



SLOVENSKI STANDARD

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Ogrevalni sistemi in sistemi za hlajenje z vodo v stavbah - Sistemi za ogrevanje prostora in pitne vode v stavbah - 3. del: Izmerjena energetska učinkovitost

Heating systems and water based cooling systems in buildings - Heating systems and DHW in buildings - Part 3: Measured energy performance

Heizungsanlagen und wassergeführte Kühlanlagen in Gebäuden - Heizungsanlagen und Trinkwassererwärmung in Gebäuden - Teil 3: Gemessene Gesamtenergieeffizienz

Systèmes de chauffage et systèmes de refroidissement à eau dans les bâtiments - Systèmes de chauffage et production d'eau chaude sanitaire dans les bâtiments - Partie 3: Performance énergétique mesurée

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Systèmes de chauffage et systèmes de refroidissement à
eau dans les bâtiments - Systèmes de chauffage et
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Gebäuden - Heizungsanlagen und Trinkwassererwärmung
in Gebäuden - Teil 3: Gemessene Gesamtenergieeffizienz

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 228.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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COMITÉ EUROPÉEN DE NORMALISATION
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Contents

Page

| | |
|--|----|
| Foreword..... | 4 |
| 1 Scope..... | 7 |
| 2 Normative references | 7 |
| 3 Terms and definitions..... | 7 |
| 4 Symbols and abbreviations | 8 |
| 4.1 Symbols | 8 |
| 4.2 Subscripts | 8 |
| 5 Description of the methods..... | 9 |
| 5.1 Available procedures..... | 9 |
| 5.2 Assessment of measured heating and domestic hot water delivered energy | 9 |
| 5.3 Assessment of measured boiler combustion efficiency | 10 |
| 5.4 Assessment of boiler seasonal efficiency | 10 |
| 5.5 Domestic hot water system efficiency..... | 11 |
| 5.6 Application data | 11 |
| 6 Measured delivered energy for heating | 11 |
| 6.1 Output data..... | 11 |
| 6.2 Assessment and measurement periods and intervals | 12 |
| 6.3 Input data..... | 12 |
| 6.4 Assessment of delivered and exported energy carriers amount | 13 |
| 6.5 Data about boundary conditions..... | 17 |
| 6.6 Converting to delivered and exported energy | 19 |
| 6.7 Preparation of data | 19 |
| 6.8 Interpolation of seasonal measurements..... | 21 |
| 6.9 Energy signature method | 25 |
| 6.10 Special cases | 27 |
| 6.11 Plain reporting..... | 27 |
| 6.12 Exported energy..... | 28 |
| 6.13 Reporting | 28 |
| 6.14 Limits of application | 28 |
| 6.15 Linear regression sub procedure..... | 28 |
| 7 Boiler combustion efficiency | 30 |
| 7.1 Output data..... | 30 |
| 7.2 Input data..... | 30 |
| 7.3 Measuring procedure | 31 |
| 7.4 Combustion efficiency calculation | 31 |
| 7.5 Condensation latent heat calculation | 31 |
| 8 Assessment of measured heating generation efficiency | 34 |
| 8.1 Output data..... | 34 |
| 8.2 Input data..... | 34 |
| 8.3 Available methods | 35 |
| 8.4 Boiler β_{cmb} (average load) determination | 35 |
| 8.5 Estimation of loss factors | 36 |
| 8.6 Reporting | 39 |
| 9 Assessment of measured domestic hot water energy performance and system efficiency | 39 |
| 9.1 Domestic hot water energy performance | 39 |
| 9.2 Domestic hot water efficiency | 40 |
| 9.3 Reporting | 40 |

| | | |
|---|--|----|
| 10 | Assessment of the energy performance for other services..... | 40 |
| 11 | Quality control..... | 41 |
| 12 | Compliance check | 41 |
| Annex A (normative) Template for the specification of application data | | 42 |
| A.1 | Properties of energy carriers | 42 |
| A.2 | Default data for measured energy calculation | 43 |
| A.3 | Default values for non EPBD uses of fuels..... | 45 |
| A.4 | Default values for combustion efficiency | 45 |
| A.5 | Default values for boiler seasonal efficiency | 46 |
| Annex B (informative) Default application data | | 47 |
| B.1 | Properties of energy carriers | 47 |
| B.2 | Default data for measured energy calculation | 49 |
| B.3 | Default values for non EPBD uses of fuels..... | 51 |
| B.4 | Default values for combustion efficiency | 52 |
| B.5 | Default values for boiler seasonal efficiency | 52 |
| Annex C (informative) Template for the input data preparation and presentation..... | | 54 |
| Annex D (informative) Delivered energy assessment flowchart | | 55 |
| Bibliography..... | | 56 |

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prEN 15378-3:2014 (E)

Foreword

This document (prEN 15378-3:2014) has been prepared by Technical Committee CEN/TC 228 “Heating systems and water based cooling systems in buildings”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

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Introduction

This standard is part of a set of standards developed to support the EPBD¹⁾ implementation, hereafter called "EPB standards".

EPB standards deal with energy performance calculation and other related aspects (like system sizing) to provide the building services considered in the EPBD directive.

TC 228 deals with heating systems in buildings. Subjects covered by TC 228 are:

- energy performance calculation for heating systems;
- inspection of heating systems;
- design of heating systems;
- installation and commissioning of heating systems.

This is a new standard developed during mandate M480. It incorporates provisions previously stated in EN 15603:2008 and EN 15378:2008.

Figure 1 shows the relative position of this standard within the EPB standards.

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1) Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast)

prEN 15378-3:2014 (E)

| Overarching | | Building (as such) | | Technical Building Systems | | | | | | | | | | |
|-------------|---|--------------------|--------------|---|--------------|---|-----------|-------------|----------------|------------------|----------------------|----------|-------------------------------|------------------------|
| | Descriptions | | Descriptions | | Descriptions | Heating | Cooling | Ventilation | Humidification | Dehumidification | Domestic Hot water | Lighting | Building automation & control | Electricity production |
| sub 1 | | M1 | sub 1 | M2 | sub 1 | M3 | M4 | M5 | M6 | M7 | M8 | M9 | M10 | M11 |
| 1 | General | | 1 | General | 1 | General | 15316-1 | | | | 15316-1 | | | |
| 2 | Common terms and definitions; symbols, units and subscripts | | 2 | Building Energy Needs | 2 | Needs | | | | | 12831-3 ? | | | |
| 3 | Applications | | 3 | (Free) Indoor Conditions without Systems | 3 | Maximum Load and Power | 12831-1 | | | | 12831-3 | | | |
| 4 | Ways to Express Energy Performance | | 4 | Ways to Express Energy Performance | 4 | Ways to Express Energy Performance | 15316-1 | | | | 15316-1 | | | |
| 5 | Building Functions and Building Boundaries | | 5 | Heat Transfer by Transmission | 5 | Emission & control | 15316-2 | 15316-2 | | | | | | |
| 6 | Building Occupancy and Operating Conditions | | 6 | Heat Transfer by Infiltration and Ventilation | 6 | Distribution & control | 15316-3 | 15316-3 | | | 15316-3 | | | |
| 7 | Aggregation of Energy Services and Energy Carriers | | 7 | Internal Heat Gains | 7 | Storage & control | 15316-5 | | | | 15316-5 15316-4-3 | | | |
| 8 | Building Partitioning | | 8 | Solar Heat Gains | 8 | Generation | | | | | | | | |
| | | | | | 8-1 | Combustion boilers | 15316-4-1 | | | | 15316-4-1 | | | |
| | | | | | 8-2 | Heat pumps | 15316-4-2 | 15316-4-2 | | | 15316-4-2 | | | |
| | | | | | 8-3 | Thermal solar Photovoltaics | 15316-4-3 | | | | 15316-4-3 | | | 15316-4-3 |
| | | | | | 8-4 | On-site cogeneration | 15316-4-4 | | | | 15316-4-4 | | | 15316-4-4 |
| | | | | | 8-5 | District heating and cooling | 15316-4-5 | 15316-4-5 | | | | | | 15316-4-5 |
| | | | | | 8-6 | Direct electrical heater | 15316-4-6 | | | | 15316-4-6 | | | |
| | | | | | 8-7 | Wind turbines | | | | | | | | 15316-4-7 |
| | | | | | 8-8 | Radiant heating, stoves | 15316-4-8 | | | | | | | |
| 9 | Calculated Energy Performance | | 9 | Building Dynamics (thermal mass) | 9 | Load dispatching and operating conditions | | | | | | | | |
| 10 | Measured Energy Performance | | 10 | Measured Energy Performance | 10 | Measured Energy Performance | 15378-3 | | | | 15378-3 | | | |
| 11 | Inspection | | 11 | Inspection | 11 | Inspection | 15378-1 | | | | 15378-1 | | | |
| 12 | Ways to Express Indoor Comfort | | 12 | -- | 12 | BMS | | | | | | | | |
| 13 | External Environment Conditions | | | | | | | | | | | | | |
| 14 | Economic Calculation | 1545 9-1 | | | | | | | | | | | | |

Figure 1 — Position of EN 15378-3 within the modular structure

1 Scope

This standard specifies methods to assess the energy performance to provide heating and domestic hot water to a building based on measurements.

This standard covers the assessment of the heating and domestic hot water energy performance of a building or of building elements based on measurements. This includes:

- assessment of the heating and domestic hot water performance of the building based on measurement of the amount of delivered energy carriers;
- assessment of the energy performance of systems, subsystems and building elements, based on measurements.

This standard does not cover measured energy performance on ventilation, cooling, air conditioning and lighting systems.

Figure 1 shows the relative position of this standard within the EPB standards.

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 ISO 7345:1995, Thermal insulation. Physical quantities and definitions

prEN 15603:2013, Energy performance of buildings — Overarching standard EPBD

EN 50379:2012, Specification for portable electrical apparatus designed to measure combustion flue gas parameters of heating appliances

EN ISO 13790:2008, Energy performance of buildings — Calculation of energy use for space heating and cooling

EN 15251, Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN ISO 7345:1995, prEN 15603:2013 and the following specific definitions apply.

3.1

Assessment period

Time for which the measured amount of energy shall be determined.

3.2

Measurement interval

Time between individual measurements.

prEN 15378-3:2014 (E)

3.3

Measurement period

Interval of time covered by measurement intervals.

4 Symbols and abbreviations

4.1 Symbols

For the purposes of this European Standard, the symbols given in prEN 15603:2013 and the specific symbols listed in table 1 apply

Table 1 — Symbols and units

| Symbol | Name of quantity | Unit |
|--|--|---|
| DD | Degree-days | °Cday |
| M | Amount of energy carrier | kg, l, Sm ³ , m ³ , Nm ³ , kWh |
| R | Meter reading | kg, l, Sm ³ , m ³ , Nm ³ , kWh |
| D | Date | Calendar day |
| n | number of values | - |
| X | Independent variable | any |
| Y | Dependent variable | any |
| a | Constant term of the regression line | any ⁽¹⁾ |
| b | Angular coefficient (slope) of the regression line | any |
| δ | mean error | any ⁽¹⁾ |
| R | Correlation coefficient | - e-ee74-4c33-9802- |
| ξ | absolute humidity | kg/Nm ³ |
| m | mass | kg |
| H | calorific value | |
| α | loss factor | - |
| h | latent heat | J/kg or Wh/kg |
| NOTES to table 1 | | |
| ⁽¹⁾ the unit shall be the same as Y | | |

4.2 Subscripts

For the purposes of this European Standard, the subscripts given in prEN 15603:2013, and the specific subscripts listed in table 2 apply.

Table 2 —Subscripts

| | | | | | |
|-------|-------------------------------------|-----|--|-------|---|
| a | Angular coefficient | eq | equivalent | norm | normalised |
| abs | absolute (temperature and pressure) | fg | flue gas | O2 | oxygen |
| adj | Adjusted | fin | final | op | operation |
| b | Base coefficient | ge | generator envelope | pmp | pump |
| ch | chimney | gnr | generator (operating time) | real | actual conditions |
| cmb | combustion | H0 | heating shut-off | ref | reference |
| CO2 | carbon dioxide | H2O | water vapour | reg | regression |
| cold | cold (domestic water) | HnH | heating and non-heating | s | gross (<u>s</u> uperior calorific value) |
| cond | condensing | hot | at hot delivery temperature (domestic water) | st | stoichiometric |
| corr | corrected | i | net (<u>i</u> nferior calorific value) | stock | in the storage |
| count | counter | ini | initial | sup | supplied |
| dry | dry | nH | non-heating | | |

5 Description of the methods

5.1 Available procedures

This standard includes the following procedures:

- assessment of measured delivered energy for heating and domestic hot water energy
- assessment of measured boiler combustion efficiency
- assessment of measured seasonal boiler efficiency
- assessment of measured seasonal domestic hot water system efficiency.

5.2 Assessment of measured heating and domestic hot water delivered energy

5.2.1 Output of the method

This method covers the assessment of measured delivered energy for heating and/or domestic hot water production.

The output is the amount of delivered and exported energy carriers $E_{\text{del;meas;cr,i}}$ and $E_{\text{exp;meas;cr,i}}$

5.2.2 Optional procedures

This standard includes procedures to adjust measured delivered energy according to actual climate and conditions of use. The delivered energy is evaluated by energy carrier and, where applicable, by service. The weighting according to weighting factors (e. g. primary energy, CO2 emissions) is covered in prEN 15603:2013.

The procedure consists of the following sequence with the specified alternatives for each step:

- 1) getting the amount of delivered and exported energy carriers:
 - i) meters readings;

prEN 15378-3:2014 (E)

- ii) invoice analysis;
- iii) other delivered energy estimation techniques;
- 2) getting data about corresponding boundary conditions (building use, climate) etc.
- 3) separating other uses and services than heating;
- 4) separating domestic hot water from other uses;
- 5) neutralizing/adjusting procedures for user behaviour and climate;
 - i) degree days correlation;
 - ii) energy signature;
 - iii) domestic hot water volume;
- 6) validating the data;
- 7) reporting.

NOTE Measured energy rating is also referred to as "operational rating".

5.2.3 Validation of measured rating

Measured rating is valid only if all conditions specified in the standard are satisfied (e. g. number of available measurements, source of data, results validation criteria, etc.).

If the measured energy performance is not valid, new measurements shall be performed.

NOTE if a measured energy performance is envisaged, this should be taken into account at design stage: the necessary instruments should be installed and recording procedures should be applied. Otherwise it is not likely that data of acceptable quality will be found.

5.3 Assessment of measured boiler combustion efficiency**5.3.1 Output of the method**

Following application of this method, the following data are obtained:

- $\alpha_{ch,on}$, losses through the chimney with burner on;
- α_{cond} , condensation latent heat recovery factor;
- η_{comb} , combustion efficiency.

5.3.2 Optional methods

Only one method is given, based on flue gas analysis

5.4 Assessment of boiler seasonal efficiency**5.4.1 Output of the method**

Following application of this method, the following data are obtained:

- $\eta_{\text{blr;seas}}$ boiler seasonal efficiency;
- $\beta_{\text{cmb;seas}}$ seasonal boiler load factor.

5.4.2 Optional methods

The procedure consists of on the following sequence with the specified alternatives for each step:

- measuring combustion efficiency η_{cmb} ;
- assessing seasonal load factor $\beta_{\text{cmb;seas}}$;
- assessing heat loss factors:
 - from tabulated values;
 - according to optional specific measurement procedure
- calculating estimated boiler seasonal efficiency $\eta_{\text{blr;seas}}$:
 - boiler cycling method;
 - total stand-by losses method.

5.5 Domestic hot water system efficiency

5.5.1 Output of the method

Following application of this method, the following data are obtained:

- $\eta_{\text{W;sys;meas}}$ measured seasonal domestic hot water production efficiency

5.5.2 Optional methods

The procedure consists of the following steps:

- Assessing domestic hot water produced and energy need
- Assessing delivered energy carriers
- Assessing domestic hot water efficiency

5.6 Application data

The required application data shall be specified according to the format given in normative annex A.

Default application data is given in informative annex B.

6 Measured delivered energy for heating

6.1 Output data

The output data of this method are listed in table 3.

Table 3 – Measured heating and domestic hot water energy performance output data

| Description | Symbol | Unit | Intended destination module |
|--|------------------------------|------|-----------------------------|
| Delivered energy carrier j name | CAR_NAME_j ⁽¹⁾ | kWh | M1-10 |
| Measured normalised delivered energy carrier j for heating | $E_{del;H;norm;DD}$ | kWh | M1-10 |
| Measured delivered energy carrier j for domestic hot water | $E_{del;cr;j;meas;W}$ | kWh | M1-10 |
| Amount of exported energy carrier | $E_{exp;cr;j;meas}$ | kWh | M1-10 |
| ⁽¹⁾ CAR_NAME_j is the name of energy carrier j | | | |

6.2 Assessment and measurement periods and intervals

The assessment period for heating shall be one heating season.

The assessment period for domestic hot water production shall be one year.

The measurement intervals can be yearly, seasonal, monthly, weekly or daily.

The total measurement period is the total time covered by measurement intervals.

NOTE Measurements are seldom available on the exact required date. Where applicable, tolerances and procedures to adjust measurements are given in the following.

6.3 Input data

6.3.1 Data on delivered energy carrier amount

The procedure is based on the acquisition of the following data:

Table 4 – Measured input data

| Name | Symbol | Unit | Range | Origin Module | Varying |
|--|---------------------|---------|-----------|---------------|---------|
| Meter readings | $R_{cr,i,t}$ | various | 0...∞ | Local | YES |
| Day of readings | $D_{meas,i,t}$ | date | 0...∞ | Local | YES |
| Pressure of metered gas | $P_{meas;abs}$ | Pa abs | 0...∞ | Local | YES |
| Temperature of metered gas | T_{meas} | K | 250...350 | Local | YES |
| Proportionality coefficient of meter | C_{count} | various | 0...∞ | Local | YES |
| Fuel amount in stock | $M_{stock;cr,i,t}$ | various | 0...∞ | Local | YES |
| Amount of fuel supply | $M_{sup;cr,i,t}$ | various | 0...∞ | Local | YES |
| Absorbed electrical power of each device i | $\Phi_{el,i}$ | W | 0...∞ | Local | YES |
| Operation time of device i | $t_{op,i}$ | s or h | 0...∞ | Local | YES |
| Measured external air temperature | $\vartheta_{ext,t}$ | °C | -50...50 | Local | YES |

| | | | | | |
|---|---------------------------------------|----------------|-----------|-------|-----|
| Measured internal air temperature | $\vartheta_{\text{int},t}$ | °C | -50...50 | Local | YES |
| Volume of space covered by internal temperature sensor j. | V_j | m ³ | 0...∞ | Local | YES |
| Power of non EPB uses | $\Phi_{\text{del},\text{nEPUs}}$ | W | 0...∞ | Local | YES |
| Reference internal temperature for spaces | $\vartheta_{\text{int},\text{ref},k}$ | °C | -50...50 | Local | YES |
| Net or gross volume of spaces | V_j | m ³ | 0...∞ | Local | YES |
| Ratio of heat gains and losses | γ_H | - | 0...10 | Local | YES |
| Utilization factor of heat gains | $\eta_{H,\text{gn}}$ | - | 0...1 | Local | YES |
| Reference degree days | DD_{ref} | | 0...10000 | Local | YES |

6.3.2 Data on properties of energy carriers

Calorific values and densities of fuels shall be specified according to the template given in clause A.1 of normative annex A. Default values are given in clause B.1 of informative annex B.

6.4 Assessment of delivered and exported energy carriers amount

6.4.1 General

The delivered and exported energy carrier flows at the assessment boundary shall be identified and listed.

For each measurement of an energy carrier flow, one shall identify:

- the supplied generators, devices and appliances;
- the service(s) provided by each supplied generator, device and appliance, including non-EPB services, if any;
- if the services are provided to the whole building or only to part of it.

Energy carrier use evaluation for a heating and domestic hot water systems shall take into account:

- the main energy carrier(s);
- auxiliary energy.

The source of data can be recorded data, energy bills, or measurements.

Auxiliary energy that is not metered shall be assessed according to 6.4.6.2.

6.4.2 Metered energy carriers (electricity, gas, district heating and cooling)

6.4.2.1 General

The delivered amount of a metered energy carrier during a measurement interval t $M_{\text{del};\text{cr},i,t;\text{meas}}$ is the difference of two readings of the meter taken at the beginning and at the end of each measurement interval.

$$M_{\text{del};\text{cr},i,t;\text{meas}} = R_{\text{cr},i,t;\text{fin}} - R_{\text{cr},i,t;\text{ini}} \quad (1)$$

where