Inspection of boilers and heating systems – *Revision of EN 15378-1*

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This article describes the revision of EN 15378 about the inspection of heating systems. It has been updated following changes in the EPBD requirements. It is now easier to use and software proof. Specific solutions have been introduced to meet the demanding requirements of EPBD articles 14 and 16.

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Context of the revision

EPBD requirements

The original EPBD Directive (2002/91/EC) required two types of inspection:

- a "*regular inspection of boilers*", to be repeated periodically and limited to the assessment of the boiler efficiency.
- a "*one-off inspection of heating systems*" to be performed only once on "older" systems, extending to the whole heating systems and requiring to check the sizing of the boiler.

Therefore EN 15378:2006 had two separate procedures for boiler and heating system inspection.

Now art. 14 of Directive 2010/31/EU ("EPBD recast" in the following) asks only for a "regular inspection of the accessible parts of systems used for heating buildings… (omissis) … with boilers of an effective rated output of more than 20 kW". According to this new requirement, in the prEN15378-1:

- the "*heating systems inspection*" procedure has been updated to comply with the EPBD recast requirements;
- the "*boiler inspection*" procedure has been kept indeed, because in many Member States such procedures are in place independently from EPBD inspection requirements and it might be useful to organise them in a consistent way.

The inspection requirements are also quite demanding:

- Art. 14 of EPBD recast states that the "**inspection shall include an assessment of** the **boiler efficiency** and **the boiler sizing** compared with the heating requirements of the building".
- Art. 16 of EPBD recast requires that "An inspection report shall be issued after each inspection of a heating or air-conditioning system. The inspection report shall contain the result of the inspection performed … and **include recommendations for the cost-effective improvement of the energy performance of the inspected system**. … The inspection report shall be handed over to the owner or tenant of the building".

The issues of assessing boiler efficiency, assessing boiler sizing and finding cost-effective improvements are described in the following.

The scope of the directive is restricted to "heating systems with boilers with a higher output than 20 kW". This does not exclude the possibility to use this standard for other types of generation devices (e.g. warm air heaters, heat pumps, thermal solar,

CHP, etc) and to domestic hot water systems if appropriate additional levels are defined.

Level and details of inspection

One may expect quite different levels of inspection depending on the size, type and complexity of the building and of the heating system. **Moreover, these expectations are quite different in the EU countries**.

The old EN 15378:2006 included a fully flexible mechanism called "*inspection classes*". It was based on a series of tables that allowed to define independently "inspection classes" and the corresponding inspection details. Information on how to proceed for the inspection of any subsystem was given in a series of informative annexes. This was like a huge toolbox, with quite few "ready to use" examples. This required a lot of work by national standardisation bodies.

The new revision has kept the high flexibility but it is easier to handle, two "ready to use" inspection classes are defined and there is a clear correlation between the normative text that gives the basic procedure, the inspection class definition and the inspection checklist and report.

Coordination with other standards

The current EN 15378 included all the required calculation methods in the informative annexes. They have been moved into the new prEN 15378-3 "Measured energy performance".

Software proof

All EPB calculation standards can be applied practically only if professional software tools are available. This is obvious for energy performance calculation methods.

The inspection standard can also be supported by software tools. Generating statistics on inspection requires a high standardisation in format and structure of the acquired data.

This is supported by the definition of "inspection items" in clause A.1.3 that requires specification of the type of data to be acquired following inspection, including predefined set of possible answers.

The structure of the new prEN 15378-1:2014

Clauses 1 to 4 are regulated clauses (scope, definitions, normative references, symbols etc.).

Clause 5 gives the general principle of the inspection and sets how to define custom inspection levels.

Clause 6 and 7 describe the inspection procedures related to:

- inspection of the heat generators;
- inspection of the entire heating systems according.

Clause 7 shall be applied to comply with requirements of EPBD recast.

Annex A (normative) is the template for the specification of inspection detailed requirements and default data.

Annex B (informative) contains 2 default inspection levels, considered to be the minimum to comply with EPBD recast for small (e.g. single family houses) and large buildings (block buildings) respectively.

Annex C (informative) are 2 default inspection reports, consistent with the 2 default inspection classes given in annex B.

All other information can be found in the accompanying prCEN/TR 15378-2.

Specific issues

Inspection levels

Inclusion/omission/alternatives of individual inspection items as well as border lines between levels are specified through tables compiled according to the template given in annex A.

A default specification of two basic inspection levels is given in informative annex B:

- default level 1 inspection is intended for single family dwellings;
- default level 2 inspection is intended for block buildings with a centralised heating system and for non-residential buildings.

Inspection classes are defined freely and given a unique name using a first table.

A second table gives the overview of the required inspection steps and inspection methods depending on the inspection class. Each procedure step is a row with:

- the reference to the to the procedure clause in the core text of the standard;
- the information if this inspection step is required or not (some inspection steps are optional);
- the reference to an inspection methodology given in the accompanying CEN/TR 15378-2 or in suitable existing national procedures.

Table 1 is an excerpt of table B.2 of prEN 15378-1 that defines default inspection level 1.

The referenced procedure can be a table of inspection items (see **Table 2**), a reference to an EN standard or to a national procedure.

Then the inspection items are specified in tables. Each inspection item is a row with:

- the reference to the procedure clause;
- the name of the inspection item;
- the type of information to be recorded (string, number and units, list of options, etc.);
- the rating value (efficiency or points) associated to that item.

Table 2 is an excerpt of table B.3 of prEN 15378-1 that defines the heating system and inspection identification for level 1 inspections.

For each inspection item, one field shall be made available in the inspection checklist and report. **Table 3** is an excerpt of annex C (roughly corresponding to the items shown in **Table 2**) where a default inspection report for inspection level 1 is given. There is one field in the report for each inspection item.

Table 1. Excerpt of Table B.2 – Overview of required sections for level 1.

Ref	Section	Required	Referenced procedures
7.3	Heating system and inspection identification	Yes	Table B.3
7.4	Document identification	Yes	Table B.4
7.5	Heating system functionality check	NO	
…			
7.13	Boiler performance	Yes	prEN 15378-3 – clause 7 Table B.12
…			

Table 2. Excerpt of Table B.3 – Heating system and inspection identification for level 1.

Ref	Inspection item	Type of information / values	Efficiency / points
7.3	Date of inspection	Date	n.a.
7.3	Inspector name	String	n.a.
7.3	Inspection level	Level identification	n.a.
7.3	Building unit identifier	String	n.a.
…			
7.3	Services provided by the heating system	One or more of the following • heating • domestic hot water • other	n.a.

Table 3. Excerpt of annex C3 – Heating system inspection report for level 1.

Date of inspection	_____ / _____ / _____	Inspector name	_____
Inspection level	1	Building category	_____
Address	_____	Zip / City _____	_____
Building unit identification	_____	Heating system ID code	_____

…

Services provided by the heating system	☐ heating	
	☐ domestic hot water	
	☐ other	_____

Boiler efficiency

"**Boiler efficiency**" is an ambiguous term: one may understand "combustion efficiency", "seasonal efficiency", "thermal efficiency"... Given the context, it is reasonable to expect that the "seasonal efficiency" $\eta_{blr;seas}$ has to be estimated.

The following equations are given (now in EN 15378-3) for a quick estimation:

$$\eta_{blr;seas} = \eta_{cmb} - \left(\frac{1}{\beta_{cmb}} - 1\right) \cdot \alpha_{ch,off} - \frac{1}{\beta_{cmb}} \cdot \alpha_{ge}$$

or

$$\eta_{blr;seas} = \left(\eta_{cmb} - \alpha_{ge}\right) \cdot \frac{100 - \frac{\alpha_{P0}}{\beta_{cmb}}}{100 - \alpha_{P0}}$$

Where:

η_{cmb} = the combustion efficiency that can be easily measured

α_{ge}, $\alpha_{ch;off}$, α_{P0} = the losses factors are taken from tables or sometimes can be obtained from estimations (α_{ge})

β_{cmb} = the load factor can be derived from the actual fuel consumption or from default values tables.

Boiler sizing

The "**boiler sizing**" assessment is potentially time consuming because it implies a comparison between a boiler property (available heat power output) and the building heat load. The following methods have been made available to get a quick estimation of the boiler sizing:

- using a default specific heat load per floor area (W/m²) depending on building typology;
- using a default fuel consumption per unit power (kWh/kW).

The method based on fuel consumption can be interpreted as the result of a simplified energy signature, as shown in **Figure 1:**

- Point "A" is the shut-off temperature, typically 2…4°C less than the internal set temperature so 0 kW @ 17°C.
- Point "B" (80 kW @ 6°C) is obtained as the average seasonal power (from yearly fuel consumption and yearly boiler operating hours) and seasonal external temperature (from degree days)
- The simplified energy signature is defined by points "A" and "B".
- The required peak power 170 kW can be read on the energy signature at "C", the design external temperature which is –6°C in the example.

The resulting ratio between yearly energy and peak power is the number of utilisation hours of the peak power. This simplified method is quite useful, provided that no significant reheat power is needed and that the historic fuel consumption refers to the continuous use of the whole building, which is normally the case in the collective residential sector.

Cost effective improvements

Finding "**cost effective improvements**" implies a comparison between costs and benefits. A reliable answer implies the estimation of:

- the cost of the suggested improvement action;
- the running costs before the implementation of the suggested action;
- the running costs after the implementation of the suggested action.

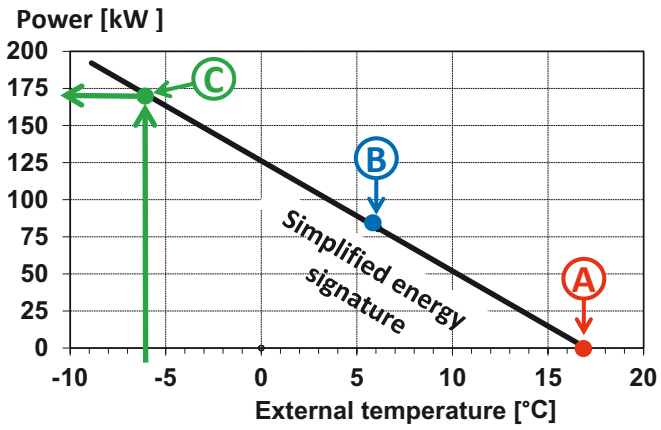

Figure 1. Generator sizing example using the simplified energy signature.

This is the basic work of a full energy audit. This cannot be done in the context and with the expected cost and effort of an "inspection". Cost effective improvements may be identified with little effort only if they are already known for repetitive cases. The list of possible improvement actions should support this approach.

The suggested layout of the report reminds that there are two types of possible improvement actions:

- low cost or highly effective actions with a short pay back (e.g. less than about 5 years) that can and should be immediately implemented;
- actions with long or even no pay back that are not immediately cost effective but that can and should be implemented following specific events when the marginal cost of an upgrade is low (e.g. an existing boiler should be upgraded when it has to be replaced)

If this is not mentioned, either there will be few cost-effective recommendations or both components and appliances might be replaced missing a possible upgrade.

Inspection report

The list of inspection items is the inspection checklist but it is also the basis of the inspection report. The only difference is the presentation order of items and the addition of recommendations.

The first page of the inspection report includes the most relevant information for the tenant or owner of the building such as:

- building and inspection identification;
- advice for improvements;
- estimated boiler efficiency;
- estimated sizing;
- report delivery receipt.

All other details are given in the subsequent pages. This layout emphasizes the intended message to the owner or tenant.

Conclusion and comments

The inspection of heating systems standard has been updated to comply with the new requirements of EPBD recast. The mechanism of inspection classes has been improved and made clearer. The inspection checklist is structured so that it is made easy to design software tools to assist the inspection task. The standard now includes finished, ready to use, inspection checklists and reports. Significant changes may still occur after the public enquiry process depending on the nature of the comments.

Further improvements may include extension to other types of generation systems.

The weak point remains the fact that it is not easy to meet all the requirements for recommendations and information if this has to be based on inspection evidence only. It is the author's opinion that the inspection may raise some recommendations in evident cases but in most cases it would be wise to recommend an energy audit (even to impose it in case of evidence of very high energy use) instead of giving generic recommendations.

EPBD recast requires the inspection of heating, ventilation and air conditioning systems. It is surprising that though most of the attention in the past was given to the thermal protection of buildings, no "building inspection" is required. Improvement potentials can be identified on buildings as well as on systems. ■

References

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