.3 Determination of the temperature of the air and of the mean radiant and operative temperature (see E.3)

Air temperature measurements may be required in the room, at the exhaust air terminal device or in the duct.

For the measurements of air temperature in the room the measuring points in the occupied zone, shall be agreed between the parties concerned.

When – due to high or low surface temperatures (windows, cooling/heating panels etc.) – thermal discomfort is suspected, it may be necessary to evaluate the operative temperature (see E.3.1).

6.3.4 Measurement of the air humidity

The measurements of the air humidity and temperature in the room provide information as to the operation of the system regarding humidifying or dehumidifying.

In connection with the measurement of the air humidity, the air temperature shall also be measured at the same location. In the case of measurements in ducts and air conditioning systems with underpressure, measuring errors due to an infiltration of room air shall be avoided.

The use of recording instruments is necessary. The recording period shall last for 24 h at least.

For measuring devices see E.4.

6.3.5 Measurement of the sound pressure level

The A-weighted sound pressure level shall be determined at places of work. Corresponding conditions within the room are given in CR 1752. (See also E.5.)

Outside the building, measurements of noise emission can be necessary at locations such as property boundaries or 0,5 m in front of a neighbouring open window taking account of any special conditions.

In all cases the extraneous sound pressure level shall additionally be recorded when the system is not in operation.

6.3.6 Measurement of the drawing of current

In accordance with E.6.

6.4 Accompanying measurements

The following data should be determined in order to record the operating conditions during the functional test:

– outdoor temperature and humidity,

– hot and cold water temperature at the distributor or at the air heater and air cooler,

– water flow rate in the hot water and cold water pipe system and

– pressure difference at the pumps.

7 Special measurements (see Annex F)

7.1 General

The measurements together with the appropriate measuring instruments can necessitate a considerable amount of work and associated costs. These require special contractual agreements which cover the nature and scope of performance.

Special measurements are appropriate where functional measurements are not sufficient to verify the quality of the system in the desired range of accuracy.

The programme of measurements, the parameters to be measured, the measuring instruments and the measuring points shall be agreed separately. The agreement should also cover the permitted uncertainty of the measured results. The agreement should be made before the particular system is installed. The work and cost involved in the measurements shall be commensurate with the requirements of the system. If the measuring uncertainty cannot be achieved for an acceptable cost, the client shall be informed with adequate notice before the measuring has commenced. The measurements should be performed only by persons possessing the necessary knowledge and experience.

The measurements can be restricted to equipment or components in the system.

It may be necessary to test the system during summer and winter operation.

The operating mode during the measurements should, where possible, reflect the agreed conditions. If this is not the case, it shall be possible to deduce the design data. For certain components (e. g. heat exchanger, cooler), it is necessary to convert the measuring results to the design data.

If operational or technical aspects do not permit an instrument or element to be measured when it is installed, then the item may be tested on a test bed.

When judging the results of measuring in an air conditioned space the influence of physical characteristics of the building should be taken into account.

For approval measuring instruments see F.1.

7.2 Parameters

See F.3.

7.3 Measurements of components

7.3.1 Fans

7.3.1.1 Measuring

For testing a fan which forms part of an air-conditioning system the following data shall be determined:

- air flow according to F.3.4,
- total pressure difference,
- pressure and temperature in the measurement cross-section according to F.3.1 and F.3.2,
- electric power taken according to F.3.9 and
- speed of rotation (rpm).

The speed of rotation is usually measured with a tachometer, a stroboscope, or a pulse counter.

7.3.1.2 Measurement uncertainty

The air flow and total pressure difference shall be converted by calculation to density $\rho = 1{,}2$ kg/m³. The assessment should take account of the installed situation and the inflow conditions.

The uncertainty shall be calculated in accordance with 7.5.

7.3.2 Filters

See also EN 779.

7.3.2.1 Measurements

For testing an installed filter the following data shall be measured:

– air flow according to F.3.4,

– velocity distribution at the filter according to E.1 and

– pressure drop according F.3.1.

Check that the filter is properly installed and is seated without leaks.

For high efficiency particulate air filters of classes H and U, in accordance with EN 1822-1, evidence shall be provided that no leaks are present in the filter material, the joint between the filter and the frame and the frame itself.

Depending on the installed situation of the filter two methods can be used to test such filters:

– the oil thread test,

– the particle count method.

7.3.2.2 Measurement uncertainty

The uncertainty of the measurements of the air flow and the pressure drop shall be calculated in accordance with 7.5.

7.3.3 Heat exchangers

It is assumed that the characteristic curves of the heat exchanger (operation characteristic data) are available from which the heating or cooling of the air as a temperature difference or as a relative parameter (related to the maximum temperature difference) as a function of the other mass flow (e. g. water) - and the pressure drop on the air side as a function of air flow - can be seen.

For air coolers, designed such that water condenses, the characteristic curves, under consideration of the humidity precipitation on the entire cooling surface, are - also for wet operation - decisive. In this case enthalpies shall be used instead of temperatures.

A heat recovery system is a type of heat exchanger, so the same rules as for heat exchangers apply analogously.

Regenerative heat recovery systems which also transmit air humidity (category III) are characterized not only by the heating but also by the humidification (returned humidity index).

In general, not only the parameters determining the thermal performance and the pressure drop but also the uniformity of temperature over the duct cross-section after the individual heat exchangers shall be tested .

7.3.3.1 Measuring

The following parameters shall be measured:

– air flow and air temperature at inlet and outlet of the heat exchanger,

– maximum deviation of air temperature from a mean value at inlet and outlet of the heat exchanger and

– pressure drop of the air flow and the flow of heating medium or coolant.

Additionally the following should be measured:

– in the case of air heaters, the flow rate of the heating medium and its cooling, and the air humidity at the air terminal device,

– in the case of air coolers, the flow rate of the coolant and its heat gain, and also the reduction of humidity,

– in the case of heat recovery systems with humidity transmission (category III), the increase of humidity (return humidity index),

– in the case of regenerative heat recovery systems (categories II and III), the flow rate of the heat medium (e. g. also indirectly through the rotor rpm) and the power taken by the drive motor (e. g. for driving the rotor or a circulation pump).

If the characteristic lines are available, it is sufficient to measure at a single operating point.

If no characteristic lines are available and if the measured air flow rate differs greatly (> 30 %) from the design rated value, then the heating index (return heating index) or the cooling index should be measured with at least three different air flow rates and converted by calculation to the design operating point. During this time, the other mass flow rate shall be held within the design region (± 20 %).

Measurements on air heaters before and after the humidifier are basically performed together with the humidifier (see 7.3.4). It is not necessary to make separate measurements on the individual heat exchangers and on the concurrently operated humidifier. This assumes that with uniform temperatures at the air inlet to the air heater the temperatures at the air outlet from the air heater do not vary over the cross-section by more than 10 % from a mean value. In this case it is sufficient to measure the flow rate of the heating medium and its cooling at one of the heat exchangers. The heating power of the individual air heaters is calculated from the total heating power and the enthalpy differences taken from the "h, x - diagram", (see Figure G.12). The course of state of the air in the humidifier is given by the air temperature at the inlet and

– in the case of spray or trickle humidifiers, by the wet-bulb temperature at the outlet (whereby for recirculating humidifiers, quasi-adiabatic, operating in equilibrium it is sufficient to measure the water temperature instead of the air temperatures),

– in the case of steam or vapour humidifiers by the temperature of the steam or vapour.

If necessary, the thermal balance shall consider heat flows through duct walls or fan casings.

7.3.3.2 Measurement uncertainty

The uncertainty limits of the measurement shall be calculated in accordance with 7.5.

7.3.4 Air humidifiers

For measurements on air humidifiers the same rules as for heat exchangers (see 7.3.3) apply analogously. The measurement shall be made together with the heat exchangers in the same test (see 7.3.3.1).

In the case of spray and trickle humidifiers it is assumed that the characteristic curves for the humidifier are available which show the humidification in terms of difference in the humidity content of the air or as a relative parameter related to the maximum difference of the humidity content and the pressure drop on the air side (including separator) as a function of the air flow rate. Additional characteristics apart from the design features such as number and arrangement of spray nozzles are the water flow and its pressure and temperature.

In the case of steam or vapour humidifiers the decisive parameters are the temperature, pressure and flow rate of the steam. In addition to these parameters, the degree of freedom from mist in the humidified air stream should be tested, characterized for instance by the necessary distance of certain filters or other components after the steam humidifier at various steam flow rates in relation to the air flow rate.

In addition to the steam flow rate and parameters determining the humidity, measurement should also be made of the uniformity of the humidity over the cross-section after the humidifier.