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**Draft**

# COMMUNICATION FROM THE COMMISSION

**in the framework of the implementation of Commission Regulation (EU) No …/… implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for water heaters and hot water storage tanks, and of the implementation of Commission Delegated Regulation (EU) No …/… supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to the energy labelling of water heaters, hot water storage tanks and packages of water heater and solar device**

**(2012/C …/…)**

(Text with EEA relevance)

1. Publication of titles and references of transitional methods of measurement and calculation[1] for the implementation of Regulation (EU) No …/…, and in particular Annexes III, IV and V thereof, and for the implementation of Regulation (EU) No …/…, and in particular Annexes VII, VIII and IX thereof.

2. Parameters *in italics* are determined in Regulation (EU) No …/… and in Regulation (EU) No …/…

3. References

| **Measured/calculated parameter** | **Organisation** | **Reference** | **Title** |
|---|---|---|---|
| Test procedure for $A_{sol}$, *IAM* and additional elements of collector efficiency testing of parameters $\eta_0$, $a_1$, $a_2$, *IAM* | CEN | EN 12975-2:2006 | Thermal solar systems and components - Solar collectors - Part 2: Test methods |
| Sound power level of heat pump water heaters | CEN | EN 12102 :2008 | Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling - Measurement of airborne noise - Determination of the sound power |
| Standby power consumption solsb | CLC | EN 62301:2005 | Household Electrical Appliances: Measurement of standby power |
| Test-rig for $Q_{elec}$ of electric storage water heaters | CLC | prEN 50440: 2010 | Efficiency of domestic electrical storage water heaters |
| Test-rig for $Q_{elec}$ of electric instantaneous water heaters | CLC | EN 50193:1997, Clause 6, 7.1 (incl. Fig.1), 7.2 | Closed electrical instantaneous eater heaters, Methods for measuring performance. |
| Test-rig for $Q_{fuel}$ and $Q_{elec}$ of gas-fired instantaneous water heaters | CEN | EN 26:1997/A3:2006, Clause 7.1, except clause 7.1.5.4. | Gas-fired instantaneous water heaters for sanitary uses production, fitted with atmospheric burners |
| Test-rig for $Q_{fuel}$ and $Q_{elec}$ of gas-fired storage water heaters | CEN | EN 89:1999/A4:2006, Clause 7.1, except clause 7.1.5.4. | Gas-fired storage water heaters for the production of domestic hot water |

[1] It is intended that these transitional methods will ultimately be replaced by harmonised standard(s). When available, reference(s) to the harmonised standard(s) will be published in the Official Journal of the European Union in accordance with Articles 9 and 10 of Directive 2009/125/EC.

| Measured/calculated parameter | Organisation | Reference | Title |
|---|---|---|---|
| Test-preparation for $Q_{fuel}$ of gas-fired instantaneous water heaters and gas-fired storage water heaters | CEN | EN 13203-2: 2006, Annex B | Gas-fired domestic appliances producing hot water - Appliances not exceeding 70 kW heat input and 300 litres water storage capacity - Part 2: Assessment of energy consumption |
| Test-rig for heat pump water heaters | CEN | FprEN 16147: January 2011 | Heat pumps with electrically driven compressors - Testing and requirements for marking for domestic hot water units |
| Standing loss *S* of storage tanks | CEN | EN 12897: 2006, clause 6.2.7 and Annex B | Water Supply – Specification for indirectly heated unvented (closed) storage water heaters. |
| Standing loss *S* and psbsol of storage tanks | CEN | EN 12977-3:2008 | Thermal solar systems and components - Custom built systems - Part 3: Performance test methods for solar water heater stores |
| Standing loss *S* of storage tanks | CEN | EN 15332: 2007, Clauses 5.1 and 5.4 (Measurement of standby-loss) | Heating boilers – Energy assessment of hot water storage tanks |
| Standing loss *S* of storage tanks | CLC | EN 60379: 2004, clauses 9, 10, 11, 12 and 14 | Methods for measuring the performance of electric storage water-heaters for household purposes |
| Emission of nitrogen oxides $NO_x$ | CEN | FprEN 15502-1: July 2010, clause 8.13 NOx | Classification, test- and calculation methods |
| Water heating energy efficiency $\eta_{wh}$ of water heaters and standing loss *S* of storage tanks | European Commission | Point 4 of this Communication | Additional elements for measurements and calculations related to the energy efficiency of water heaters and storage tanks |

4. Additional elements for measurements and calculations related to the energy efficiency of water heaters and storage tanks

4.1. Definitions

- "uncertainty of measurement (accuracy)" is the precision with which an instrument is capable to represent an actual value as established by a highly-calibrated measurement reference;
- "permissible deviation (average over test period)" is the maximum difference, negatively or positively, allowed between a measured parameter, averaged over the test period, and a set value;
- "permissible deviations of individual measured values from average values" is the maximum difference, negatively or positively, allowed between a measured parameter and the average value of that parameter over the test period;
- "instantaneous water heater" is a water heater where the heating of water is directly dependent on the draw-off [2];

4.2. Energy inputs

(a) Electricity and fossil fuels

[2] Definition from EN 26

| Measured parameter | Unit | Value | Permissible deviation (average over test period) | Uncertainty of measurement (accuracy) |
|---|---|---|---|---|
| **Electricity** | | | | |
| Power | W | | | ± 2 % |
| Energy | kWh | | | ± 2 % |
| Voltage, test-period > 48 h | V | 230 / 400 | ± 4 % | ± 0,5 % |
| Voltage, test-period < 48h | V | 230 / 400 | ± 2 % | |
| Voltage, test-period < 1 h | V | 230 / 400 | ± 1 % | ± 0,5 % |
| Electric current | A | | | ± 0,5 % |
| Frequency | Hz | 50 | ± 1 % | |
| **Gas** | | | | |
| Types | - | Test gases GAD | | |
| Net calorific value (NCV) | $MJ/m^3$ | Test gases GAD | | ± 1 % |
| Temperature | K | 288,15 | | ± 0,5 |
| Pressure | mbar | 1 013,25 | | ± 1 % |
| Density | $dm^3/kg$ | | | ± 0,5 % |
| Flow rate | $m^3/s$ or l/min | | | ± 1 % |
| **Oil** | | | | |
| **Heating gas oil** | | | | |
| Composition, Carbon/ Hydrogen/ Sulfur | kg/kg | 86/13,6/0,2 % | | |
| N-fraction | mg/kg | 140 | ± 70 | |
| Net calorific value (NCV, Hi) | MJ/kg | 42,689 | | |
| Gross calorific value (*GCV*, Hs) | MJ/kg | 45,55 | | |
| Density $\rho15$ at 15 °C | $kg/dm^3$ | 0,85 | | |
| **Kerosene** | | | | |
| composition, Carbon/ Hydrogen/ Sulfur | kg/kg | 85/14,1/0,4 % | | |
| N-fraction | mg/kg | 140 | ± 70 | |
| Net calorific value (NCV, Hi) | MJ/kg | 43,3 | | |
| Gross calorific value (*GCV*, Hs) | MJ/kg | 46,2 | | |
| density $\rho15$ at 15 °C | $kg/dm^3$ | 0,79 | | |

(b) Solar energy for solar collector tests

| Measured parameter | Unit | Value | Permissible deviation (average over test period) | Uncertainty of measurement (accuracy) |
|---|---|---|---|---|
| Test solar irradiance (global G, short wave) | W/m² | > 700 W/m² | ± 50 W/m² (test) | ± 10 W/m² (indoors) |
| Diffuse solar irradiance (fraction of total G) | % | < 30% | | |
| Thermal irradiance variation (indoors) | W/m² | | | ± 10 W/m² |
| Fluid temperature at collector inlet/outlet | °C/ K | range 0-99 ºC | ± 0,1 K | ± 0,1 K |
| Fluid temperature difference inlet/outlet | | | | ± 0,05 K |
| Incidence angle (to normal) | ° | < 20° | ± 2 % (<20°) | |
| Air speed parallel to collector | m/s | 3 ± 1 m/s | | 0,5 m/s |
| Fluid flow rate (also for simulator) | kg/s | 0,02 kg/s per m² collector aperture area | ± 10 % between tests | |
| Pipe heat loss of loop in test | W/K | <0,2 W/K | | |

(c) Ambient heat energy

| Measured parameter | Unit | Permissible deviation (average over test period) | Permissible deviations (individual tests) | Uncertainty of measurement (accuracy) |
|---|---|---|---|---|
| **Brine or water heat source** | | | | |
| *Water/brine inlet temperature* | °C | ± 0,2 | ± 0,5 | ± 0,1 |
| *Volume flow* | m³/s or l/min | ± 2 % | ± 5 % | ± 5 % |
| Static pressure difference | Pa | - | ± 10 % | ± 5 Pa/ 5 % |
| **Air heat source** | | | | |
| *Outdoor air temperature (dry bulb) $T_j$* | °C | ± 0,3 | ± 1 | ± 0,2 |
| *Vent exhaust air temperature* | °C | ± 0,3 | ± 1 | ± 0,2 |
| Mixed air temperature | °C | ± 0,3 | ± 1 | ± 0,2 |

| | | | | |
|---|---|---|---|---|
| *Volume flow* | dm³/s | ± 5 % | ± 10 % | ± 5 % |
| Static pressure difference | Pa | - | ± 10 % | ± 5 Pa/ 5 % |

(d) Test conditions and tolerances on outputs

| **Measured parameter** | **Unit** | **Value** | **Permissible deviation (average over test period)** | **Permissible deviations (individual tests)** | **Uncertainty of measurement (accuracy)** |
|---|---|---|---|---|---|
| **Ambient** | | | | | |
| *Ambient temperature indoors* | °C or K | 20 °C | ± 1 K | ± 2 K | ± 1 K |
| Air speed heat pump (at water heater off) | m/s | < 1,5 m/s | | | |
| Air speed other | m/s | < 0,5 m/s | | | |
| **Sanitary water** | | | | | |
| Cold water temperature solar | °C or K | 10 °C | ± 1 K | ± 1 K | ± 0,2 K |
| Cold water temperature other | °C or K | 10 °C | ± 1 K | ± 1 K | ± 1 K |
| Cold water pressure gas-fired water heaters | bar | 2 bar | | ± 0,1 bar | |
| Cold water pressure other (except electric instantaneous water heaters) | bar | 3 bar | | | ± 5 % |
| Hot water temperature gas-fired water heaters | °C or K | | | | ± 0,5 K |
| Hot water temperature electric instantaneous | °C or K | | | | ± 1 K |
| Water temperature (in-/outlet) other | °C or K | | | | ± 0,5 K |
| Volume flowrate heat pump water heaters | dm³/s | | ± 5 % | ± 10% | ± 2 % |
| Volume flowrate other water heaters | dm³/s | | | | ± 1 % |

4.3. Test procedure for conventional water heaters

The test procedure for conventional water heaters to establish the daily electricity consumption $Q_{elec}$ and the daily fuel consumption $Q_{fuel}$ fuel during a 24-hour measurement cycle is the following:

(a) Installation

The conventional water heater is installed in test environment according to manufacturer’s instructions. Designated floor-standing appliances may be placed on the floor, on a stand supplied with the product, or on a platform for easy access. Wall-mounted products are mounted on a panel at least 150 mm from any structural wall with a free space of at least 250 mm above and below the product and at least 700 mm to the sides. Products designated to be built-in are mounted according to manufacturer’s instructions. The product is shielded from direct solar radiation, except solar collectors.

(b) Stabilisation

The product is kept at ambient conditions until all parts of the product have reached ambient conditions ± 2 K, at least 24 hours for storage type products.

(c) For storage water heaters, filling and heat-up

Storage water heaters are filled with cold water. Filling stops at the applicable cold water pressure.

The product is energized to reach “out-of-the-box” factory settings, e.g. for storage temperature. The product’s own means of control (thermostat) is used. The next stage starts at thermostat cut out.

(d) For storage water heaters, stabilisation at zero-load

The product is kept at normal operating conditions as specified by the manufacturer without draw-offs during at least 12 hours.

For storage water heater subject to a control cycle this stage ends - and next stage starts - at the first thermostat cut-out after 12 hours.

During this stage the total fuel consumption in kWh in terms of *GCV*, the total electricity consumption in kWh in terms of final energy and the exact time elapsed in h are recorded.

(e) Water draw-offs

During the water draw-offs relevant technical parameters (power, temperature, etc.) are established. For dynamic parameters the overall sample rate is 10 s or less. During draw-offs the recommended sample rate is 5 s or less.

The fossil fuel and electricity consumption over the 24-hour measurement cycle, Qtestfuel and Qtestelec, are corrected as specified in point (g).

(f) For storage water heaters, re-stabilisation at zero-load

The product is kept at nominal operating conditions without draw-offs during at least 12 hours.

For storage water heaters subject to a control cycle this stage ends at the first thermostat cut-out after 12 hours.

During this stage the total fuel consumption in kWh in terms of *GCV*, the total electricity consumption in kWh final energy and the exact time elapsed in hours are recorded.

(g) For storage water heaters, *mixed water at 40 °C (V40)*

Immediately following measurement according to point (f) the water heater is switched off after the last cut-out of the thermostat.

Then a quantity of water equal to the rated capacity is withdrawn through the outlet at a constant rate of flow by supplying cold water. The flow of water from open outlet water heaters is controlled by the inlet valve. The flow in any other type of water heaters is kept constant by means of a valve fitted in the outlet or the inlet.

The rate of flow is adjusted to the maximum value according to the declared load profile.

The normalised value of the average temperature is calculated according to the following equation:

$$\theta_p[°C] = \left(T_{set} - 10\right) \times \frac{\left(\theta'_p - \theta_c\right)}{\left(T_{set} - \theta_c\right)} + 10$$

Where:

– $T_{set}$ in °C is the water temperature, without withdrawal of water, measured with a thermocouple placed inside the upper section of the tank. For metal tanks the thermocouple may be placed on the outer surface of the tank as well. This value is the water temperature measured after the last cut-out of the thermostat during the step set out in point (f),

– $\theta_c$ in °C is the average temperature of inlet cold water during the test,

– $\theta'_p$ in °C is the average temperature of outlet water and its normalized value is named $\theta_p$ in °C.

Temperature readings are preferable taken continuously. Alternatively, they may be taken at equal intervals evenly spread over the discharge, for example every 5 litres (maximum). If there is a sharp drop in temperature, additional readings may be necessary in order to correctly calculate the average value $\theta'_p$.

Outlet water temperature is always ≥ 40 °C which is to be taken into account for the calculation of $\theta_p$.

Quantity of hot water $V_{40}$ in litres delivered with a temperature of at least 40 °C will be calculated by the following equation:

$$V_{40}\,[litres] = V_{40\exp} \cdot \frac{(\theta_p - 10)}{30}$$

Where:

– the volume $V_{40\_exp}$ in litres corresponds to the quantity of water delivered at least 40 °C.

(h) Reporting of $Q_{fuel}$ and $Q_{elec}$

Qtestfuel and Qtestelec are corrected for any energy surplus or deficit outside the strict 24-hour measurement cycle, i.e. a possible energy difference before and after is taken into account. Furthermore, any surplus or deficit in the delivered useful energy content of the hot water is taken into account in the following equations for $Q_{fuel}$ and $Q_{elec}$:

$$Q_{fuel} = \left(\frac{Q_{ref}}{Q_{H2O}}\right) \times \left\{Q_{testfuel} + \frac{1{,}163 \times C_{act} \times (T_3(t_3) - T_5(t_5))}{1000}\right\}$$

$$Q_{elec} = \left(\frac{Q_{ref}}{Q_{H2O}}\right) \times \left\{Q_{testelec} + \frac{1{,}163 \times C_{act} \times (T_3(t_3) - T_5(t_5))}{1000}\right\}$$

Where:

– $Q_{H2O}$ in kWh is the useful energy content of the hot water drawn-off,

– $T_3$ and $T_5$ are water temperatures measured at the dome of water heater, respectively at $t_3$ and $t_5$.

4.4. Test procedure for heat pump water heaters

A proposal for a test procedure has been prepared by TC59X/WG4 to test a heat pump water heater using electricity.

4.5. Test procedure for electric instantaneous water heaters

Electric instantaneous water heaters are a relatively homogenous product group, where differences in test results between individual products are small and in the order of magnitude of allowable tolerances. For that reason a simplified, but more accurate test method with a better repeatability is foreseen. Thermal losses from heat transfer processes during operation and standby (zero-load) losses are neglected.

First, static electric power losses are measured (product of voltage and current) for the transformation from mains power supply to the electric resistance heating element at nominal load after at least 30 minutes of operation at this nominal load. For electronic instantaneous water heaters the voltage between the power terminals of the triacs is subtracted from the measured voltage. The measuring equipment should respond fast enough to enable correct measurement of power, including reactive power. Measurement can be done with measuring devices which operate in their optimal measurement range and use a measurement time interval as long as necessary to attain reliable results.

Second, the time tstarti is measured, which elapses between energizing the heating element and the moment the product delivers useful water, i.e. reaches specific $T_{mi}$ values at flow rates *fi*, for each draw-off i for the load profile. For each combination of $T_{mi}$ and *fi* at least three measurements are done; the resulting tstart is the mean value from these measurements.

The value of $Q_{elec}$ is calculated as follows:

$$Q_{elec} = \frac{V_1 \times I_1}{V_2 \times I_2} \times \left[ Q_{ref} + \sum_{i=1}^{n} wh \times tstart_i \times (Tm_i - Tcold) \times f_i \right]$$

Where:

– $V_1$, $V_2$ are voltages of mains power supply ($V_1$) and electric heating element ($V_2$) respectively, measured across the terminals and the connectors of the heating elements, in Volts;

– $I_1$, $I_2$ are electric currents of mains power supply ($I_1$) and electric heating element ($I_2$), measured for each phase, in Ampere;

– wh is specific heat of water: 0,00116 kWh/litre · K;

– n is total number of draw-offs in the load profile;

– i is index of draw-off in the load profile;

– $tstart_i$ is time elapsed between energizing the heating element and the moment the product delivers useful water for draw-off i, in h;

– $Tm_i$ is the water temperature rise, expressed in degrees Celsius, at which hot water starts contributing to the reference energy;

– Tcold is the cold water inlet temperature 10 ºC;

– $f_i$ is the flow rate, expressed in litres per minute, for which hot water is contributing to the reference energy If this flow rate is too low to allow correct operation of the water heater, then the minimum flow rate to allow correct operation of the water heater throughout the test is used.

4.6. Smart control test procedure for water heaters

(a) Electric storage water heaters

Use the test methodology described in prEN 50440.

(b) Electric Instantaneous Water Heaters

The test procedure for electric instantaneous water heaters comprises control to supply the required power to the water heating system by means of:

– Power control capable of switching any required power between at least 50 % and maximum rated power with a maximum power resolution of 200 W depending on flow rate and water temperature to minimize power consumption;

– devices to detect at least the flow rate and the inlet or outlet temperature;

– a device which calculates without user intervention, the power required to stabilize the temperature of the outlet water at the desired level in-between switch on flow rate and power limit, regardless of flow rate, water pressure and inlet temperature.

(c) Heat pump water heaters

Use the test methodology proposed by TC59X/WG4.

(d) The following *SCF* ranges are typical:

– Declared load profiles XXS to S: 7 % to 15 %;

– Declared load profiles M to 4XL: 10 % to 20 %.

4.7. Solar water heaters and solar-only systems, testing and calculation methods

For the assessment of the annual non-solar heat contribution $Q_{nonsol}$ in kWh in terms of primary energy and/or kWh in terms of *GCV* the following methods are applicable:

– The SOLCAL method[3]

– The SOLICS method[4]

The SOLCAL method requires that the efficiency parameters of the solar collector are assessed separately and that the overall system performance is determined on the basis of the non-solar heat contribution to the solar system and the specific efficiency of a stand-alone water heater.

(a) Solar collector testing

For solar collectors at least 4 x 4 tests apply, with 4 different collector inlet temperatures $t_{in}$ evenly spaced over the operating range and 4 test samples per collector inlet temperature are measured to obtain test values for the water outlet temperature $t_e$, the ambient temperature $t_a$, the solar irradiance G and the measured collector efficiency at the test point $\eta_{col}$. If possible, one inlet

[3] EN15316-4-3, B based method
[4] ISO 9459-5 based method

temperature is selected with $t_m = t_a \pm 3$ K to obtain an accurate assessment of the zero-load efficiency $\eta_0$. With fixed collector (no automatic tracking) and test conditions permitting, two test samples should be done before solar noon and 2 after. Maximum temperature of the heat transfer fluid (i.e. the top of the operating range) is > 80 ºC. The recommended maximum value of the reduced temperature difference $T^*_m$ is > 0,09 m²KW$^{-1}$.

For the instantaneous collector efficiency $\eta_{col}$ a continuous efficiency curve of the format as in the following equation is obtained by statistical curve fitting of the test point results, using the least square method:

$$\eta_{col} = \eta_0 - a_1 \times T^*_m - a_2 \times G\ (T^*_m)^2$$

Where:

– $T^*_m$ is the reduced temperature difference in m²KW$^{-1}$, with

$$T^*_m = (t_m - t_a) / G$$

Where:

– $t_a$ is the ambient or surrounding air temperature;

– $t_m$ is the mean temperature of the heat transfer fluid:

$$t_m = t_{in} + 0{,}5 \times \Delta T$$

Where:

– $t_{in}$ is the collector inlet temperature;

– $\Delta T$ is temperature difference between fluid outlet and inlet (= $t_e - t_{in}$).

All tests are performed according to EN 12975-2, EN 12977-2 and EN 12977-3. Converting so-called quasi-dynamic model parameters to a steady-state reference case to arrive at the parameters above is permitted. The Incidence Angle Modifier *IAM* is determined in accordance with EN 12975-2.

(b) SOLCAL method

The SOLCAL method requires

– The solar collector parameters $A_{sol}$, $\eta_0$, $a_1$, $a_2$ and *IAM*;

– The nominal volume of the storage tank volume (Vnom) in litres, the volume of the non-solar heat storage (Vbu) in litres and the specific standing loss (psbsol) in W/K (K expresses the difference between store and ambient temperature);

– The auxiliary electricity consumption at stabilised operating conditions $Q_{aux}$;

– The standby power consumption *solstandby*;

– The pump power consumption *solpump.*

The calculation assumes default values for the specific insulation of the collector loop pipes (= 6 + 0,3 $W/Km^2$) and the heat capacity of the heat exchanger ($100 \cdot W/Km^2$). $m^2$ stands for the collector aperture area. Furthermore, it is assumed that the solar heat store periods are less than one month.

For the purpose of establishing the total energy efficiency performance of solar-only system and conventional water heater or of a solar water heater, the SOLCAL method determines the annual non-solar heat contribution $Q_{nonsol}$ in kWh with

$Q_{nonsol}$ = SUM ($Qnonsol_{tm}$) in kWh/a

Where:

– SUM ($Qnonsol_{tm}$) is the sum of the all monthly non-solar heat contribution of the conventional water heater or the conventional heat generator being part of a solar water heater; with

$Qnonsol_{tm} = Lwh_{tm} - LsolW_{tm} + psbSol \bullet Vbu / Vnom \bullet (60 - Ta) \bullet 0{,}732$

The monthly heat demand for the solar thermal system is defined as:

$Lwh_{tm} = 30{,}5 \bullet 0{,}6 \bullet (Q_{ref} + 1{,}09)$

Where:

– 0,6 represents a factor to calculate the average heat demand from the load profile;

– 1,09 represents the average distribution losses.

The following calculations are performed:

$LsolW1_{tm} = Lwh_{tm} \cdot (1{,}029 \cdot Y_{tm} - 0{,}065 \cdot X_{tm} - 0{,}245 \cdot Y_{tm}^2 + 0{,}0018 \cdot X_{tm}^2 + 0{,}0215 \cdot Y_{tm}^3)$

$LsolW_{tm} = LsolW1_{tm} - Qbuf_{tm}$

The minimum value of $LsolW_{tm}$ is 0 and the maximum value is $Lwh_{tm.}$

Where:

– $Qbuf_{tm}$ is the solar storage tank correction in kWh/month; with

Qbuftm = Psbsol • (Vnom - Vbu) / Vnom • (10 - 50 • LsolW1tm/ Lwhtm - Ta) • 0,732;

Where:

– 0,732 is a factor that takes into account the average monthly hours (24 • 30,5);

– Psbsol is the specific standing loss of the solar heat store in W/K as determined in accordance with point 4.8(a);

– Ta is the monthly average air temperature surrounding the heat store in °C; with

– Ta = 20 when the heat store is inside the building envelope;

– Ta = $Tout_{tm}$ when the heat store is outside the building envelope;

– $Tout_{tm}$ is the average daytime temperature in °C for average, colder and warmer climate conditions.

$X_{tm}$ and $Y_{tm}$ are aggregated coefficients:

$X_{tm} = A_{sol} \cdot (Ac + UL) \cdot etaloop \cdot (Trefw - Tout_{tm}) \cdot ccap \cdot 0{,}732 / Lwh_{tm}$

The minimum value of $X_{tm}$ is 0 and the maximum value is 18.

Where:

– $Ac = a_1 + a_2 \cdot 40$;

– $UL = (6 + 0{,}3 \cdot A_{sol}) / A_{sol}$ is loop losses in W/(m²K);

– $etaloop = 1 - (\eta_0 \cdot a_1) / 100$;

– $Trefw = 11{,}6 + 1{,}18 \cdot 40 + 3{,}86 \cdot Tcold - 1{,}32 \cdot Tout_{tm;}$

– Tcold is the cold water temperature, default 10 °C;

– $Tout_{tm}$ is the *average daytime temperature in °C for average, colder and warmer climate conditions*;

– ccap is storage coefficient with $ccap = (75 \cdot A_{sol} / Vsol)^{0.25}$;

$Y_{tm} = A_{sol} \cdot IAM \cdot \eta_0 \cdot etaloop \cdot QsolM_{tm} \cdot 0.732 / Lwh_{tm}$

The minimum value of $Y_{tm}$ is 0 and the maximum value is 3.

Where:

– etaloop is loop efficiency with $etaloop = 1 - (\eta_0 \cdot a_1)/100$;

– $QsolM_{tm}$ is the *average global solar irradiance in W/m² for average, colder and warmer climate conditions*.

The auxiliary electricity consumption $Q_{aux}$ is calculated as follows:

$Q_{aux} = CC \cdot (solpump \cdot solhrs + solstandby \cdot 24 \cdot 365) / 1000$

Where:

– solhrs is the number of active solar hours in h; with

– solhrs = 2 000 for solar water heaters.

(c) SOLICS Method

The SOLICS method is based on the test method described in ISO 9459-5:2007. The procedure to determine the solar output is referenced as follows:

– Terms and definitions according to ISO 9459-5:2007, chapter 3;

– Symbols, units and nomenclature according to ISO 9459-5:2007, chapter 4;

– The system is mounted according to ISO 9459-5:2007, paragraph 5.1;

– The test facility, instrumentation and sensor locations are according to ISO 9459-5:2007, chapter 5;

– The tests are performed according to ISO 9459-5:2007, chapter 6;

– Based on the test results the system parameters are identified according to ISO 9459-5:2007, chapter 7. The dynamic fitting algorithm and simulation model as described in ISO 9459-5:2007, Annex A, are used;

– The annual performance is calculated with the simulation model as described in ISO 9459-5:2007, Annex A, the identified parameters and the following settings:

– *Average daytime temperature in °C for average, colder and warmer climate conditions and average global solar irradiance in W/m$^2$ for average, colder and warmer climate conditions*;

– Hourly values for global solar irradiance according to an appropriate CEC test reference year;

– Mains water temperature: 10 °C;

– Ambient temperature of the store (buffer inside: 20 °C, buffer outside: ambient temperature);

– Auxiliary electricity consumption: by declaration;

– Auxiliary set temperature: by declaration and with a minimum value of 60 °C;

– Auxiliary heater time control: by declaration.

Annual heat demand: $0{,}6 \cdot 366 \cdot (Q_{ref} + 1{,}09)$

Where:

– 0,6 represents a factor to calculate the average heat demand from the load profile;

– 1,09 represents the average distribution losses.

The auxiliary electricity consumption $Q_{aux}$ is calculated as follows:

$Q_{aux} = CC \cdot (solpump \cdot \text{solhrs} + solstandby \cdot 24 \cdot 365) / 1000$

Where

– solhrs is the number of active solar hours in h; with

– solhrs = 2 000 for solar water heaters.

For the purpose of establishing the total energy efficiency performance of solar-only system and conventional water heater or of a solar water heater, the SOLICS method determines the annual non-solar heat contribution $Q_{nonsol}$ in kWh in terms of primary energy and/or kWh in terms of *GCV* as follows:

– For solar-only systems:

$Q_{nonsol} = 0{,}6 \cdot 366 \cdot (Q_{ref} + 1{,}09) - \text{QL}$

Where:

– QL is the heat delivered by the solar heating system in kWh/a.

– For solar water heater:

$Q_{nonsol}$ = Qaux,net

Where:

– Qaux,net is the net non-solar energy demand in kWh/a.

4.8. Storage tank test procedures

(a) Standing loss

The standing loss *S* of storage tanks can be assessed using any of the methods referenced in point 3, including the standing loss of the solar storage tank psbsol. Where the measurement results from the applicable standards are expressed in kWh/24 hours, the result will be divided by (1000/24) to arrive at values for *S* in W. For the specific standing loss – per degree of temperature difference between store and ambient — of solar storage tanks psbsol, the heat loss can be determined in W/K directly by using EN 12977-3 or it can be found indirectly by dividing the heat loss in W by 45 (Tstore = 65 °C, Tambient = 20 °C) to arrive at a value in W/K. Where the results of EN 12977-3, expressed in W/K, are used for the assessment of *S* they are multiplied by 45.

(b) Storage volume

The volume of the tank in a storage electric water heater is measured as follows:

The heating of the storage water heater is switched off. Then the storage water heater is filled with cold water in accordance with the manufacturer's instruction and the water supply is cut off.

It is then emptied through the water inlet or, if this is not possible, through the drain plug opening.

Water in the feed cistern of a cistern-fed water-heater is excluded from the quantity withdrawn.

The water withdrawn is measured.

4.9. Solar pump power test procedure

The solar pump power is rated as the electrical consumption under nominal operating conditions. Start-up effects under 5 minutes are disregarded. Solar pumps that are continuously controlled, or controlled in at least three steps, are rated as 50% of the rated electrical power of the solar pump.