*This project is funded by the Horizon 2020 Framework Program of the European Union*

# Built2Spec

**Built to Specifications – Tools for the 21st Century Construction Site**

**H2020 Grant Agreement – 637221**

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# D5.2 Minimal Survey Data Set

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|---|---|
| Deliverable nature: | Other (OT) |
| Dissemination level: (Confidentiality) | Public (PU) |
| Contractual delivery date: | **M28** – April 30th 2017 |
| Actual delivery date: | 28th April 2017 |
| Version: | 1 |
| Total number of pages: | 83 |
| Keywords: | Self-inspection, Compliance, Build Quality. |

# Executive Summary

This report describes how the key energy efficiency and indoor environmental quality checks, identified in Task 5.1 (and still in progress), that are critical to compliance and performance targets for a building can be used with the self-inspection technologies of the Built2Spec Project. It starts by discussing the wide range of parameters that need to be specified and assessed to ensure that a building meets a customer's requirements. Many of these relate to energy efficiency and are often requirements of Regulations, Rules and Standards defined in a range of documents in the country and region where the building is constructed. Others relate to noise and air quality that may also be part of local legislated requirements. A further group, such as building dimensions, are primarily customer requirements but may be subject to some regulatory requirements.

The fundamental requirements are similar in all European countries because all have to comply with the Energy Performance of Buildings Directive, but the method of measurement and performance criteria differ significantly so the set of data to be collected from a building needs to be adapted to local requirements. In addition to these variations, individual customers may have different requirements and priorities for their buildings.

Examples are taken from the England and Wales, Ireland, France, Spain, Italy and the Passivhaus Standards but requirements in other countries and regions have also been considered with some detail included in appendices and more detail is available in spreadsheets that accompany this report. The B2S partners led by BSRIA identified 53 aspects of building specification that are likely to require checking and further details of these are included in Appendix K. This is the Minimal Data Set. It is broken down into 34 checks that are measurable during the construction phase, (Table 7, and 19) that need to be assessed from manufacturer's data, building models or long term measurement, (Table 8).

Some guidance is provided on how to use the Minimal Survey Data Set in specification of building and refurbishment projects and how to make the checks as the building project progresses.

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# Abbreviations

**B2S** = Built to Specifications

**BBC** = Effinergie label aimed at identifying new buildings or new parts of buildings whose very low energy requirements contribute to achieving the 2050 objective of reducing greenhouse gas emissions in France

**BER** = Building Emission Rate, the UK parameter for annual $CO_2$ emissions from non-dwellings

**BREEAM** = Building Research Establishment Environmental Assessment Method, originating in UK but used Worldwide

**COP** = Coefficient of Performance, performance rating for heat pumps

**COST** = European Cooperation in Science and Technology

**CSTB** = Scientific and technical centre for building in France

**CTE** = Código Técnico de la Edificación – Building Technical Code in Spain

**DER** = Dwelling Emission Rate, the UK parameter for annual $CO_2$ emissions from dwellings

**DOA** = Description of Action**;**

**IAQ** = Indoor Air Quality

**ITACA** = The "ITACA Protocol" is the Italian (not mandatory) building energy and environmental sustainability assessment tool.

**LEED** = Leadership in energy and environmental design originating in USA, but used Worldwide.

**MVHR** = Mechanical Ventilation and Heat Recovery

**NCM** = National Calculation Methodology – the generic term for the calculation method for annual energy use by buildings required by the Energy Performance of Buildings Directive.

**SAP** = Standard Assessment Procedure, the NCM for UK dwellings

**SBEM** = Simplified Building Energy Model, the NCM for UK non-domestic buildings

**TER** = Target Emission Rate based on a building that is the same size and shape as the actual building, constructed to a specification as detailed in the NCM and denoted the 'Notional Building'

**ThBCE** = the NCM in France

**WP** = Work Package.

# 1 Introduction

***A list of the Minimal Survey Data Set which can be efficiently captured to satisfy each self-inspection technique and quality check procedure and test.***

This report sets out the Minimal Data Set for checking compliance with a building specification during construction or refurbishment using technologies being developed under the Built2Spec Project. The approach to generating the Minimal Data Set was to identify the essential and frequently used specification parameters and criteria that must be satisfied in a compliant building and to separate these into design and construction stage checks. Throughout the work it is recognised that specifications vary between countries, between regions within countries and due to customer requirements. This report concludes with a Minimal Data Set for Construction Stage and another for Design Stage checks that will need to be collected before a building is accepted.

## 1.1 What is compliance?

The process of checking a building for compliance with the specification is the essence of the Built2Spec project. Lack of a process and the tools to use it has historically been one of the main reasons why buildings fail to satisfy the expectations of the stakeholders. Defining the checks that have to be done is therefore one of the key deliverables for the project. When developing the schedule of checks to be done on a completed building we have considered three aspects:

1. Contractual and Regulatory requirements
2. Potential benefits from checking
3. Possibility of checking including new tools under Built2Spec

Potentially every aspect of the building specification should be checked on completion to ensure that the building has been built in accordance with the specification. This might be considered a contractual requirement, but in practice many checks that would be desirable are not possible. The challenge is to identify the aspects of the building most important to the 'customer' the person or legal entity paying for the building. This list is likely to vary for each building so a definitive list cannot be made. Requirements are generally defined by Contract Clauses or Regulations. Contract Clauses may be anything that the customer requires and it is impossible to make a full list of these. Regulations are somewhat easier, but there are still variations between countries.

This report applies to all partners' countries but where examples are included they are generally taken from the UK and mostly from Regulations referring to England and Wales. The compliance checks discussed in this report are from Regulations and common customer requirements.

The objective of this work is to produce a list of parameters that may be checked before handover of a building, and the project team can agree on which they value as measures of project success.

## 1.2 Energy efficiency and other measures

The main emphasis of Built2Spec is on energy efficiency, but there are other regulations for buildings that are not devised for energy efficiency but have an effect on energy efficiency because they influence the way the building can be used. Noise level and air quality are included because they affect the usability of the building and that is likely to influence the energy efficiency.

## 1.3 Key energy efficiency quality check measures

Built2Spec Task 5.1 developed a list of Key Energy Efficiency Quality Check Measures, which were summarised for new-build and retrofit projects in a spreadsheet in July 2016. The summary for new—build can be seen at the end of this document in Appendix A to Appendix D.

## 1.4 Building regulations for energy efficiency

Building Regulations, Building Standards or Building Codes are the main source of compliance requirements. The Building Regulations for England and Wales for example are very brief on the subject of energy efficiency; Statutory Instrument 2010 No. 2214 says 'Reasonable provision shall be made for the conservation of fuel and power in buildings'.

However there are 'Approved Documents' that provide interpretation of the Regulations. Therefore the normal way of complying with Building Regulations on energy efficiency is to follow the recommendations of 'Approved Document L' 'Conservation of fuel and power'.

Approved Document L includes limits on:

- Overall energy consumption of the building expressed as Carbon Emission
- U values of building elements
- Thermal Bridging 'Y' value[1]
- Ψ values of building element interfaces
- A minimum ventilation rate
- Risk of overheating
- Plant efficiency
- Air leakage from buildings

Most of these are conventionally satisfied at Design Stage. Only air leakage has a compulsory check on completion. There are 4 editions of the Approved Document L for England and Wales:

- Approved Document L1A: conservation of fuel and power in new dwellings,
- Approved Document L1B: conservation of fuel and power in existing dwellings,
- Approved Document L2A: conservation of fuel and power in new buildings other than dwellings,
- Approved Document L2B: conservation of fuel and power in existing buildings other than dwellings

Approved Document F provides Regulations and guidance on achieving adequate rates of ventilation

Other Parts covered by Built2Spec are:

- Part C: Site preparation and resistance to contaminants and moisture
- Part E: Resistance to passage of sound

[1] The Y-value is determined by quantifying this extra heat loss at junctions through thermal bridging by way of its linear thermal transmittance or Psi (Ψ) value in units of (W/mK). The PSI value target is set within Table K1 of SAP, for instance the target PSI value for a window reveal is set at 0.05, but this can be improved to around 0.02 using proprietary closers or wider traditional reveal insulation. When all the junctions are quantified (in lineal metres) they are multiplied by their individual PSI Values. The sum of all the L x PSI are then divided by the Total Heat-loss Area for the building (ie. The area of walls, floor roofs and openings) and this results in your Y-value.

- Part G: Sanitation, Hot Water Safety and Water Efficiency
- Part J: Combustion appliances and fuel storage systems

Further interpretation for England and Wales is provided by
• Domestic Building Services Compliance Guide 2010 Edition with 2011 amendments, July 2011
• Non-Domestic Building Services Compliance Guide 2010 Edition with 2011 amendments, July 2011

Technically it would be possible to comply with Statutory Instrument 2010 No. 2214 by arguing that a building satisfies each requirement of the high level Regulations, but this may require a Court appearance to justify the energy efficiency measures used. For practical purposes it is the Approved Documents, particularly Approved document L and the Compliance Guides that form the basis of compliance checking on 99% of new and refurbished buildings.

Briefly these requirements usually mean that the owner of a new or refurbished building must:

1. Before work can start, provide calculations that demonstrate the $CO_2$ emission from the building does not exceed the target $CO_2$ emission rate.
2. On completion, a notice that the $CO_2$ emission rate of the building as-constructed does not exceed the target $CO_2$ emission rate.
3. On completion provide an Energy Performance Certificate

Strictly there is no requirement to demonstrate that the completed building physically meets the requirements of the Building Regulations relating to conservation of fuel and power.

However, Regulation 45 states:
"The local authority may make such tests of any building work as may be necessary to establish whether it complies with regulation 7 or any of the applicable requirements contained in Schedule 1". This effectively means that the building must be built in accordance with the specification because it may not get approval if it is not.

- Also, the building client is likely to ask for some evidence that the building complies with all relevant regulations to protect themselves from any future prosecution.

Built2Spec Task 5.1 also collected information about the specific Building Regulations for each partner country. The comparable Regulations for partner countries are listed in Appendix E. Sample sets of the detailed requirements are included in Appendix F to Appendix I.

## 1.5 The NCM – SAP and SBEM

To comply with the Energy Performance of Buildings Directive, each European country must have a National Calculation Methodology, NCM. In the UK the NCM is split into SBEM (Simplified Building Energy Model) for commercial and SAP (Standard Assessment Procedure) for domestic buildings.

SAP is used to demonstrate compliance with building regulations for dwellings – Part L (England and Wales), Section 6 (Scotland) and Part F (Northern Ireland) – and to provide an energy rating for dwellings, which is then displayed in an Energy Performance Certificate. This methodology complies with the Energy Performance of Buildings Directive.

All the building data is entered into the SAP, normally in desktop software, to give the criteria on which acceptance is based. The SAP rating is based on the energy costs associated with space and water heating, ventilation and lighting, minus the cost savings from energy generation technologies. The calculation is based on the energy balance taking into account a range of factors that contribute to energy efficiency:

• Materials used for construction of the dwelling

• Thermal insulation of the building fabric

• Ventilation characteristics of the dwelling and ventilation equipment

• Efficiency and control of the heating system(s)

• Solar gains through openings of the dwelling

• The fuel used to provide space and water heating, ventilation and lighting

• Renewable energy technologies

The Dwelling $CO_2$ Emission Rate is used for the purposes of compliance with building regulations. It is equal to the annual $CO_2$ emissions per unit floor area for space and water heating, ventilation and lighting, minus the emissions saved by energy generation technologies, expressed in kg/m²/year.

Other energy performance criteria relate to installed equipment such as fans and boilers and test data is usually supplied by the product manufacturer and not amenable to post-completion testing. In order to provide a more accurate rating, SAP Appendix Q offers the opportunity to include manufacturer and product specific performance data for evaluation on SAP assessments, which was originally not available when SAP was published in 2005. This information is made available to energy performance assessors. It also sets out the test and calculation methods for product performance – and how the results of these tests can be used in SAP calculations. Values in SAP-Q are from actual test measurements. The Appendix Q website http://www.sap-appendixq.org.uk/page.jsp?id=1 provides a searchable database of performance data for technologies and products, which can be entered into a SAP calculation. Technologies currently assessed via Appendix Q include:

• Heat Pumps – air source and ground source

• Mechanical ventilation systems

• Flue Gas Heat Recovery Systems (FGHRS)

• Waste Water Heat Recovery Systems (WWHRS)

• Hot Water Only Boilers

SBEM is required to produce evaluations in non-domestic buildings in order to generate Energy Performance Certificates and demonstrates compliance with Part L/F of Building Regulations. It was originally based on the Dutch methodology NEN 2916:1998 (Energy Performance of Non-Residential Buildings) and has since been modified to comply with the recent CEN Standards.

The main calculation is of BER (Building Emission Rate, $CO_2$ emitted annually, per square meter – kg $CO_2$/m²/year) which must not exceed the TER (Target Emission Rate based on a building that is the same size and shape as the actual building, constructed to a specification as detailed in the NCM and denoted the 'Notional Building') . The TER can only be calculated by SBEM and it is not only affected by size and shape of the building but also the type of ventilation and whether there are rooflights for example.

There are separate detailed requirements on some building elements for buildings that are not dwellings as shown in **Table 1**.

**Table 1 UK Building energy performance criteria and test methods (non-dwellings)**

| Parameter | Measurement method | Criteria | Units |
|---|---|---|---|
| Heat loss or gain through individual building elements | Thermal imaging of all internal surfaces and compensation for dynamic thermal environment | Spec. for each element or area weighted average<br>Roof <0.25, Wall <0.35<br>Floor <0.25<br>Swimming pool <0.3<br>Window/door <2.2<br>Large door <1.5<br>High usage door <3.5<br>Roof vents <3.5<br>Wall/floor spot <0.7<br>Roof spot <0.35 | W/m²K |
| Ventilation rate | Air flow measurement through main plant or individual inlets and outlets | Part F, UK Building Regulations: 10 l/s/p Total outdoor air supply rate with no smoking and no significant pollution sources. Extract rates are also given:<br>• Printers / Photocopier rooms – 20 l/s per machine<br>• WC/Urinal – 6 l/s each<br>• Shower – 15 l/s each But Spec. may have greater requirement | litre/s/person |
| Airtightness | Air pressurisation and flow rate measurement or new alternative methods | 10 or Spec. | $m^3/ /(m^2 \cdot h)$ @50 Pa |
| Thermal Bridging Ψ value at each interface | Thermal imaging of all internal interfaces and compensation for dynamic thermal environment | Spec. | W/mK |
| Thermal Bridging 'Y' value | Addition of individual Ψ value x length and division by envelope area | < 15% of total fabric heat loss or Spec.. | W/K m² |

**Note**: Spot U value limits are set by Approved Document C to avoid the risk of condensation forming on surfaces

# 2 Requirements in other partner countries

BSRIA used information collected information about Regulations in partner countries: UK, Scotland, Northern Ireland, Ireland, Spain, Germany (Passivhaus, Federal and State Regulations[2]), The Netherlands, Italy (Casa Clima)[3], France (BBC Effinergie).

Detailed information was obtained for some countries and it is clear that there are regional variations in other countries as well as in the UK.

## 2.1 France

There are also additional compliance tests required for sound insulation and indoor air quality that are not covered by the EPBD.

French thermal regulation is also based on a national calculation methodology named "règles ThBCE" or ThBCE rules. They give all the formulas to apply in order to demonstrate compliance. Tools used for that have to be validated by an official structure (the CSTB : Scientic and technical centre for building).

Contrary to UK, there is no difference between commercial and domestic building rules. But there is a difference between new buildings and existing buildings.

First, the regulation for existing buildings is split into a global calculation for buildings with:

- A net floor Area superior to 1000m²
- And a retrofit cost >25% of the value of the building
- A date of construction > 1948

and an element per element regulation for all others buildings. For the latter, a further ministerial order (22th March 2017) reinforce criteria for an application the 1st January 2018. Criteria now depend on the climatic zone:

[2] The building regulations differ from state to state, and are laid down in the Landesbauordnungen (Building Code of the States). The Musterbauordnung (Model Building Code) at Federal level offers a prototype for the individual Landesbauordnungen.

[3] R2M and DE5 provided the national regulation requirements and also the LEED and the ITACA sustainability protocol which are both spplied in Italy. The tables in this report and the spreadsheets refer mainly to the Regulations because LEED and ITACA are optional.

**Figure 1 : French climatic zones**

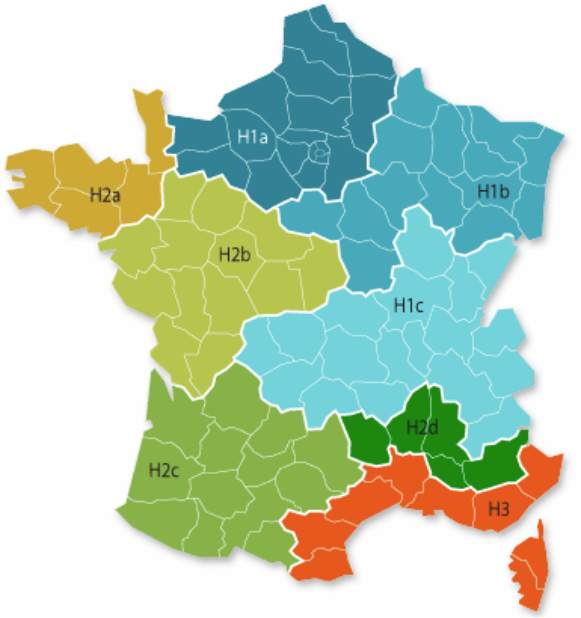


**Table 2 French Building energy performance criteria for the element per element regulation**

| | Minimal thermal resistance [m².K/W] | | |
|---|---|---|---|
| | Zone H1A, H1B or H1C | Zone H2A, H2B, H2C and H3 with an altitude superior to 800m | Zone H3 with an altitude inferior to 800m |
| Exterior wall and pitched roof with a slope >60° | 2.9 | 2.9 | 2.2 |
| Wall in contact with an unheating room | 2 | | |
| Flat roof | 3.3 | | |
| Floor of lost attic | 5.8 | | |
| pitched roof with a slope < 60° | 4.4 | 4.3 | 4 |
| Floor | 2.7 | 2.7 | 2.1 |
| | | | |
| | Transmission coefficient [W/(m²K)] | | |
| Window | Uw<1.9 | | |
| door | Ud<2 | | |
| Glass roof | Ucw<2.5 | | |
| veranda | U<2.5 | | |
| | | | |
| Efficiency of gas/oil space heating system | >90.9% | | |
| Heat pump for heating | Coefficient of performance, COP>3.2 or 2.7 | | |
| Efficiency of cooling system | EER>2.8 for air-air<br>EER>3 for water-air<br>EER>2.6 for air-water<br>EER>3 for water-water | | |
| Ventilation fan efficiency | In residential buildings, energy demand> 0,25Wh/m³ per fan (or 0,4 with filters)<br>In other buildings, energy demand> 0,3Wh/m³ per fan (or 0,45 with filters) | | |

**Note: This is only for existing buildings**

In France, the thermal regulation of 2012 (RT2012) It enforces two kinds of requirements:

1. 3 requirements of objectives :
    a. A maximum value for the coefficient Bbio ("Besoins Bioclimatiques" for bioclimatic needs) which is a weighted sum of the heating needs, lighting needs and cooling needs. For the calculation of the heating needs, a ventilation system of reference is used (heat recovery system)
    b. A maximum value for energy used (Cep)for heating, cooling, lighting, domestic hot water, pump and fan in primary energy
    c. A summer mean temperature (Tic)
2. several requirements of means
    a. reduction of thermal bridges
    b. reduction of air leakage
    c. a minimum area of windows for visual comfort
    d. a minimum use renewable natural sources of energy
    e. a maximum photo voltaic generation allowing to reduce the global energy used.
    f. In residential buildings, the presence a counting system of all energy uses.

In 2018 or 2020, a new regulation will replace the RT2012. The main change will be the addition of a requirement in term s of $CO_2$ emitted.

## 2.2 Passivhaus

For the purposes of the Built2Spec Project the Passivhaus Standard is treated in the same way as another set of National Regulations. Passivhaus originated in Germany, and is widely used there for highly energy efficient buildings that exceed Regional and Federal Standards. The Passivhaus Standard is also used in other countries. In a Passivhaus thermal comfort is achieved to the greatest practical extent through the use of passive measures listed below which can be applied not only to the residential sector but also to commercial, industrial and public buildings:

- good levels of insulation with minimal thermal bridges
- passive solar gains and internal heat sources
- excellent level of airtightness
- good indoor air quality, provided by a whole house mechanical ventilation system with highly efficient heat recovery

The Passivhaus standard is a comprehensive low energy standard intended primarily for new buildings. The Passivhaus standard can be applied not only to residential dwellings but also to commercial, industrial and public buildings.

This has led to the following functional definition of a Passivhaus.

*"A Passivhaus is a building, for which thermal comfort can be achieved solely by post-heating or post-cooling of the fresh air mass, which is required to achieve sufficient indoor air quality conditions – without the need for additional recirculation of air."*

**Table 3** shows the energy performance targets that define the standard and must be met in order for certification to be achieved. Only the air change rate is practically measurable at construction stage.

**Table 3 Passivhaus Energy performance targets and air changes per hour**

| | |
|---|---|
| Specific Heating Demand | ≤ 15 kWh/m². yr |
| Specific Cooling Demand | ≤ 15 kWh/m². yr |
| Specific Heating Load | ≤ 10 W/m² |
| Specific Primary Energy Demand | ≤ 120 kWh/m². yr |
| Air Changes Per Hour | ≤ 0.6 @ n50 |
| Overheating, hours over 25°C | ≤ 10% of occupied hours |

The Passivhaus standard can be achieved when refurbishing buildings although this can prove costly, for more on Passivhaus refurbishment please see the EnerPHit standard.

The standard requires that the Primary Energy demand target is met in all cases, this figure must include the space heating, domestic hot water, lighting, fans and pumps and also all of the projected appliance consumption. In addition to the primary energy demand the standard permits that either the Specific Heating Demand or the Specific Heating Load must be met.

Passivhaus has advisory limits for other criteria as shown in **Table 4**. All the values in **Table 4** are measurable on real buildings except the MVHR coefficient so these could be in the minimal data set for a Passivhaus building.

**Table 4 Passivhaus Elemental backstop values**

| **Design Component** | **Limiting value** |
|---|---|
| Walls, Roof, Floor U-values | ≤0.15 (W/m²K) |
| Glazing unit U-values | ≤0.8 (W/m²K) |
| Installed glazing U-values | ≤0.85 (W/m²K) |
| Door U-values | ≤0.8 (W/m²K) |
| Infiltration (ach-1) | ≤0.6 @ n50 |
| Thermal bridging (linear ψ value) | ≤0.01 (W/mK) |
| MVHR coefficient (η HR) | ≥0.75 |
| Ventilation electric limit | 0.45 Wh/m³ |
| Maximum sound from MVHR unit | 35 dBA |
| Maximum transfer sound in occupied rooms | 20 dBA |
| Appliances | High efficiency recommended |
| Lighting | High efficiency recommended |
| On site renewables | No requirement but SHW typical |

Note opaque U-values are only recommended targets and are not critical to certification

## 2.3 Spain

We know that there are 12 climate zones in Spain (according to rules in Spain, Código Técnico de la Edificación –CTE-) for instance as shown in Table 5 and the airtightness and thermal insulation requirements differ between zones.

**Table 5 Climate zones in Spain**

| Climatic Zone | Representative city | Climatic Zone | Representative city |
|---|---|---|---|
| A3 | Cádiz | C3 | Granada |
| A4 | Almería | C4 | Toledo |

| | | | |
|---|---|---|---|
| B3 | Valencia | D1 | Lugo |
| B4 | Sevilla | D2 | Zamora |
| C1 | Bilbao | D3 | Madrid |
| C2 | Barcelona | E1 | Burgos |

The fundamental limit for energy performance is based on the value resulting from Equation 1. The heating demand of the building or the enlarged part, if any, must not exceed the limit value $D_{cal, lim}$ obtained by the following expression

**Equation 1**

D cal, lim = D cal, base + F cal, sup / S

where,

D cal, lim is the limit value of the *energy demand* for heating, expressed in kWh / m ² · year, of *living spaces*;

D cal, base is the base value of the *energy demand* of heating, for each *climatic zone* of in- corresponding to the building, that takes the values of table 2.1 (Documento Básico HE Ahorro de Energía);

F cal, sup is the surface corrector factor of the *heating* energy *demand*, which takes the Values in table 2.1 in the source document;

S is the useful surface of the *living spaces* of the building, in m².

**Table 2.1 Base value and surface corrector factor of heating energy demand – Winter climate zone**

| **Q** | **α** | **A*** | **B*** | **C*** | **D** | **E** |
|---|---|---|---|---|---|---|
| *Cep,base [kW·h/m²·año]* | 40 | 40 | 45 | 50 | 60 | 70 |
| *Fep,sup* | 1000 | 1000 | 1000 | 1500 | 3000 | 4000 |

* The energy demand of refrigeration of the building or the enlarged part, if appropriate, must not surpass the limit value $D_{ref, lim}$ = 15 kW · h / m² · year for summer climatic zones 1, 2 and 3, or the limit value $D_{ref, lim}$ = 20 kW · h / m² · year for the summer climate zone 4.

The percentage of savings of the joint energy demand of heating and cooling, with respect to the reference building of the building or the enlarged part, where appropriate, must be equal to or greater than values set out in Table 2.2 of the source document

**Table 2.2 Percentage of minimum savings of the joint energy demand with respect to the reference building for buildings of other uses, in%**

| **Zone Climate of summer** | **Low** | **Half** | **high** | **Very high** |
|---|---|---|---|---|
| 1, 2 | 25% | 25% | 25% | 10% |
| 3. 4 | 25% | 20% | 15% | 0% |

The thermal transmittance and air permeability of the voids and the thermal transmittance of the opaque walls, roofs and floors forming part of the thermal envelope of the building must not exceed the values established in Table 2.3 of the source document. This check excludes Thermal bridges

**Table 2.3 Maximum thermal transmittance and air permeability of the elements of the thermal envelope**

| | α | A | B | C | D | E |
|---|---|---|---|---|---|---|
| Thermal transmittance of walls and elements in Contact the ground (1) [W / m² · K] | 1.35 | 1.25 | 1.00 | 0.75 | 0.60 | 0.55 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Transmittance of roofs and floors in Contact with air [W / m ² · K] | 1.2 | 0.8 | 0.65 | 0.5 | 0.4 | 0.35 |
| Thermal transmittance of holes (2) [W / m² · K] | 5.7 | 5.7 | 4.2 | 3.1 | 2.7 | 2.5 |
| Air permeability of voids (3) [m ³ / h · m ² ] | ≤50 | ≤50 | ≤50 | ≤27 | ≤27 | ≤27 |

(1) For elements in contact with the ground, the indicated value is required only to the first wall buried underground, or first metre perimeter of floor resting on the ground to a depth of 0.50m.
(2) Considered as glass assembly and frame. It includes skylights and dormer windows.
(3) Permeability of joinery is indicated as an overpressure of 100Pa

## 2.4 Ireland

Ireland is about to publish its new Part L Energy Efficiency Requirements for Non-Residential Buildings (April 2017) but at time of writing this information is not yet available. The summary of requirements below is therefore only for dwellings. A more complete summary of the Irish Building Regulations is provided in the attached spreadsheet containing equivalent summaries for the UK, Spain, France, Italy, Germany, the Netherlands and Ireland. This spreadsheet also includes the Passivhaus standards.

| Parameter | Measurement method | Criteria | Units |
|---|---|---|---|
| Heat loss or gain through individual building elements | Thermal imaging of all internal surfaces and compensation for dynamic thermal environment | Pitched Roof < 0.16<br>Flat Roof < 0.20<br>Roof light < 0.16<br>Wall < 0.21<br>Window/door < 1.6<br>Ground Floor < 0.21<br>Basement floor < 0.21<br>Basement wall < 0.21 | U-value<br>W/m²K |
| Ventilation rate | Air flow measurement through main plant or individual inlets and outlets | Part F, Irish Building Regulations:<br>8 l/s/p Total outdoor air supply rate with no smoking and no significant pollution sources.<br>Extract rates:<br>• Printers / Photocopier rooms : 20 l/s per machine<br>• WC/Urinal : 6 l/s each<br>• Shower : 15 l/s each | Litre/s/person |
| Airtightness | Air pressurisation and flow rate measurement or new alternative methods | 7.0 m³/m²/hr<br><br>or Project Spec. | m³/ /(m²·h) @50 Pa |
| Thermal Bridging Ψ value at each interface | Thermal imaging of all internal interfaces and compensation for dynamic thermal environment | 0.15 W/mK default maximum<br><br>A lower value to be proven by calculations by accredited expert | W/mK |
| Thermal Bridging 'Y' value | Addition of individual Ψ value x length and division by envelope area | < 15% of total fabric heat loss or Spec. | W/K m² |
| Acoustics | Independent test & certificate | Separating wall :<br>Airborne sound : 53 dB min DnT,w<br>Separating floor:<br>Airborne sound : 53 dB min DnT,w<br>Impact sound : 58 dB max LnT,w | dB |

| Parameter | Measurement method | Criteria | Units |
|---|---|---|---|
| **Maximum Permitted Energy Performance Coefficient (MPEPC)** | Calculation using the national DEAP (Dwelling Energy Assessment Procedure) software tool compared to reference dwelling | Maximum 0.4 | Ratio |
| **Maximum Permitted Carbon Performance Coefficient (MPCPC)** | Calculation using the national DEAP (Dwelling Energy Assessment Procedure) software tool compared to reference dwelling | Maximum 0.46 | Ratio |

## 2.5 Italy

There are six climate zones in Italy as shown in **Table 1**Table 6. These are classified in terms of Heating Degree Days, HDD. Annual energy use $Ep_{gl,tot}$ must not exceed the usage by a reference building, $Ep_{gl,tot\ ref\ building}$. according to National Regulation 2010/31/UE.

The reference building must have:
1. same geometry as the design building;
2. same orientation;
3. same climatic zone;
4. same use;
5. same external condition (e.g. shadow, …);
6. minimum parameters indicated in the regulations (e.g. U values, efficiency, ...)

$$Ep_{gl,tot} < Ep_{gl,tot\ ref\ building}$$

**Table 6 Climate Zones in Italy**

| Name of climatic zone | Description of zone | Representative regions / cities |
|---|---|---|
| Zone A | HDD < 600 | Lampedusa |
| Zone B | 600 < HDD < 900 | Palermo, Reggio Calabria |
| Zone C | 900 < HDD < 1400 | Napoli, Bari, Cagliari |
| Zone D | 1400 < HDD < 2100 | Roma, Firenze, Genova, Ancona |
| Zone E | 2100 < HDD < 3000 | Milano, Torino, Venezia, Bologna, Perugia |
| Zone F | HDD > 3000 | Belluno, Cuneo |

There are also regulations that specify a minimum value for thermal capacity of building materials, "UNI EN ISO 13786:2008, D.M. 26/06/15

Thermal Inertia Envelope (vertical opaque walls) Ms > 230 kg/m² or YIE < 0,10 W/m²K

Ms: superficial mass of the element; characteristics of material needed

Yie: Periodic thermal transmittance; thermal characteristics of material needed

These are calculated values or from manufacturers' literature.

## 2.6 Sound insulation

In the UK Building Regulations Part E requires a level of sound insulation between dwellings and specifies acceptance criteria for walls, floors and impact noise through floors. The World Health Organization (2009) report "Night noise guidelines for Europe", http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf and BR-AD-E set the criteria in the UK. There is also an EU report from COST Action TU0901: Integrating and Harmonizing Sound Insulation Aspects in Sustainable Urban Housing Constructions 'Building acoustics throughout Europe Volume 1: Towards a common framework in building acoustics throughout Europe'. This compares the different noise control assessment methods in 29 European countries and 3 overseas countries. They found 7 basic airborne noise transmission 'descriptors' used in different countries and 22 variations in the criteria.

In France, the acoustic regulation follows European standards for the 1st January 2000. So European criteria are used with national values:

Residential building: ministerial order of 30th June 1999
Other kind of building:
Educational facilities: ministerial order of 25th April 2003
Health care establishments: ministerial order of 25th April 2003
Hotels: ministerial order of 25th April 2003

In addition, for residential building, the contracting authority has to produce a certificate at the end of the construction stage. This certificate is based on report made during the design and construction stages. If the building contains more than 10 dwellings, measurements have to be done, see Table 7.

**Table 7 Sound insulation requirements in France**

| Measurement | Size of the building | Minimum number of measurement | |
|---|---|---|---|
| | | Single dwellings | Collective dwellings |
| Airborne sound insulation exterior wall | From 10 to 30 dwellings | 0 or 1 | 0 or 1 |
| | More than 30 dwellings | 1 to 2 | 1 to 2 |
| Airborne sound insulation Separating Walls | From 10 to 30 dwellings | 2 | 4 |
| | More than 30 dwellings | 4 | 6 |
| Equivalent absorption area of absorbing materials in common walkways | From 10 to 30 dwellings | | 1 |
| | More than 30 dwellings | | 2 |
| Level shock noise | From 10 to 30 dwellings | 2 | 3 |
| | More than 30 dwellings | 3 | 5 |
| Sound level of individual heating, cooling or domestic hot water equipment | From 10 to 30 dwellings | 0 or 1 | 0 or 1 |
| | More than 30 dwellings | 0 or 2 | 0 or 2 |
| Sound level of ventilation unit | From 10 to 30 dwellings | From 1 to 2 | From 1 to 3 |
| | More than 30 dwellings | 3 | 5 |
| Sound level of individual equipments between dwellings | From 10 to 30 dwellings | 1 | 1 |
| | More than 30 dwellings | 2 | 2 |
| Sound level of collective equipments (except ventilation) | From 10 to 30 dwellings | | From 0 to 3 |
| | More than 30 dwellings | | From 0 to 3 |

## 2.7 Indoor air quality (IAQ)

- There is currently little demand for Indoor Air Quality assessment in the UK. A UK Government review by the Parliamentary Office of Science and Technology (Number 366, November 2010) stated:

The EU Air Quality Framework Directive (96/62/EC) and its sister directives define the policy framework for 12 potential air pollutants known to have a harmful effect on human health, including $NO_2$, carbon monoxide and PM. However this framework is wholly focused on outdoor air quality and does not apply to indoor air. UK bodies involved in regulating air quality (indoors and out) include:

- Department for Communities and Local Government (CLG) which takes the lead on Building Regulations through its Housing Health and Safety Rating System.
- Department of the Environment, Food and Rural Affairs (Defra) and the devolved assemblies which fund the national UK monitoring network for air pollution outside.

- Department of Health and the Health Protection Agency (HPA), which lead on the health impacts of air pollution.

- Health and Safety Executive, which leads on limiting exposure to harmful levels of air pollutants at work (not covered in the scope of this POSTnote).

Approved Document F on ventilation, specifies indoor air quality standards for a limited number of substances only, and Approved Document C includes radon. However, the regulations place more emphasis on air-tightness (energy efficiency) than on ventilation. Furthermore, they recommend minimum levels of air flow (ventilation) through a building and assume that outdoor air is "fresh". Finally, while the regulations nominally apply both to new buildings and to work undertaken on existing buildings, in practice they are most likely to be enforced in new developments.

There are effectively no regulations in the UK for air quality in buildings. The main driver for indoor air quality standards and assessments come from sustainability standards such as BREEAM, which covers VOC concentrations:

1. *The Formaldehyde concentration level is measured post construction (but pre-occupancy) and is found to be less than or equal to 100µg/m³ averaged over 30 minutes (WHO guidelines, source BRE Digest 464 part 2.*

2. *The total volatile organic compound (TVOC) concentration is measured post construction (but pre-occupancy) and found to be less than 300µg/ m³ over 8 hours, in line with the Building Regulation requirements.*

3. *Where levels are found to exceed these limits, the project team confirms the measures that have, or will be undertaken in accordance with the IAQ plan, to reduce the TVOC and formaldehyde levels to within the above limits.*

### 2.7.1 IAQ in France

In France, the indoor air quality has been identified as a priority of the 2nd and the 3rd national plans of the "Grenelle de l'environnement". The Grenelle de l'environnement is an open multi-party conference that brings together representatives of national and local government and organizations (industry, labour, professional associations, non-governmental organizations), with the goal of unifying a position on a specific theme. Following these plans, several regulations have been set in order to improve the IAQ:

- The decree n°2011-1728 - 2/12/11 which states that the indoor air quality has to be monitored in specific public access buildings such as schools and day-care centers. The application of this decree, initially planned in 2015, has been reported until January, 1st 2018. Moreover, the decree has been modified and the assessment of the IAQ is not compulsory anymore for public access buildings which prove that they respect the specifications required. In consequence, the demand for IAQ assessment is not very high.

- The decree n° 2015-1926 which gives guide values for three pollutants for public access buildings: formaldehyde (100µg/m³), benzene (10µg/m³), tetrachloroethylene (1250 µg/m³).

- The decree n° 2011-321 du 23 mars 2011 which imposes the labelling of construction products according to their pollutant emission. This label targets 10 pollutant species and allow the consumer to choose low emissive materials.

The Ministry in charge of the regulations regarding the working conditions has also established guide values regarding indoor air pollutant concentrations in a regulation: Arrêté du 30 juin in relation with the article R. 23255 of the working code. However, the guide values are so high that they are never reached. In consequence, only specific companies working with specific products such as glue manufacturer are controlled for this matter.

Also, the government has set different minimum ventilation rates depending on the building type. These values are presented in different regulations:

- Dwelling: Arrêté du 24 mars 1982, modifié par l'arrêté du 28 novembre 1983

- Tertiary building: Working code (article R.4222-6)

- Other (classroom, daycare centers,…): Circulaire du 9 août 1978

Several French agencies are also working on the topic:

- The "Observatoire de la Qualité de l'Air Intérieur" (OQAI) is dedicated to this topic. They conduct several studies on different topics such as the assessment of the current state of the indoor air quality in France, or the impact of the new thermal regulation on the indoor air quality.

- The "ANSES" is working principally on defining guide values for the indoor air pollutants concentrations. So far, they published guide values for the following pollutants: formaldehyde, carbon monoxide, benzene, naphthalene, trichloroethylene, tetrachloroethylene, particles, cyanhydric acid, Nitrogen dioxide, acrolein, and acetaldehyde.

- Local associations has been created for the assessment of the air quality. They control the outdoor air pollution with monitoring stations based on all the territory. When the pollutants concentration is too high, some actions can be taken such as the reduction of the speed limit on the road.

Despite these regulations and these agencies, there is little demand for indoor air quality assessment in France. As for UK, the main driver for indoor air assessments remains sustainability standards such as HQE, BREEAM, or LEED. However, with the increasing awareness of the population to this matter and the emerging regulations, we can expect that the demand will be higher in the next years.

# 3 Building specification requirements

The Building Specification can say whatever the procurement team want.

Typically this includes:

- Dimensions
- Materials
- Finishes
- Internal temperature
- Internal humidity
- Internal air movement
- Occupant comfort level
- Renewable energy source
- Surface temperatures to avoid condensation and mould growth
- Sustainability rating – which may require higher performance levels for items already covered by Regulations

## 3.1 Construction and post completion building checks

The B2S partners led by BSRIA identified 53 aspects of building specification that are likely to require checking and further details of these are included in Appendix K. The detail is not complete because some of the requirements are very complex and depend on the building and exact location A copy of the spreadsheet [Summary of Building Checks WP 5.2.xlsx] is included with this report.

The spreadsheet shows an X in some cells where there is a requirement but the detail of the requirement is uncertain or too complex to include in the table. Further information may be obtained from project partners with more knowledge of their local building Standards or others to describe the exact requirement.

Some compliance checks are simply not amenable to testing during the construction stage or on completion. Either they are design requirements or they require long periods of monitoring, as would be the case for measurement of total energy use over a year. Only 34 of the original 53 Building Checks can reasonably be tested during construction or on completion. These are tabled in Appendix L. It is proposed that Appendix L should form the basis of further work developing tests through the remaining part of the Built2Spec Project.

## 3.2 How to use the minimal survey data set requirements

At the start of a building project the client and the construction team (The Stakeholders) should agree the requirements that they will use as acceptance criteria for the building. This should involve review of the full 'Minimal Survey Data Set Requirements' and decisions about which are most important to the building project stakeholders. Some requirements will be compulsory because of Regulations that exist in the location where the building is to be built. Others may be requirements of stakeholder policies such as a customer company Sustainability Policy. With most of the requirements, an acceptance criterion needs to be set, for example Airtightness test result less than 5 $m^3/ (m^2 \cdot h)$ @50 Pa. The information in **Table 8** is an example of the Minimal Data Set for Construction Stage. Criteria may be deleted or added if there are special requirements.

**Table 8** has been generated for the Regulations applicable to England and Wales. Comparable tables will need to be generated by users in other countries based on their regulations and climatic conditions.

The agreed set of Minimal Survey Data Set Requirements should be written into the Building Specification along with a program of when in the building program they can be tested and 'signed off'. The system of recording compliance also needs to be agreed and integrated into the VCMP. The Built2Spec Project is working towards a fully integrated Virtual Construction Management Platform (VCMP) and this will include all the criteria from **Table 8** and allow the addition of new criteria.

As the building progresses the requirements will be tested; for example building air permeability can be tested when the building has reached a stage of completion of the external envelope. As with most of the requirements, the compliance testing requires specialist equipment and data processing. Only the single figure air permeability value needs to be considered by the compliance checking system. Thermal imaging requires a different stage of completion, as well as complete cladding the building also needs heating to provide a temperature difference that will drive heat transfer through the building fabric. Conventionally a temperature difference of 10K has been required to overcome variations due to thermal storage and diurnal temperature variations. Methods being developed in Built2Spec will allow thermal imaging with a smaller temperature difference and therefore less internal heating or cooling. This will make it easier to undertake thermal imaging as a check of insulation at an earlier stage in the construction programme.

Some parameters will need to be checked before the building is accepted, but are not measurable at construction stage. These are shown in Table 8..

**Table 8 Minimal Data Set Example – Construction Stage data**

| | Parameter | Measurement method | Criteria |
|---|---|---|---|
| 1. | Dimensions of all building fabric as specified | Dimensional Survey on site or BIM tolerances check throughout construction | Measurements using B2S methods from other work packages |
| 2. | Maximum annual building energy use | Energy rating from design calculation | The parameters that fed into the NCM Energy Performance calculation need to be checked. This will vary from country to country |
| 3. | Carbon emissions | Calculation from energy use multiplied by the appropriate factor for each fuel | as above |
| 4. | Indoor comfort temperature | Spot check temperature reading | Spot check temperatures during acceptance test. Is each room being heated and cooled to the design temperature under appropriate conditions. This test may have to be repeated at different seasons |
| 5. | Indoor relative humidity | Spot check RH sensor reading | as above |
| 6. | PMV (Predicted Mean Vote) | Spot check PMV comfort calculation | Where this is a requirement assess PMV using a system such as Testo 480 or Arvind HD32.3 -CV |
| 7. | Ventilation rate | Balometer reading of flow rate through each air terminal | Commissioning report showing flow rate through each terminal |
| 8. | Purge ventilation | Balometer reading of flow rate through each air terminal | Commissioning report showing flow rate through each terminal |

| | Parameter | Measurement method | Criteria |
|---|---|---|---|
| 9. | Building air permeability | Airtightness test | Airtightness test certificate from test conducted in Standard way: ISO 9972 or •ATTMA TSL1 September 2016 Edition – Air testing standard for residential dwellings •ATTMA TSL2 September 2010 Edition – Air testing standard for non-dwellings |
| 10 | Thermal Bridging Psi value | Have accredited details been used? Or advanced testing procedure | Thermal imaging with calculation of Psi value from surface temperatures in corners, around openings and other non-repeating thermal bridges. Accredited details have known psi values. |
| 11 | Thermal Bridging 'Y' value | Calculation from Psi values and building dimensions | Calculation from Psi values and building dimensions. $Y = (\Sigma L \times \Psi) / As$ where As = heat loss surface area |
| 12 | Internal Surface Temperature | Surface temperature spot checks using thermal imaging or a surface temperature sensor | Thermal imaging with calculation of TI or Fsi value from surface temperatures. Acceptable ranges are >0.9 for swimming pools, >0.75 for dwellings or schools and >0.5 for commercial buildings |
| 13 | Solar gain | Spot Check surface temperature of internal surfaces against thermal model | Limits on solar gain are usually expressed as an upper temperature limit so the spot check should be done when there is maximum solar gain on the façade of the room being tested. |
| 14 | Basement floor U-value | Heat flux meter reading or thermal imaging in accordance with ISO9869:2 | If required, U values can be measured, but method is time consuming, taking between 5 and 20 days |
| 15 | Basement wall U-value | | |
| 16 | Ground Floor U-value | | |
| 17 | Wall U-value | | |
| 18 | Door U-value | | |
| 19 | Window U-value | | |
| 20 | Pitched roof U-value | | |
| 21 | Flat roof U-value | | |
| 22 | Roof window U-value | | |
| 23 | Heating Controls | Check functional capability of control system for control by time, temperature, occupancy etc | Does control system switch on and off at the right thresholds and times? |
| 24 | Renewable energy - total | Spot check generation meters | Take spot readings of kW and kWh and check that they are in acceptable range |
| 25 | Renewable thermal energy | Spot check generation meters | Take spot readings of kW and kWh and check that they are in acceptable range |
| 26 | Renewable electricity | Spot check generation meters | Take spot readings of kW and kWh and check that they are in acceptable range |
| 27 | Airborne sound insulation Separating Walls | Sound test of separating wall insulation | Sound insulation test report showing acceptable result. Test methods and criteria differ between countries |

| | Parameter | Measurement method | Criteria |
|---|---|---|---|
| 28 | Airborne sound insulation Separating Floors | Sound test of separating floor insulation | Sound insulation test report showing acceptable result. Test methods and criteria differ between countries |
| 29 | Sound level of ventilation unit and other equipment | Decibel reading when equipment operating | Sound insulation test report showing acceptable result. Test methods and criteria differ between countries |
| 30 | Indoor Air Quality | IAQ sensor check or VOC measurement to EN 13649:2002 | VOC measurement by approved method and acceptable result. Eg BREEAM requires<br>1. The Formaldehyde concentration level is measured post construction (but pre-occupancy) and is found to be less than or equal to 100µg/m³ averaged over 30 minutes.<br>2. The total volatile organic compound (TVOC) concentration is measured post construction (but pre-occupancy) and found to be less than 300µg/ m³ over 8 hours, in line with the Building Regulation requirements. |
| 31 | VOC concentration | IAQ sensor check or VOC measurement to EN 13649:2003 | As above |
| 32 | Total power of Lighting | Electricity consumption of lighting when all switched on | Meter reading |
| 33 | Pipe insulation effectiveness | Check insulation type and thickness against EN ISO 12241:2008. In UK the Non-Domestic Compliance Guide 2013 recommends BS 5422 | Visual inspection and certificate |
| 34 | Smart Materials | Functional test of any smart materials used | As specified |

**Table 9Minimal Data Set Example – Design Stage data**

| Number | Target | Parameters | Notes |
|---|---|---|---|
| 35. | Materials of all building components as specified | Checklist | |
| 36. | Heating energy demand | Design calculation | Some countries assess heating and cooling energy separately |
| 37. | Cooling energy demand | Design calculation | Some countries assess heating and cooling energy separately |
| 38. | Energy Performance | Design calculation | From dynamic thermal simulation using specified software |
| 39. | Ventilation fan efficiency | Manufacturer's data | Fan power required for a specific ventilation rate |

| Number | Target | Parameters | Notes |
|---|---|---|---|
| 40. | Heat recovery ventilation efficiency | Manufacturer's data | |
| 41. | Air permeability walls | Manufacturer's and design data | Cannot easily be measured in situ |
| 42. | Air permeability roofs & floors | Manufacturer's and design data | Cannot easily be measured in situ |
| 43. | Air permeability windows | Manufacturer's and design data | Cannot easily be measured in situ |
| 44. | Air permeability partitions | Manufacturer's and design data | Cannot easily be measured in situ |
| 45. | Frequency of overheating | Design calculation | From dynamic thermal simulation using specified software |
| 46. | Frequency of over humidity | Design calculation | From dynamic thermal simulation using specified software |
| 47. | Efficiency of gas/oil space heating system | Manufacturer's and design data | |
| 48. | Efficiency of gas / oil DHW system | Manufacturer's and design data | |
| 49. | Efficiency of biomass space heating system | Manufacturer's and design data | |
| 50. | Efficiency of secondary heating system | Manufacturer's and design data | |
| 51. | Efficiency of cooling system | Manufacturer's and design data | |
| 52. | Lighting efficiency | Manufacturer's and design data | |
| 53. | VEEI (Value of Energy Efficiency of the Installation) | Design calculation | |

# Annex A Key energy efficiency measures for new buildings

| | |
|---|---|
| **I** | ***Planning and Design*** |
| **1** | **Targets** |
| | Define building energy and resource and performance targets |
| **2** | **Design** |
| | Optimise Form = Surface Area to Volume ratio, RES assessment; optimise ventilation strategy, optimise common spaces |
| | Orientation |
| **II** | ***Building envelope*** |
| **3** | **Windows & doors: size, orientation, spec** |
| | Set up indicators (compulsory or optional, according to situation) |
| **4** | **Solar shading to reduce cooling load** |
| | Set up indicators (compulsory or optional, according to situation) |
| **5** | **Airtightness** |
| | Set up indicators (compulsory or optional, according to situation) |
| **6** | **Thermal Bridging** |
| | Set up indicators (compulsory or optional, according to situation) |
| **7** | **Optimise insulation of external envelope** |
| | Set up indicators (compulsory or optional, according to situation) |
| **III** | ***Mechanical and electrical services*** |
| **8** | **Ventilation** |
| | Install ventilation system to ensure minimum ACH |
| | Set up minimal efficiency target |
| **9** | **Heating, Cooling and DHW systems** |
| | Install efficiency of heating, hot water and cooling systems |
| | Set up minimal efficiency target |
| **10** | **Electric appliances** |
| | Install to most efficient appliances |
| | Install efficient light bulbs and tubes |
| | Set up minimal efficiency target |
| **11** | **Water services** |
| | Install efficient water services and fittings |
| | Set up minimal efficiency target |
| **12** | **Energy recovery** |
| | Install Energy recovery technology on all energy systems |
| | Set up minimal efficiency target |

| | |
|---|---|
| **13** | **Energy storage** |
| | Install energy storage systems |
| | Set up minimal energy storage capacity |
| **14** | **Renewable Energy systems** |
| | Install renewable energy systems |
| | Set up generation target |
| **15** | **All services** |
| | Commissioning of all services and BMS |
| | Adjust all services controls to minimise energy use |
| **IV** | ***Monitoring*** |
| **16** | Implement efficient management procedures with Monitoring and Targeting |
| | Install sensors and sub-metering energy management system |
| **V** | ***Soft Landings Framework*** |
| **17** | Use *Soft Landings Framework* or similar (including probably some indicators addressing user interaction) |
| | Implement awareness, education and training programme for energy efficiency |
| | Designate an energy manager (or a team) among the users |
| **VI** | ***Overall performance*** |
| **18** | (target definition above) |
| **VII** | ***Non-Energy Qualities + Technologies for better buildings*** |
| **19** | **Indoor Air Quality** |
| **20** | **Acoustic Quality** |
| **21** | **Use Smart Materials** |
| **22** | **Use BIM for information integration** |

# Annex B Key energy efficiency measures – design stage

| | |
|---|---|
| **I** | ***Planning and Design*** |
| **0** | **Check Design Team using *Integrated Design Process*** |
| | |
| **1** | Targets |
| | Energy use simulation / modelling at concept design stage |
| | **Check** that design fulfills targets |
| | |
| **2** | Design |
| | Energy use simulation / modelling at concept design stage |
| | **Check building** orientation optimises passive solar and site opportunities |
| | |
| **II** | Building envelope |
| **3** | Check if the design achieves the specified targets |
| | |
| **4** | Check passive solar heat gain Check design of solar shading effective for location |
| | **Check mode of operation** for solar shading (manual, auto or both) according to requirements |
| | |
| **5** | **Check** airtightness target is defined, check the strategy and the elements |
| | |
| **6** | Check thermal bridging detail calculations, completeness, technical correctness of critical details |
| | |
| **7** | Check U-value calculation of external envelope upgrades |
| | |
| **III** | **Mechanical and electrical services** |
| **8** | **Ventilation** |
| | Check ventilation system achieves air change standard |
| | **Check ventilation** system designed for energy efficiency (confirm efficiency is in line with energy simulations) |
| | |
| **9** | Heating, Cooling and DHW systems |
| | **Check efficiency of** upgrade design for heating, DHW, cooling, |
| | |
| **10** | Electric appliances |
| | **Check efficient** appliances have been selected |

| | |
|---|---|
| | Check efficiency of all light fittings: select most efficient fittings |
| | |
| **11** | **Water services** |
| | Check water conserving fittings have been selected |
| | |
| **12** | **Energy recovery** |
| | Check *design of* energy recovery systems for efficiency |
| | |
| **13** | Energy storage |
| | **Check energy storage** systems meet requirements |
| | |
| **14** | Renewable Energy systems |
| | **Check renewable energy systems integrated into design** |
| | Check that expected generation fulfils the target |
| | |
| **15** | All services |
| | Check the commissioning of all services and BMS |
| | Check adjustment of all service controls |
| | |
| **IV** | **Monitoring** |
| **16** | Check energy management and M&T programme developed |
| | Check design of energy monitoring system developed |
| | |
| **V** | **Soft Landings Framework** |
| **17** | Check *Soft Landings* or similar procedures developed for client and design team |
| | Check awareness, education and training programme developed |
| | Check that the energy manager has been designated |
| | |
| **VI** | **Overall performance** |
| **18** | Complete whole building energy simulation analysis and refine design in an iterative process |
| | Check the plausibility and consistency between energetic design, drawings and the specifications |
| | |
| **VII** | **Non-Energy Qualities + Technologies for better buildings** |
| **19** | Check IAQ standards or requirements beyond standards defined and specified |
| **20** | Check acoustic performance specification defined |
| **21** | Check 'smart' materials integrated into design |

| | |
|---|---|
| **22** | Integrate all of the above information in the BIM model |

# Annex C Key energy efficiency measures – construction stage

| | | Quality Check Method |
|---|---|---|
| **0** | **Check all site workers trained to use VCMP** | Online check of users |
| 1 | No check required | |
| 2 | No check required | |
| | Check the understanding of the procurement team relating to energy efficiency | Confirmation |
| | Check the availability of complete, consistent and updated information on-site | Confirmation |
| | **Building envelope** | |
| **3** | Check spec of glazing/windows and other transparent components delivered | Photo evidence/ Bar code scanning (opt.) |
| | Evidence of correct installation of windows/doors and other transparent components | Photo evidence (many) |
| **4** | Check solar shading systems installed correctly | Photo evidence |
| **5** | Evidence check of airtightness detail construction | visual check + pictures |
| | Check results of airtightness testing meet targets and action any necessary improvements | Pulse A/T tests |
| **6** | Evidence check of thermal bridging detail construction | Thermal Imaging/visual check + pictures |
| **7** | Evidence check of insulation installation | Thermal Imaging/visual check + pictures |
| | Check installed insulation achieves performance U-value | Thermal Imaging |
| | Check that product fulfils requirement | |
| **III** | **Mechanical and electrical services** | |
| **8** | **Ventilation** | |
| | Test airtightness of ventilation ducts and balance system | Flow balancing, A/T test |
| | Check ventilation system/installed correctly and ductwork airtight, check noise protection | A/T test, confirmation |
| **9** | **Heating, Cooling and DHW systems** | |
| | Check heating, cooling and DHW installed and commissioned correctly | Certificates of Performance |
| | Confirm that set point temperatures are as projected | |
| **10** | **Electric appliances** | |
| | Check correct appliances have been installed | Photo evidence |
| | Check correct fittings installed | Photo evidence |
| **11** | **Water services** | |
| | Check water conserving fittings have been installed correctly | Record of flow rates |

| | | |
|---|---|---|
| | Check that product fulfils requirement | Photo evidence |
| **12** | **Energy recovery** | |
| | Check energy recovery systems installed and commissioned correctly | Certificate of Performance |
| | Check that product fulfils requirement | Photo evidence |
| **13** | **Energy storage** | |
| | Check energy storage system correctly installed and commissioned | Certificate of performance |
| | Check that product fulfils requirement | Photo evidence |
| **14** | **Renewable Energy systems** | |
| | Check renewable energy systems installed correctly, certified if necessary | Certificate of performance |
| | Check that product fulfils requirement | Photo evidence |
| **15** | **All services** | |
| | Check correct equipment and BMS installed | Photo evidence |
| | Check control settings during commissioning | Record control settings |
| | Check that product fulfils requirement | |
| **IV** | **Monitoring** | |
| **16** | No check required for this item at this stage | No check |
| | Check sensors, sub-meters of monitoring system installed correctly | Photo evidence |
| | Check that product fulfils requirement | Photo evidence |
| **V** | **Soft Landings Framework** | |
| **17** | Check *Soft Landings* procedures implemented during commissioning and handover stages | Minutes of meetings |
| | No check required for this item at this stage | No check |
| **VI** | **Overall performance** | |
| **18** | During commissioning check BMS and energy use against simulation model | Report |
| | Check if the energy balance calculation updated with the as-built information and if the targets are still be met | Confirm |
| **VII** | **Non-Energy Qualities + Technologies for better buildings** | |
| **19** | Check IAQ of building before handover meets specified standard | B2S IAQ Sensor Test |
| **20** | Check spaces meet acoustic performance as they are finished | B2S Acoustic test |
| **21** | Check 'smart' materials sensors wired to monitoring system | Sensor performance check |
| **22** | Integrate all of the above information in the BIM model | Record checks in BIM |

# Annex D Key energy efficiency measures – occupation stage

| | | |
|---|---|---|
| **0** | | No check required |
| 1 | | No check required |
| **2** | | No check required |
| | **Building envelope** | |
| **3** | No check required for this item | No check required |
| **4** | Check angle of solar shading effective | Photo evidence in sunlight |
| **5** | | No check required |
| | Check airtightness after first year of occupation | B2S Pulse A/T test |
| **6** | Check with thermal imaging thermal bridges perform as designed | B2S Thermal Imaging |
| **7** | Check with thermal imaging no insulation is missing | B2S Thermal Imaging |
| | Check installed U-value of external envelope insulation | Monitored results |
| **III** | **Mechanical and electrical services** | |
| **8** | **Ventilation** | |
| | Check filters in ventilation system changed / washed after first 6 months | Maintenance check: photo evidence |
| | Check airtightness after first year of occupation | B2S Pulse A/T test |
| **9** | **Heating, Cooling and DHW systems** | |
| | Check with thermal imaging no insulation is missing | B2S Thermal Imaging |
| | Check seasonal commissioning of HVAC systems completed | Report on seasonal commissioning |
| **10** | **Electric appliances** | |
| | Check electrical consumption on all circuits via sub-meters and record | Monitored results |
| | No check at this stage | |
| **11** | **Water services** | |
| | Check water use by meter monthly and record consumption | Monitored results |
| **12** | **Energy recovery** | |
| | Check monitored performance of energy recovery systems | Monitored results |
| **13** | **Energy storage** | |
| | Check monitored performance of energy storage system | Monitored results |
| **14** | **Renewable Energy systems** | |
| | Check monitored performance of RE and all systems with M&T report | Monitored results |
| **15** | **All services** | |

| | | |
|---|---|---|
| | Check sensors and sub-meters working correctly and recalibrate after first year | Calibration testing by specialist |
| | Check control settings match use and BMS | No check required |
| **IV** | **Monitoring** | |
| **16** | Check monitoring data | Analysis and plausibility check |
| | Check M&T annual energy use report completed | Analysis and report |
| **V** | **Soft Landings Framework** | |
| **17** | Check occupants trained in *Soft Landings process or similar* | Minutes of Progress meetings |
| | Provide feedback to design team as part of *Soft Landings* process | *Soft Landings* reports / POE survey |
| **VI** | **Overall performance** | |
| **18** | Check M&T annual energy use report completed | Analysis and report |
| | Compare the actual with the designed performance and take action if not. | Document |
| | Check that actions are undertaken to correct deviations | Confirm |
| VII | **Non-Energy Qualities + Technologies for better buildings** | |
| **19** | Check IAQ of occupied building meets specified standard | B2S IAQ Sensor Test |
| **20** | Check spaces meet acoustic performance | B2S Acoustic test |
| **21** | Check 'smart' materials sensors sending data to monitoring system | Monitoring system report |
| **22** | Update BIM with all building information and changes | Use BIM as Asset Management Tool |

# Annex E Building regulations in partner countries

| Country | Sub group | Document |
|---|---|---|
| IRE | | Technical Guidance Document E – Sound<br>Technical Guidance Document F- Ventilation<br>Technical Guidance Document L- Conservation of Fuel and Energy – Dwellings<br>Technical Guidance Document L- Conservation of Fuel and Energy – Buildings other than Dwellings |
| UK (E&W) | New Dwelling | Approved Document L1A: conservation of fuel and power in new dwellings, |
| | Existing Dwelling | Approved Document L1B: conservation of fuel and power in existing dwellings, |
| | New other | Approved Document L2A: conservation of fuel and power in new buildings other than dwellings, |
| | Existing other | Approved Document L2B: conservation of fuel and power in existing buildings other than dwellings |
| Scot-land | Domestic | Technical Handbook 2016 Domestic – Part 6: Energy, Part 5: Noise, Part 3. Environment |
| | Non-Domestic | Technical Handbook 2016 Non-Domestic - Part 6: Energy, Part 5: Noise, Part 3. Environment |
| Northern Ireland | Domestic | Technical Booklet F1 - Conservation of fuel and power in dwellings, K – Ventilation, G - Resistance to the passage of sound |
| | Non-Domestic | Technical Booklet F2 - Conservation of fuel and power in buildings other than dwellings, K – Ventilation, G - Resistance to the passage of sound |
| Es | Domestic | Código Técnico de la Edificación (CTE) (Technical Building Code), Documento Básico HE Ahorro de Energía (DBHE) (Basic energy saving document) |
| | Non-Domestic | Reglamento Instalaciones Termicas en los Edificios (RITE) (Regulation of Thermal Installations in Buildings) |
| De | | |
| NL | | Netherlands Building Energy Regulations (English Translation) Chapter 5. Technical Building Regulations in terms of energy and environment, new construction |
| PH | | The Passivhaus Standard http://www.passivhaus.org.uk/standard.jsp?id=18 |
| I | | In Italy planning and building control as well as environmental matters, and so the system of regulation of sustainability aspects of construction, are in the competence of the 20 Regions. Of these, five regions (namely Sardinia, Sicily, Trentino-Alto Adige/Südtirol, Vale de Aosta and Friuli-Venezia Giulia) have a particular degree of legislative and financial autonomy. Trentino-Alto Adige/Südtirol is a special case and consists of two autonomous provinces within the region, Trento and Bolzano-Bozen, which have their own construction regulations (and special climatic factors due to their alpine geography). Optionally some buildings also comply with ITACA a sustainability certification protocol. http://www.itaca.org/valutazione_sostenibilita.asp |
| Fr | | Code de la construction et de l'habitation (or Building code is a general code which gives general definitions or rules. Numerous ministerial decrees give details on different aspects) https://www.legifrance.gouv.fr/affichCode.do?cidTexte=LEGITEXT000006074096&dateTexte=20131112 |

# Annex F Residential building regulation requirement in UK and Ireland

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ireland** | **Dwellings** | | | | | | **UK** | **Dwellings** | | | | | |
| | | | | | | | | | | | | | |
| Building Regulations Part L (Conservation of fuel and power) 2011 | **Maximum annual dwelling energy use** | 75 kWh/m²/pa | Calculation of total dwelling energy use using the national DEAP ( Dwelling Energy Assessment Procedure) software tool | *Building Energy Rating* certificate based on DEAP assessment proving compliance | kWh/m² | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | Dwelling fabric energy efficiency (DFEE) | DFEE must be no worse than the TFEE (target fabric energy efficiency) | Calculation of total dwelling energy use using the SAP 2012 software tool | SAP rating document | kg/m²/yr |
| Part L 2011 | **Maximum Permitted Energy Performance Coefficient (MPEPC)** | Maximum 0.4 | Calculation of total dwelling energy use using the national DEAP ( Dwelling Energy Assessment Procedure) software tool compared to reference dwelling | DEAP | ratio | | | | | | | | |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part L 2011 | **Maximum Permitted Carbon Performance Coefficient (MPCPC)** | Maximum 0.46 | Calculation of total dwelling carbn emissions using the national DEAP ( Dwelling Energy Assessment Procedure) software tool compared to reference dwelling | DEAP | ratio | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | Dwelling $CO_2$ emission rate (DER) | DER must be no worse than the TER (target $CO_2$ efficienct rate) | Calculation of total dwelling carbon emissions using the SAP 2012 software tool compared to the Notional Building | SAP rating document | |
| | | | | | | | | | | | | | |
| Part F 2009 | **Ventilation rate** | Various: P14 Part F | Air change rate | Ventilation design calculations | l/sec/person | | The Building Regulations 2010 as amended | Approved Document F Ventilation | Ventilation rate - extract ventilation | Various, Section 5 | Air change rate | | l/sec/person, ac/hr |
| | | | | | | | The Building Regulations 2010 as amended | Approved Document F Ventilation | Ventilation rate - whole dwelling ventilation rate | Various, Section 5 | Air change rate | | |
| Part F 2009 | **Purge ventilation** | Openable window 1/20th floor area | Calculation of window to floor area for each habitable room | Area calculation | | | The Building Regulations 2010 as amended | Approved Document F Ventilation | Purge ventilation | 4ac/hr (clause 5.7), may be by openable window - area of at least 1/10th of the floor area of the room | Calculation of window to floor area for each habitable room | | |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part L 2011 | **Heat Recovery Ventilation efficiency** | Specific Fan Power 1.5W/L/sec 66% Heat recovery efficiency | System Performance | Manufacturer's DOP (Declaration of Performance) | W/L/sec Seasonal heat recovery efficiency % | | The Building Regulations 2010 as amended | Domestic Building Services Compliance Guide | Heat recovery ventilation efficiency | Specific Fan Power 1.5W/L/sec 70% Heat recovery efficiency | System Performance | | |
| Part L 2011 | **Airtightness (permeability)** | Max 7 $m^3$/hr/$m^2$ airtightness | Air leakage at a pressure of 50Pa | Airtightness test to I.S. EN 13829: 2000 | $m^3$/hr/m1 | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | Air tightness (permeability) | Maximum value of 10$m^3$/hr/$m^2$, depending on assessment strategy | Air leakage at a pressure of 50Pa | Air tightness test in accordance with ATTMA publication 'Measuirng air permeability of building envelopes (dwellings)', plus equipment calibration certificates | $m^3$/hr/$m^2$ |
| Part L 2011 | **Thermal Bridging 'Y' value** | 0.15, 0.08 (default) or calculated W/$m^2$/k | Thermal Bridge calculations | Detail calculation by certified assessor | W/$m^2$/k | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | **Thermal Bridging 'Y' value** | 0.15W/$m^2$K (default) or calculated according to BR 497 | Thermal Bridge calculations | | W/$m^2$/K |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part L 2011 | **Thermal Bridging PSI value** | W/m²/k | Thermal Bridge calculations | Detail calculation by certified assessor | W/m²/k | | | | | | | | |
| Part L 2011 | **Internal Surface Temperature** | > 14°C | Thermal Bridge calculations | Detail calculation by certified assessor | °C | | | | | | | | |
| Part L 2011 | **Basement floor U-value** | 0.21 W/m²/k | U-value calculation | Calculated U-value to I.S. EN ISO 6946: | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | **Basement floor U-value** | 0.25 W/m²/k (floor value used as no specific value for basement floor) | U-value calculation using methodology described in BR 443 | | W/m²/K |
| Part L 2011 | **Basement wall U-value** | 0.21 W/m²/k | U-value calculation | Calculated U-value | | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | **Basement wall U-value** | 0.30 W/m²/k (wall value used as no specific value for basement wall) | U-value calculation using methodology described in BR 443 | | W/m²/K |
| Part L 2011 | **Ground Floor U-value** | 0.21 W/m²/k | U-value calculation | Calculated U-value | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | **Ground Floor U-value** | 0.25 W/m²/k | U-value calculation using methodology described in BR 443 | | W/m²/K |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part L 2011 | **Wall U-value** | 0.21 W/m²/k | U-value calculation | Calculated U-value | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | **Wall U-value** | 0.30 W/m²/k | U-value calculation using methodology described in BR 443 | | W/m²/K |
| Part L 2011 | **Door U-value** | 1.6 W/m²/k | U-value calculation | Manufacturer's DOP | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | **Door U-value** | 2.0 W/m²/k | U-value calculation using methodology described in BR 443 | | W/m²/K |
| Part L 2011 | **Window U-value** | 1.6 W/m²/k | U-value calculation | Manufacturer's DOP | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | **Window U-value** | 2.0 W/m²/k | U-value calculation using methodology described in BR 443 | | W/m²/K |
| Part L 2011 | **Pitched roof U-value** | 0.16 W/m²/k | U-value calculation | Calculated U-value | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | **Pitched roof U-value** | 0.20 W/m²/k | U-value calculation using methodology described in BR 443 | | W/m²/K |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part L 2011 | **Flat roof U-value** | 0.20 W/m²/k | U-value calculation | Calculated U-value | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | **Flat roof U-value** | 0.20 W/m²/k | U-value calculation using methodology described in BR 443 | | W/m²/K |
| Part L 2011 | **Roof window U-value** | 1.6 W/m²/k | U-value calculation | Manufacturer's DOP | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L1A Conservation of fuel and power in new dwellings, 2013 edition | **Roof window U-value** | 2.0 W/m²/k | U-value calculation using methodology described in BR 443 | | W/m²/K |
| Part L 2011 | **Efficiency of gas/oil space heating system** | 90% | % Seasonal Efficiency | Manufacturer's DOP | % | | The Building Regulations 2010 as amended | Domestic Building Services Compliance Guide | Efficiency of gas/oil fired space heating and domestic hot water systems | Gas and oil fired condensing boilers - 88% | % Seasonal Efficiency | SEDBUK 2009 listing | % |
| Part L 2011 | **Efficiency of gas / oil DHW system** | 90% | % Seasonal Efficiency | Manufacturer's DOP | % | | | | | | | | |
| Part L 2011 | **Efficiency of biomass space heating system** | 77% | % Seasonal Efficiency | Manufacturer's DOP | % | | The Building Regulations 2010 as amended | Domestic Building Services Compliance Guide | Efficiency of biomass space heating systems | Various from 65% to 75% (Table 21) | % Seasonal Efficiency | HETAS approved products list | % |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part L 2011 | **Efficiency of secondary heating system** | varies | % Seasonal Efficiency | Manufacturer's DOP | % | | The Building Regulations 2010 as amended | Domestic Building Services Compliance Guide | Efficiency of biomass secondary space heating systems | Various from 65% to 75% (Table 21) | % Seasonal Efficiency | HETAS approved products list | % |
| Part L 2011 | **Heating Controls** | Min 3 zone programmable controls | | Manufacturer's DOP | | | The Building Regulations 2010 as amended | Domestic Building Services Compliance Guide | Heating controls | Boiler and pump switch off on no heat demand; zone valves for each heating circuit; time and temperature controls for hot water | | | |
| Part L 2011 | **Renewable energy requirement** | | | | | | | | | | | | |
| Part L 2011 | **Renewable thermal energy** | 10 kWh/m²/pa | Calculation of system performance | Manufacturer's DOP | kWh/m²/pa | | The Building Regulations 2010 as amended | Domestic Building Services Compliance Guide | As part of overall DER/SAP calculations | | As part of overall DER/SAP calculations | | kWh/m²/pa |
| | | *and / or / with* | | | | | | | | | | | |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part L 2011 | **Renewable electricity** | 4 kWh/m²/pa | Calculation of system performance | Manufacturer's DOP | kWh/m²/pa | | The Building Regulations 2010 as amended | Domestic Building Services Compliance Guide | As part of overall DER/SAP calculations | | As part of overall DER/SAP calculations | | kWh/m²/pa |
| | | | | | | | | | | | | | |
| | **Indoor Environmental Quality** | | | | | | | | **Indoor Environmental Quality** | | | | |
| Part E 2014 | **Acoustic** | | | | | | The Building Regulations 2010 as amended | Approved Document E Resistance to the passage of sound, 2003 edition incorporating 2004, 2010, 2013 and 2015 amendments | **Acoustic** | | | | |
| | **Separating Walls** | Airborne sound : 53 dB min DnT,w | | Independent acoustic test report | dB | | The Building Regulations 2010 as amended | Approved Document E Resistance to the passage of sound, 2003 edition incorporating 2004, 2010, 2013 and 2015 amendments | **Separating Walls** | Airborne sound: 45DnT,W + Ctr dB (minimum value) | | Independent acoustic test report | dB |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Separating Floors** | Airborne sound : 53 dB min DnT,w | | Independent acoustic test report | dB | | The Building Regulations 2010 as amended | Approved Document E Resistance to the passage of sound, 2003 edition incorporating 2004, 2010, 2013 and 2015 amendments | **Separating Floors** | Airborne sound: 45DnT,W + Ctr dB (minimum value) | | Independent acoustic test report | dB |
| | | Impact sound : 58 dB max L'nT,w | | Independent acoustic test report | dB | | The Building Regulations 2010 as amended | Approved Document E Resistance to the passage of sound, 2003 edition incorporating 2004, 2010, 2013 and 2015 amendments | | Impact sound : 62 dB max L'nT,w (maximum value) | | Independent acoustic test report | dB |
| | | | | | | | | | | | | | |
| Part F 2009 | **Indoor Air Quality** | Ventilation requirements of Part F | Ventilation specification | | | | The Building Regulations 2010 as amended | Approved Document F Ventilation | **Indoor Air Quality** | Ventilation requirements of Approved Document F | | | |

NOTES 1. An empty field means either we don't have a requirement for a particular issue, or I don't know what evidence is required to satisfy the requirement.

# Annex G Non-domestic building regulation requirement in UK and Ireland

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ireland** | **Non Domestic Buildings** | | | | | | **UK** | **Non Domestic Buildings** | | | | | |
| | | | | | | | | | | | | | |
| Building Regulations Part L (Conservation of fuel and energy, Non-domestic buildings) 2011 | **Maximum annual building energy use** | kWh/m²/pa | Calculation of total building energy use using the national NEAP (Non-Domestic Energy Assessment Procedure) methodology | *Building Energy Rating* certificate from NEAP methodology | kWh/m²/pa | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | Minimum energy performance requirement expressed in terms of the mass of $CO_2$ emitted per year per square metre of the total useful floor area | BER must be no worse than the TER (target $CO_2$ efficienct rate) | Calculation of total dwelling carbon emissions using the SBEM (Simplified Building Energy Model) software tool compared to the Notional Building | SBEM rating document | $kgCO_2/m^2/pa$ |
| Part L 2011 | **Maximum annual carbon emissions** | $kgCO_2/m^2/pa$ | Result from NEAP/SBEM or simulation software | BER certificate from NEAP methodology | $kgCO_2/m^2/pa$ | | | | | | | | |
| Part L 2011 | **Maximum Permitted Energy Performance Coefficient (MPEPC)** | 1.0 | Calculation of total building energy use using the national NEAP methodology | NEAP (Non-Domestic Energy Assessment Procedure) | ratio | | | | | | | | |
| Part L 2011 | **Maximum Permitted** | 1.0 | Calculation of total building | NEAP | ratio | | | | | | | | |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Carbon Performance Coefficient (MPCPC)** | | energy use using the national NEAP methodology | | | | | | | | | | |
| CIBSE | **Ventilation rate** | Min. 8 L/sec/person Depends on building type | Air change rate | Ventilation design calculations | l/sec/person | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | Ventilation rate | 10l/s/person for offices | | | l/s/person |
| Part L 2011 | **Airtightness (permeability)** | Varies to achieve NEAP | Air leakage at a pressure of 50Pa | Airtightness test to I.S. EN 13829: 2000 | $m^3/hr/m1$ | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | Air tightness (permeability) | Maximum value of $10m^3/hr/m^2$, depending on assessment strategy | Air leakage at a pressure of 50Pa | Air tightness test in accordance with ATTMA publication 'Measuirng air permeability of building envelopes' including test results report, plus equipment calibration certificates | $m^3/hr/m^2$ |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part L 2011 | **Thermal Bridging 'Y' value** | Not yet included in NEAP | Thermal Bridge calculations | Detail calculation by certified assessor | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | **Thermal Bridging 'Y' value** | Calculated according to BR 497 | Thermal Bridge calculations | Demonstration calculation | W/m²/K |
| Part L 2011 | **Thermal Bridging PSI value** | Not yet included in NEAP | Thermal Bridge calculations | Detail calculation by certified assessor | W/m²/k | | | | | | | | |
| Part L 2011 | **Internal Surface Temperature** | Not yet included in NEAP | Thermal Bridge calculations | Detail calculation by certified assessor | °C | | | | | | | | |
| Part L 2011 | **Daily Solar Heat Gain** | 25 W/m² | U-value calculation | Calculated U-value to I.S. EN ISO 6946: | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | Limiting the effects of solar gains in summer | No worse than the stated reference glazing cases (paragraph 2.53), calculated in accordance with BS EN 410 | Calculations in accordance with BS EN 410 | Demonstration calculation | W/m²/k |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part L 2011 | **Floor U-value** | 0.37 W/m²/k | U-value calculation | Calculated U-value | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | **Floor U-value** | 0.25 W/m²/k | U-value calculation using methodology described in BR 443 | Calculated U-value | W/m²/k |
| Part L 2011 | **Wall U-value** | 0.27 W/m²/k | U-value calculation | Calculated U-value | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | **Wall U-value** | 0.35 W/m²/k | U-value calculation using methodology described in BR 443 | Calculated U-value | W/m²/k |
| Part L 2011 | **Door U-value** | 2.20 W/m²/k | U-value calculation | Manufacturer's DOP | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | **Door U-value** | 2.20 W/m²/k | U-value calculation using methodology described in BR 443 | Value provided by manufacturer | W/m²/k |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part L 2011 | **Window U-value** | 2.20 W/m²/k | U-value calculation | Manufacturer's DOP | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | **Window U-value** | 2.20 W/m²/k | U-value calculation using methodology described in BR 443 | Value provided by manufacturer | W/m²/k |
| Part L 2011 | **Pitched Roof U-value** | 0.20 W/m²/k | U-value calculation | Calculated U-value | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | **Pitched Roof U-value** | 0.25 W/m²/k | U-value calculation using methodology described in BR 443 | Calculated U-value | W/m²/k |
| Part L 2011 | **Flat Roof** | 0.22 W/m²/k | U-value calculation | Calculated U-value | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | **Flat Roof** | 0.25 W/m²/k | U-value calculation using methodology described in BR 443 | Calculated U-value | W/m²/k |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Part L 2011 | **Roof window U-value** | 2.20 W/m²/k | U-value calculation | Manufacturer's DOP | W/m²/k | | The Building Regulations 2010 as amended | Approved Document L2A Conservation of fuel and power in new buildings other than dwellings, 2013 edition | **Roof window U-value** | 2.20 W/m²/k | U-value calculation using methodology described in BR 443 | Value provided by manufacturer | W/m²/k |
| Part L 2011 | **Efficiency of heating/cooling system** | | % Seasonal Efficiency | Manufacturer's DOP | % | | The Building Regulations 2010 as amended | Non-Domestic Building Services Compliance Guide | Efficiency of heating and cooling systems | Boilers (thermal efficiency) - depending on type and capacity (Table 1) | % Seasonal Efficiency | Value provided by manufacturer | %/ratio |
| Part L 2011 | **Efficiency of DHW system** | | % Seasonal Efficiency | Manufacturer's DOP | % | | The Building Regulations 2010 as amended | Non-Domestic Building Services Compliance Guide | Efficiency of heating and cooling systems | Boilers (thermal efficiency) and chillers (energy efficiency ratio) - depending on type and capacity (Table 1) | % Seasonal Efficiency | Value provided by manufacturer | % |
| Part L 2011 | **Controls** | NEAP | | Manufacturer's DOP | | | The Building Regulations 2010 as amended | Non-Domestic Building Services Compliance Guide | Controls | Various depending on plant output (Table 5) | | Control strategy description in services report | |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | | Title of Regulation / Standard | Approved Document/ Compliance Guide | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CIBSE | **Indoor Air Quality** | CIBSE standards | Ventilation specification | | | | | | | | | | |

# Annex H Residential building regulation requirement in Spain

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| **DB HE Energy Efficiency** | | | | | | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-0_Limitation of the Energy Consumption | Limitation of the Energy Consumption | 1.Compliance with requirements of HE 0 section 2.2.1 Max. Non-renewable Primary Energy Consumption base value.<br>2.Compliance with requirements of HE 0 section 2.2.2The energy rating for nonrenewable energy consumption of primary energy indicator building at least B according as the basic procedure for certifying the energy efficiency of buildings approved by Royal Decree 235/2013, of 5 April. | | 1.Herramienta Unificada LIDER CALENER: HULC OFFICIAL SOFTWARE*<br>2. Certificado de Eficiencia energética *Building Energy Rating certificate proving compliance before and after construction. Hulc. Ce3. ce3x* | kW·h/m²·año |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-0 Limitation of the Energy Consumption (2.2.1 - Table2.1) | Non-renewable Primary Energy Consumption base value. It will vary depending on the winter climatic zone | 40 - 45 - 50 - 60- 70 KWh/m² a | Climatic zone, building use | | KWh/m² a |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-0 Limitation of the Energy Consumption (4.3 - Table 2.2) | Performance of heating production (natural gas) | 0.9 | Climatic zone, building use | | ratio |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-0 Limitation of the Energy Consumption (4.3 - Table2.2) | Performance of cooling production (electricity) | 2.0 | Climatic zone, building use | | ratio |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand | Limitation of the Energy Demand | Compliance with requirements of HE 1 Point 2 section 2.2.2.1Limitation of Energy Demand | | Herramienta Unificada LIDER CALENER: HULC OFFICIAL SOFTWARE* | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.1.1 - Table2.1) | Heating Energy Demand base value. It will vary depending on the winter climatic zone | 15 - 20 - 27 - 40 KWh/m² a | Climatic zone, building use | | KWh/m² a |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.1.1 - Table2.1) | Cooling Energy Demand base value. It will vary depending on the summer climatic zone | 15 - 20 KWh/m² a | Climatic zone, building use | | KWh/m² a |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | Air permeability of windows and doors (Airtightness). It will vary depending on the climatic zone | <50 or <27 m³/hr/m² | The permeability of the frames is the measure indicated with an overpressure of 100Pa. | UNE EN 12207 | m³/hr/m² |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (5.2.4) | Thermal Bridging | | | | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | U-vlaue of walls, floors and other elements in contact with the terrain. The U-value will vary depending on the climatic zone (the indicated value is required only the first meter of wall buried, or the first meter of soil perimeter resting on the ground to a depth of 0.50m) | 1.25 - 1.00 - 0.75 - 0.60 - 0.55 W/m²K | U-value calculation and climatic zone | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | Air permeability "α" of walls, floors and other elements in contact with the terrain | 1.35 m³/hr | | | m³/hr |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | U-vlaue of roofs and floors in contact with the air. The U-value will vary depending on the climatic zone | 0.80 - 0.65 - 0.50 - 0.40 - 0.35 W/m²K | U-value calculation and climatic zone | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | Air permeability "α" of roofs and floors in contact with the air | 1.20 m³/hr | | | m³/hr |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | U-vlaue of Windows (Include glazing and frame). The U-value will vary depending on the climatic zone | 5.70 - 4.20 - 3.10 - 2.70 - 2.50 W/m²K | U-value calculation and climatic zone | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | Air permeability "α" of windows | 5.70 m³/hr | | | m³/hr |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.4) | U-value of horizontal/vertical interior partitions between units of direrent use or common areas. The U-value will vary depending on the climatic zone | 1.25 - 1.10 - 0.95 - 0.85 - 0.70 W/m²K | U-value calculation and climatic zone | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.4) | Air permeability "α" of horizontal/vertical interior partitions between units of direrent use or common areas. | 1.35 m³/hr | | | m³/hr |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.5) | U-value of horizontal interior partitions between units of same use or common areas. The U-value will vary depending on the climatic zone | 1.80 - 1.55 - 1.35 - 1.20 - 1.00 W/m²K | U-value calculation and climatic zone | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.5) | Air permeability "α" of horizontal interior partitions between units of same use | 1.90 m³/hr | | | m³/hr |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.5) | U-value of vertical interior partitions between units of same use or common areas. The U-value will vary depending on the climatic zone | 1.40 - 1.20 - 1.00 W/m²K | U-value calculation and climatic zone | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.5) | Air permeability "α" of vertical interior partitions between units of same use | 1.40 m³/hr | | | m³/hr |
| | | Efficiency of gas/oil space heating system | | % Seasonal Efficiency | Manufacturer's DOP | % |
| | | Efficiency of gas / oil DHW system | | % Seasonal Efficiency | Manufacturer's DOP | % |
| | | Efficiency of biomass space heating system | | % Seasonal Efficiency | Manufacturer's DOP | % |
| | | Efficiency of secondary heating system | | % Seasonal Efficiency | Manufacturer's DOP | % |
| | | Heating Controls | | | Manufacturer's DOP | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-4 Minimum solar contribution to domestic hot water | Minimum solar contribution for DHW. | A minimum contribution of solar thermal zone function is set climate and the demand for ACS or pool heating the building. | | CHEQ4 OFFICIAL SOFTWARE* | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-4 Minimum solar contribution to domestic hot water (2.2.1 - Table 2.1) | Minimum solar contribuiton for DHW. It will vary depending on the climatic zone and the total DHW building demand | 30 - 40 - 50 - 60 - 70% | Climatic zone and Total DHW building demand | | % |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-4 Minimum solar contribution to domestic hot water (2.2.1 - Table 2.2) | Minimum solar contribution for indoor swimming-pools. It will vary depending on the climatic zone and the total DHW building demand | 31 - 50 - 60 - 70% | Climatic zone and Total DHW building demand | | % |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| | | | | | | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-3 Energy efficiency of a lighting installation (2.1 - Table 2.1) | Limit values of VEEI (Value of Energy Efficiency of the Installation). VEEI will vary depending on the building use | Vary between 3 and 10 W/m² | | | W/m² |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-3 Energy efficiency of a lighting installation (2.2- Table 2.2) | Maximum power of lighting. It will vary depending on the building use | Vary between 5 and 25 W/m³ | | | W/m³ |
| **DB- HS Indoor Environmental Quality** | | | | | | |
| CTE DB-HS (Código Técnico de la Edificación, Documento Básico, Salubridad) | HS-3 Indoor Air Quality | Indoor Air Quality | | | | |
| CTE DB-HS (Código Técnico de la Edificación, Documento Básico, Salubridad) | HS-3 Indoor Air Quality (table2.1) | Ventilation rate | Rooms: 5l/s, living rooms: 3l/s, kitchen: 0.7l/s/m², toilets: 15l/s each one | Air change rate | Ventilation design calculations | l/sec/person |
| CTE DB-HS (Código Técnico de la Edificación, Documento Básico, Salubridad) | HS-3 Indoor Air Quality | Purge ventilation | | | | |
| CTE DB-HS (Código Técnico de la Edificación, Documento Básico, Salubridad) | HS-3 Indoor Air Quality | Heat Recovery Ventilation efficiency | | System Performance | Manufacturer's DOP (Declaration of Performance) | W/L/sec Seasonal heat recovery efficiency % |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| **DB HR Acoustic Quality** | | | | | | |
| CTE DB-HR: DOCUMENTO BÁSICO HR PROTECCIÓN FRENTE AL RUIDO: September 2009 | (DB-HR: Basic document : Noise Protection) | Acoustic | 1. ACOUSTIC AIRBORNE SOUND INSULATION VALUES REACHED and LIMIT IMPACT SOUND VALUES NOT EXCEEDED<br>2. LIMIT REVERBERATION TIME VALUES NOT EXCEEDED<br>3. LIMITATION AND CONTROL OF VIBRATION AND NOISE OF FACILITIES | | DB-HR OFFICIAL SOFTWARE<br>Quality control checks during construction (Acoustic tests are not compulsory) | |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| CTE DB-HR: DOCUMENTO BÁSICO HR PROTECCIÓN FRENTE AL RUIDO: September 2009 | (DB-HR: Basic document : Noise Protection) Section 2,1 | 1.ACOUSTIC INSULATION | AIRBORNE SOUND:(Ra MINIMUM VALUE)<br>-Partition walls inside dwellings: Ra> 33dBA<br>-Elevator enclosure ( machinery in an indepent room): Ra> 50dBA<br>-Ducts in same use unit:<br>*Garage flue gas extraction: Ra>45dBA<br>* Ventilation HVAC ducts: Ra>33dBA<br>-Protected enclosures:<br>*With other Use unit protected or not:<br>50dBA opaque walls<br>30dBA doors /window in protected enclosure<br>20dBA doors /window in living enclosure<br>* With instalations or activity enclosures<br>55dBA walls without doors and windows<br>30dBA doors /window in living enclosure<br>* With exterior<br>Depending on Indice ruido día Ld *( Day noise Index Ld)*and Use of the building<br>betwen 30dBA and 47 dBA. *See Table 2,1 on DB HR*<br>-Living enclosures:<br>*With other Use unit protected or not :<br>45dBA opaque walls without doors and windows<br>50dBA opaque walls with doors and windows( residential and healthcare uses)<br>20dBA doors /window ( residential and healthcare uses)<br>* With instalations or activity enclosures<br>45dBA walls without doors and windows<br>50dBA opaque walls with doors and windows( residential and healthcare uses)<br>20dBA doors /window ( residential and healthcare uses)<br>* With other buildings<br>40dBA in each of the building enclosure<br>50dBA in both buildings enclosure toghether | | | dBA |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| | | | IMPACT SOUND: ( MAX VALUE)<br>- Protected enclosures:<br>*With other Use unit : 65 dB max L'nT,w (maximum value)<br>* With instalations or activity enclosures : 60 dB max L'nT,w (max value)<br>- Living enclosures:<br>* With instalations or activity enclosures : 60 dB max L'nT,w (maxi value) | | | dBA |
| CTE DB-HR: DOCUMENTO BÁSICO HR PROTECCIÓN FRENTE AL RUIDO: September 2009 | (DB-HR: Basic document : Noise Protection) APARTADO 2,2 | 2.REVERBERATION TIME VALUES | Common areaadjacent to protected enclosures with doors sharing sound absorption such area,A > 0.2 m² per m³ of enclosure volume. | | | b)m² per m³ of enclosure volume. |
| CTE DB-HR: DOCUMENTO BÁSICO HR PROTECCIÓN FRENTE AL RUIDO: September 2009 | (DB-HR: Basic document : Noise Protection) APARTADO 2,3 | 3 . NOISE AND DESIGN OF INSTALATIONS | 1 Levels of noise and vibration are limited facilities that can transmit to the enclosures protected and habitable building through fasteners or those contact points with the construction elements.<br>2 Maximum sound power level of the stationary noise generating equipment located in enclosures of facilities and grids shall be such that the levels are met immission in adjacent enclosures, expressed in the regulatory development of Law Noise 37/2003.<br>3 Maximum sound power level of equipment in indoor and outdoor areas attached, such will be in the machine's environment and the living and protected enclosures are not exceeded targets corresponding sound quality.<br>4 In addition to the specifications of paragraphs 3.3, 3.1.4.1.2, 3.1.4.2.2 and 5.1.4 will be considered | | | |

# Annex I Non-domestic building regulation requirement in Spain

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| **DB HE Energy Efficiency** | | | | | | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | **HE-0_Limitation of the Energy Consumption** | **Limitation of the Energy Consumption** | **1.Compliance with requirements of HE 0 section 2.2.1** Max. Non-renewable Primary Energy Consumption base value. **2.Compliance with requirements of HE 0 section 2.2.2**The energy rating for nonrenewable energy consumption of primary energy indicator building at least B according as the basic procedure for certifying the energy efficiency of buildings approved by Royal Decree 235/2013, of 5 April. | | **1.Herramienta Unificada LIDER CALENER: HULC OFFICIAL SOFTWARE*** **2. Certificado de Eficiencia energética** ***Building Energy Rating certificate proving compliance before and after construction. Hulc. Ce3. ce3x*** | kW·h/m²·año |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-0 Limitation of the Energy Consumption (2.2.1 - Table2.1) | **Non-renewable Primary Energy Consumption base ratio. It will vary depending on the winter climatic zone** | ≥45 KWh/m² a | | | KWh/m² a |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-0 Limitation of the Energy Consumption (4.3 - Table 2.2) | **performance of heating production (natural gas)** | 0.9 | | | ratio |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-0 Limitation of the Energy Consumption (4.3 - Table2.2) | **performance of cooling production (electricity)** | 2.0 | | | ratio |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | **HE-1 Limitation of the Energy Demand** | **Limitation of the Energy Demand** | Compliance with requirements of **HE 1 Point 2 section 2.2.2.1**Limitation of Energy Demand | | **Herramienta Unificada LIDER CALENER: HULC OFFICIAL SOFTWARE*** | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.1.1 - Table2.1) | **Heating Energy Demand base value. It will vary depending on the winter climatic zone** | 15 - 20 - 27 - 40 KWh/m² a | | | KWh/m² a |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.1.1 - Table2.1) | **Cooling Energy Demand base value. It will vary depending on the winter climatic zone** | 15 - 20 KWh/m² a | | | KWh/m² a |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.1.2 - Table2.2) | **% of Minimum savings for both, Heating and Cooling, Energy Demand compared to a reference building. It will vary depending on the winter climatic zone** | 0 - 10 - 15 - 20 - 25 % | | | % |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (5.2.4) | **Thermal Bridging** | | | | |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | **U-vlaue of walls, floors and other elements in contact with the terrain. The U-value will vary depending on the climatic zone (the indicated value is required only the first meter of wall buried, or the first meter of soil perimeter resting on the ground to a depth of 0.50m)** | 1.25 - 1.00 - 0.75 - 0.60 - 0.55 W/m²K | U-value calculation | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | **Air permeability "α" of walls, floors and other elements in contact with the terrain** | 1.35 W/m²K | | | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | **U-vlaue of roofs and floors in contact with the air. The U-value will vary depending on the climatic zone** | 0.80 - 0.65 - 0.50 - 0.40 - 0.35 W/m²K | U-value calculation | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | **Air permeability "α" of roofs and floors in contact with the air** | 1.20 W/m²K | | | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | **U-vlaue of Windows (Include glazing and frame). The U-value will vary depending on the climatic zone** | 5.70 - 4.20 - 3.10 - 2.70 - 2.50 W/m²K | U-value calculation | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.3) | **Air permeability "α" of windows** | 5.70 W/m²K | | | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.4) | **U-value of horizontal/vertical interior partitions between units of direrent use or common areas. The U-value will vary depending on the climatic zone** | 1.25 - 1.10 - 0.95 - 0.85 - 0.70 W/m²K | U-value calculation | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.4) | **Air permeability "α" of horizontal/vertical interior partitions between units of direrent use or common areas.** | 1.35 W/m²K | | | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.5) | **U-value of horizontal interior partitions between units of same use or common areas. The U-value will vary depending on the climatic zone** | 1.80 - 1.55 - 1.35 - 1.20 - 1.00 W/m²K | U-value calculation | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.5) | **Air permeability "α" of horizontal interior partitions between units of same use** | 1.90 W/m²K | | | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.5) | **U-value of vertical interior partitions between units of same use or common areas. The U-value will vary depending on the climatic zone** | 1.40 - 1.20 - 1.00 W/m²K | U-value calculation | Calculation of the U-value with the materials Manufacturer's U-value | W/m²K |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-1 Limitation of the Energy Demand (2.2.1.2 - Table2.5) | **Air permeability "α" of vertical interior partitions between units of same use** | 1.40 W/m²K | | | W/m²K |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | **HE-4 Minimum solar contribution to domestic hot water** | **Minimum solar contribution for DHW.** | A minimum contribution of solar thermal zone function is set climate and the demand for ACS or pool heating the building. | | **CHEQ4 OFFICIAL SOFTWARE*** | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-4 Minimum solar contribution to domestic hot water (2.2.1 - Table 2.1) | **Minimum solar contribuiton for DHW. It will vary depending on the climatic zone and the total DHW building demand** | 30 - 40 - 50 - 60 - 70% | Climatic zone and Total DHW building demand | | % |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | **HE-3 Energy efficiency of a lighting installation** | **Limit values of VEEI (Value of Energy Efficiency of the Installation).** | | | **Project documents** | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-3 Energy efficiency of a lighting installation (2.1 - Table 2.1) | **Limit values of VEEI (Value of Energy Efficiency of the Installation). VEEI will vary depending on the building use** | Vary between 3 and 10 W/m² | | | W/m² |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-3 Energy efficiency of a lighting installation (2.2- Table 2.2) | **Maximum power of lighting. It will vary depending on the building use** | Vary between 5 and 25 W/m³ | | | W/m³ |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | **HE-5 Minimum pv contribution for electricity production** | **pv contribution for electricity production** | | | **Project documents** | |
| CTE DB-HE (Código Técnico de la Edificación, Documento Básico, Ahorro de Energía) | HE-5 Minimum pv contribution for electricity production (2.2.1) | **pv contribution for electricity production** | Power Installation of PV panels when the building surface is >5000m² (KW) | building surface and a climatic coeficient | | KW |
| **DB- HS Indoor Environmental Quality** | | | | | | |
| CTE DB-HS (Código Técnico de la Edificación, Documento Básico, Salubridad) and RITE (Reglamento de Instalaciones térmicas de los edificios) | HS-3 Indoor Air Quality | **Indoor Air Quality** | | | | |
| CTE DB-HS (Código Técnico de la Edificación, Documento Básico, Salubridad) | HS-3 Indoor Air Quality (table2.1) | **Ventilation rate** | Parkings:120/unit, storage rooms:0.7l/s/m², warehouses:10l/s/m², | Air change rate | Ventilation design calculations | l/sec/person |
| CTE DB-HS (Código Técnico de la Edificación, Documento Básico, Salubridad) | HS-3 Indoor Air Quality | Purge ventilation | | | | |

| Title of Regulation / Standard | Document paragraph | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric |
|---|---|---|---|---|---|---|
| CTE DB-HS (Código Técnico de la Edificación, Documento Básico, Salubridad) | HS-3 Indoor Air Quality | Heat Recovery Ventilation efficiency | | System Performance | Manufacturer's DOP (Declaration of Performance) | W/L/sec Seasonal heat recovery efficiency % |
| **DB HR Acoustic Quality** | | | | | | |
| CTE DB-HR: DOCUMENTO BÁSICO HR PROTECCIÓN FRENTE AL RUIDO: September 2009 | (DB-HR: Basic document : Noise Protection) | Acoustic | 1. ACOUSTIC AIRBORNE SOUND INSULATION VALUES REACHED and LIMIT IMPACT SOUND VALUES NOT EXCEEDED<br>2. LIMIT REVERBERATION TIME VALUES NOT EXCEEDED<br>3. LIMITATION AND CONTROL OF VIBRATION AND NOISE OF FACILITIES | | | DB-HR OFFICIAL SOFTWARE Quality control checks during construction (Acoustic tests are not compulsory) |

| | | | | | |
|---|---|---|---|---|---|
| CTE DB-HR: DOCUMENTO BÁSICO HR PROTECCIÓN FRENTE AL RUIDO: September 2009 | (DB-HR: Basic document : Noise Protection) Section 2,1 | 1.ACOUSTIC INSULATION | AIRBORNE SOUND:(Ra MINIMUM VALUE)<br>-Partition walls inside dwellings: Ra> 33dBA<br>-Elevator enclosure ( machinery in an indepent room): Ra> 50dBA<br>-Ducts in same use unit:<br>*Garage flue gas extraction: Ra>45dBA<br>* Ventilation HVAC ducts: Ra>33dBA<br>-Protected enclosures:<br>*With other Use unit protected or not:<br>50dBA opaque walls<br>30dBA doors /window in protected enclosure<br>20dBA doors /window in living enclosure<br>* With instalations or activity enclosures<br>55dBA walls without doors and windows<br>30dBA doors /window in living enclosure<br>* With exterior<br>Depending on Indice ruido día Ld ( Day noise Index Ld)and Use of the building<br>betwen 30dBA and 47 dBA. See Table 2,1 on DB HR<br>-Living enclosures:<br>*With other Use unit protected or not :<br>45dBA opaque walls without doors and windows<br>50dBA opaque walls with doors and windows( residential and healthcare uses)<br>20dBA doors /window ( residential and healthcare uses)<br>* With instalations or activity enclosures<br>45dBA walls without doors and windows<br>50dBA opaque walls with doors and windows( residential and healthcare uses)<br>20dBA doors /window ( residential and healthcare uses)<br>* With other buildings<br>40dBA in each of the building enclosure<br>50dBA in both buildings enclosure toghether | | dBA |
| | | | **IMPACT SOUND: ( MAX VALUE)**<br>**- Protected enclosures:**<br>*With other Use unit : 65 dB max L'nT,w (maximum value)<br>* With instalations or activity enclosures : 60 dB max L'nT,w (maximum value)<br>**- Living enclosures:**<br>* With instalations or activity enclosures : 60 dB max L'nT,w (maximum value) | | dBA |

| | | | | | | |
|---|---|---|---|---|---|---|
| CTE DB-HR: DOCUMENTO BÁSICO HR PROTECCIÓN FRENTE AL RUIDO: September 2009 | (DB-HR: Basic document : Noise Protection) APARTADO 2,2 | 2.REVERBERATION TIME VALUES | A) Envelope of conference room, a dining room and a restaurant, have sufficient sound absorption such that:<br>a) reverberation time in classrooms and conference rooms empty (unoccupied and unfurnished) whose volume is less than 350 $m^3$, no greater than 0.7 s.<br>b) The reverberation time in classrooms and conference rooms empty, but including total of the seats, the volume is less than 350 $m^3$, no greater than 0.5 s.<br>c) The reverberation time in empty restaurants and canteens will not be greater than 0.9 s.<br>B)common area of a residential building,public, educational and hospital adjacent to protected enclosures with doors sharing sound absorption such area,A > 0.2 $m^2$ per $m^3$ of enclosure volume. | | | a) s.<br>b) $m^2$ per $m^3$ of enclosure volume. |
| CTE DB-HR: DOCUMENTO BÁSICO HR PROTECCIÓN FRENTE AL RUIDO: September 2009 | (DB-HR: Basic document : Noise Protection) APARTADO 2,3 | 3 . NOISE AND DESIGN OF INSTALATIONS | 1,Levels of noise and vibration are limited facilities that can transmit to the enclosures protected and habitable building through fasteners or those contact points with the construction elements.<br>2 Maximum sound power level of the stationary noise generating equipment located in enclosures of facilities and grids shall be such that the levels are met immission in adjacent enclosures, expressed in the regulatory development of Law Noise 37/2003.<br>3 Maximum sound power level of equipment in indoor and outdoor areas<br>attached, such will be in the machine's environment and the living and protected enclosures are not exceeded targets corresponding sound quality.<br>4 In addition to the specifications of paragraphs 3.3, 3.1.4.1.2, 3.1.4.2.2 and 5.1.4 will be considered | | | |

# Annex J Passivhaus

PH criteria: http://passivehouse.com/downloads/03_building_criteria_en.pdf EnerPHit DWELLINGS RETROFITS CENTRAL EUROPE: COOL-TEMPERATE CLIMATE

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | Comment |
|---|---|---|---|---|---|---|
| 1. | **Efficiency results** | | | | | |
| PH Criteria | Heating demand | 25 kWh/(m²a) | | PH Criteria 2.2 | kWh/(m²a) | Reference area: TFA (according to PHPP manual) |
| PH Criteria | Heating load | - | | | W/m² | Reference area: TFA (according to PHPP manual) |
| PH Criteria | Cooling & dehum. demand | ≤ 15 kWh/(m²a) + dehumid. | Only for active cooling | PH Criteria 2.1 | kWh/(m²a) | Reference area: TFA (according to PHPP manual) |
| PH Criteria | Cooling load | - | | | W/m² | Reference area: TFA (according to PHPP manual) |
| PH Criteria | Frequency of overheating (> 25 °C) | ≤ 10% | Only for passive cooling | PH Criteria 2.1 | % | Of the whole time! |
| PH Criteria | Frequency of excessively high humidity (> 12g/kg) | ≤ 20% | Only for passive cooling | PH Criteria 2.1 | % | Of the whole time! |
| PH Criteria | Frequency of excessively high humidity (> 12g/kg) | ≤ 10% | Only for active cooling | PH Criteria 2.1 | % | Of the whole time! |
| PH Criteria | PER demand | ≤ 60 kWh/(m²a) + minor efficiency topup | Renewable Primary Energy | PH Criteria 2.2 | kWh/(m²a) | Including heating, DHW, auxiliary and household appliances! Reference area: TFA (according to PHPP manual) |
| PH Criteria | PE demand | ≤ 95 kWh/(m²a) + minor efficiency topup | alternatively: Primary Energy | PH Criteria 2.2 | kWh/(m²a) | Including heating, DHW, auxiliary and household appliances! Reference area: TFA (according to PHPP manual) |
| | | | | | | |
| 2. | **Ventilation parameters** | | | | | |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | Comment |
|---|---|---|---|---|---|---|
| recommendation | Ventilation rate | 0.3 | Air change rate | Ventilation design calculations | m³/h | Recommendation, can be a bit higher or lower Reference volume: TFA * 2,50m |
| recommendation | Purge ventilation | 0.3 | Air change rate | Ventilation design calculations | m³/h | Side calculation for summer ventilation: Openable windows in the building |
| PH Criteria | Ventilation Heat Recovery Efficiency | 75% | Heat recovery efficiency of the ventilation unit | PH Criteria 2.4.1 | % | According to PHI certification criteria of ventilation systems: http://passivehouse.com/downloads/03_Reqs_and_testing_procedures_ventilation_en.pdf |
| PH Criteria | Specific efficiency | 0.45 | Electric efficiency of the ventilation unit | PH Criteria 2.4.1 | [Wh/m³] | According to PHI certification criteria of ventilation systems: http://passivehouse.com/downloads/03_Reqs_and_testing_procedures_ventilation_en.pdf |
| | **Energy recovery** | | **Humidity recovery** | | | |
| PH Criteria | Airtightness (permeability) | 1 | Air leakage at a pressure of 50Pa | PH Criteria 2.2 | 1/h | Reference volume is net building volume, not including construction volumes or suspended ceilings |
| | Net air volume for the pressure test | | Net air volumes | EN 13829:2000 | m³ | To clarify airtightness value, not including construction volumes or suspended ceilings |
| PH Criteria | Sound level of ventilation unit | ≤ 25 | supply air rooms in residential buildings, and bedrooms and recreational rooms | PH Criteria 2.4.4 | db(A) | |
| PH Criteria | Sound level of ventilation unit | ≤ 30 | other rooms in non-residential buildings and extract air rooms in residential buildings | PH Criteria 2.4.4 | db(A) | |
| | | | | | | |
| **3.** | **Minimum thermal protection** | | | | | |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | Comment |
|---|---|---|---|---|---|---|
| PH Criteria | Minimum temperature factor with $f_{RSI}$ = 0,25k/W | ≥ 0,70 | Hygiene criterion | PH Criteria 2.4.3 | ratio | In PH criteria it is implemented to guarantee for a) moisture/mould-free building elements and for comfortable surface temperatures |
| PH Criteria | Maximum thermal transfer coefficient (U-Value) for vertical windows | ≤ 0,85 | Thermal comfort | PH Criteria 2.4.3 | W/m²K) | In PH criteria it is implemented to guarantee for a) moisture/mould-free building elements and for comfortable surface temperatures |
| PH Criteria | Maximum thermal transfer coefficient (U-Value) for inclined windows | ≤ 1,00 | Thermal comfort | PH Criteria 2.4.3 | W/m²K) | In PH criteria it is implemented to guarantee for a) moisture/mould-free building elements and for comfortable surface temperatures |
| PH Criteria | Maximum thermal transfer coefficient (U-Value) for horizontal windows | ≤ 1,10 | Thermal comfort | PH Criteria 2.4.3 | W/m²K) | In PH criteria it is implemented to guarantee for a) moisture/mould-free building elements and for comfortable surface temperatures |
| **4.** | **Component parameters** | | | | | |
| | Thermal Bridging 'Y' value | 0.15, 0.08 (default) or calculated W/m²/k | Thermal Bridge calculations | Detail calculation by certified assessor | W/m²/k | ??? |
| Component recommendations | Thermal Bridging PSI value | ≤ 0,01 | Thermal Bridge calculations | EN ISO 10211 | W/(mK) | According to criteria of construction systems: http://passivehouse.com/downloads/03_certification_criteria_construction_systems_en.pdf |
| Component recommendations | Internal Surface Temperature | - | Thermal Bridge calculations | PH Criteria 2.4.3 | °C | Instead: Minimum temperature factor with fRSI = 0,25k/W |
| PH Criteria | Basement floor U-value | ≤ 0,25 | U-value calculation | EN ISO 6946 | W/(m²K) | Requirement for the average component quality (for the whole building) depending on the reduction factor calculated according to the properties of the floor slab/basement |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | Comment |
|---|---|---|---|---|---|---|
| PH Criteria | Basement wall U-value | ≤ 0,25 | U-value calculation | EN ISO 6946 | W/(m²K) | Requirement for the average component quality (for the whole building) depending on the reduction factor calculated according to the properties of the floor slab/basement |
| PH Criteria | Ground Floor U-value | ≤ 0,25 | U-value calculation | EN ISO 6946 | W/(m²K) | Requirement for the average component quality (for the whole building) depending on the reduction factor calculated according to the properties of the floor slab/basement |
| PH Criteria | Wall U-value | ≤ 0,15 | U-value calculation | EN ISO 6946 | W/(m²K) | Requirement for the average component quality (for the whole building) |
| PH Criteria | Pitched roof U-value | ≤ 0,15 | U-value calculation | EN ISO 6946 | W/(m²K) | Requirement for the average component quality (for the whole building) |
| PH Criteria | Flat roof U-value | ≤ 0,15 | U-value calculation | EN ISO 6946 | W/(m²K) | Requirement for the average component quality (for the whole building) |
| PH Criteria | Door U-value (installed) | ≤ 0,85 | U-value calculation | EN ISO 10077-2 | W/(m²K) | Requirement for the average component quality (for the whole building) |
| PH Criteria | Window U-value (installed) | ≤ 0,85 | U-value calculation | EN ISO 10077-2 | W/(m²K) | Requirement for the average component quality (for the whole building) |
| PH Criteria | Pitched roof window U-value (installed) | ≤ 1,00 | U-value calculation | EN ISO 10077-2 | W/(m²K) | Requirement for the average component quality (for the whole building) |
| PH Criteria | Flat roof window U-value (installed) | ≤ 1,10 | U-value calculation | EN ISO 10077-2 | W/(m²K) | Requirement for the average component quality (for the whole building) |
| 5. | **Heat generation systems** | | | | | |
| | Efficiency of gas/oil space heating system | No requirements | % Seasonal Efficiency | Manufacturer's DOP | % | No requirements for PH, as long as PE-value or PER-value targets are fulfilled |
| | Efficiency of gas / oil DHW system | No requirements | % Seasonal Efficiency | Manufacturer's DOP | % | No requirements for PH, as long as PE-value or PER-value targets are fulfilled |
| | Efficiency of biomass space heating system | No requirements | % Seasonal Efficiency | Manufacturer's DOP | % | No requirements for PH, as long as PE-value or PER-value targets are fulfilled |

| Title of Regulation / Standard | Parameter | Criteria | Data Requirement | Evidence of Compliance | Metric | Comment |
|---|---|---|---|---|---|---|
| | Efficiency of secondary heating system | No requirements | % Seasonal Efficiency | Manufacturer's DOP | % | No requirements for PH, as long as PE-value or PER-value targets are fulfilled |
| | Heating Controls | No requirements | | Manufacturer's DOP | | No requirements for PH, as long as PE-value or PER-value targets are fulfilled |
| 6. | **Renewable energy requirement** | | | | | |
| | Renewable thermal energy | No requirements | Calculation of system performance | Manufacturer's DOP | kWh/m²/pa | |
| | Renewable electricity | No requirements | Calculation of system performance | Manufacturer's DOP | kWh/m²/pa | |
| PH Criteria | Total renewable energy | ≥ 60 kWh/(m²$_{Ground}$a) | For PH classes plus or premium only! | PH Criteria 2.1 | kWh/(m²$_{Ground}$a) | IMPORTANT: Reference area is projected ground area of the building envelope! |
| 7. | Indoor Environmental Quality | | | | | no requirements for PH |
| | | | | | | |
| | **Acoustic** | | | | | |
| | Separating Walls | No requirements | | Independent acoustic test report | dB | No requirements for PH |
| | Separating Floors | No requirements | | Independent acoustic test report | dB | No requirements for PH |
| | | No requirements | | Independent acoustic test report | dB | No requirements for PH |
| | **Indoor Air Quality** | No requirements | Ventilation specification | | | No requirements for PH, as long as PE-value or PER-value targets are fulfilled |
| | **DHW requirements** | | | | | No requirements for PH, as long as PE-value or PER-value targets are fulfilled |

# Annex K Building checks that may be required

The Information about Building Regulations obtained from Project Partners in WP5.1 was converted into a spreadsheet summarising the Minimal Survey Data Set for partner countries.

The columns in this table contain information to assist in implementing the Minimal Survey Data Set. Where information was available and could be summarised in a few words or an equation the information is entered into the table. Where it is known that information exists, but it could not be easily summarised the cell in the table contains an 'X'.

### Column Headings

| | |
|---|---|
| N | Reference number |
| Target | Objective of obtaining this data |
| Parameters | What is assessed |
| Country requirement | Information about the requirement in each partner country |
| IRE | Ireland |
| UK | UK (England and Wales) |
| Sc | UK (Scotland) |
| Nl | UK (Northern Ireland) |
| Es | Spain |
| De | Germany |
| NL | Netherlands |
| PH | Passivhaus |

| | |
|---|---|
| I | Italy |
| Fr | France |
| Design | Can this be assessed at design stage? |
| Const. | Can this be assessed during construction |
| Notes | Additional information about the data |
| Minimal Survey Data Set | What is required for the Minimal Data Set |
| Method of post-construction assessment | How the assessment is made |

| | | | **Minimal Survey Data Set** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N** | **Target** | **Parameters** | **Country requirement** | | | | | | | | | | | | **Design** | **Const.** | **Notes** | **Minimal Survey Data Set** | **Method of post-construction assessment** |
| | | | **IRE** | **UK** | | | | **Sc** | **Nl** | **Es** | **De** | **NL** | **PH** | **I** | **Fr** | | | | | |
| 1 | Dimensions of all building fabric as specified | Specified Lengths > Dimensions | X | Number entry in metres, range 0-unlimited, 2dp | Number entry in metres, range 0-unlimited, 2dp | Number entry in metres, range 0-unlimited, 2dp | Number entry in metres, range 0-unlimited, 2dp | X | X | X | X | X | X | X | X | | X | | Dimensional Survey on site or BIM tolerances check throughout construction | Measurement using B2S methods from other work packages |

| | | | Minimal Survey Data Set | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N** | **Target** | **Parameters** | **Country requirement** | | | | | | | | | | | | **Design** | **Const.** | **Notes** | **Minimal Survey Data Set** | **Method of post-construction assessment** |
| | | | **IRE** | **UK** | | | | **Sc** | **Nl** | **Es** | **De** | **NL** | **PH** | **I** | **Fr** | | | | | |
| 3 | Maximum annual building energy use | Design calculation | MPEPC = 0.6 to 1.0, MPCPC = 0.69 to 1.0 calculated from DEAP software | Text and Number entry Building Energy Rating from A1-G | Text and Number entry Building Energy Rating from A1-G | Text and Number entry Building Energy Rating from A1-G | Text and Number entry Building Energy Rating from A1-G | X | EPN 0.4 to 2.6 | None | X | X | X | $E_{pgl,tot} < E_{pgl,tot\ ref\ building}$ | $C_{ep\ max} = 50 \cdot M_{ctype} \cdot (M_{cgéo} + M_{calt} + M_{csurf} + M_{cGES})$ | X | | There are different ways of calculating this. According to EPBD there should be a NCM in each Country. Limits depend on building type. Details from www.buildingsdata.eu | Energy rating from design calculation | The parameters that fed into the NCM Energy Performance calculation need to be checked. This will vary from country to country |
| 7 | Carbon emissions | Design calculation | | Number entry in $kg/CO_2/m^2/yr$, range from 0-120, one for DER rating (actual) and one for TER (target) | Number entry in $kg/CO_2/m^2/yr$, range from 0-120, for DER rating (actual) | Number entry in $kg/CO_2/m^2/yr$, range from 0-120, one for **B**ER rating (actual) and one for TER (target) | Number entry in $kg/CO_2/m^2/yr$, range from 0-120, for BER rating (actual) | X | | | X | | | | | X | | This is the main energy performance criterion in UK. It is calculated from the energy used for heating and cooling and the carbon emission factors for the fuels | NCM output | As above |

| | | | Minimal Survey Data Set | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N** | **Target** | **Parameters** | **Country requirement** | | | | | | | | | | | | **Design** | **Const.** | **Notes** | **Minimal Survey Data Set** | **Method of post-construction assessment** |
| | | | **IRE** | **UK** | | | | **Sc** | **Nl** | **Es** | **De** | **NL** | **PH** | **I** | **Fr** | | | | | |
| 8 | Indoor comfort temperature | | | | | | | | | | | | | | X | | X | | Spot check temperatures during acceptance test. Is each room being heated and cooled to the design temperature under appropriate conditions. This test may have to be repeated at different seasons | Spot check temperature reading |
| 9 | Indoor relative humidity | Sensor measurement | | | | | | | | | | | | | | | X | | Spot check RH sensor reading | As above |
| 10 | PMV (Predicted Mean Vote) | PMV comfort range | | | | | | | | | | | | | | | X | May be a Specification clause, but not Regulatory | Spot check PMV comfort calculation | In countries or with specifications where this is a requirement assess PMV using a system such as Testo 480 or Arvind HD32.3 -CV |
| 11 | Ventilation rate | Air extract rate at each terminal | X | Number in litres per second, expected range from 0-60, whole number | | Number in litres per second, expected range from 0-60, whole number | | X | X | X | X | | X | Natural: min 0,3 vol/h, Mechanical: min 39,6 m³/h | X | | X | Requirement for at least a specified rate of fresh air | Balometer reading of flow rate through each air terminal | Commissioning report showing flow rate through each terminal |

| | | | Minimal Survey Data Set | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N** | **Target** | **Parameters** | **Country requirement** | | | | | | | | | | | | **Design** | **Const.** | **Notes** | **Minimal Survey Data Set** | **Method of post-construction assessment** |
| | | | **IRE** | **UK** | | | | **Sc** | **Nl** | **Es** | **De** | **NL** | **PH** | **I** | **Fr** | | | | | |
| 12 | Purge ventilation | Air extract rate at each terminal | X | Boost values for mechanical ventilation and opening window areas for natural vent. | Boost values for mechanical ventilation and opening window areas for natural vent. | Boost values for mechanical ventilation and opening window areas for natural vent. | Boost values for mechanical ventilation and opening window areas for natural vent. | X | X | | X | | X | openable window > Floor area/10 | | | X | Requirement for at least a specified BOOST rate of fresh air | Balometer reading of flow rate through each air terminal | Commissioning report showing flow rate through each terminal |
| 15 | Building air permability | Air leakage rate at specified pressure, internal temperature, external temperature, wind speed, barometric pressure | 7 $m^3/h$ $m^2$ @ 50Pa | Number in $m^3/h$ $m^2$ @ 50Pa, Expected Range 0-30, 1dp | Number in $m^3/h$ $m^2$ @ 50Pa, Expected Range 0-30, 1dp | Number in $m^3/h$ $m^2$ @ 50Pa, Expected Range 0-30, 1dp | Number in $m^3/h$ $m^2$ @ 50Pa, Expected Range 0-30, 1dp | X | 1.44 ach @ 10Pa | 27 to 50 $m^3/h$ $m^2$ @100Pa | 3 ach @ 50Pa | | 0.6ach @ 50Pa | Not compulsory. Air leakage at 50Pa | 0.8 to 2.5 $m^3/h$ $m^2$ @ 4Pa | | X | Specified at different flow rates and pressures per square metre of surface. Surface area may or may not include floor area | Airtightness test | Airtightness test certificate from test conducted in Standard way: ISO 9972 or •ATTMA TSL1 September 2016 Edition – Air testing standard for residential dwellings •ATTMA TSL2 September 2010 Edition – Air testing standard for non-dwellings |

| | | | Minimal Survey Data Set | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N** | **Target** | **Parameters** | **Country requirement** | | | | | | | | | | | | **Design** | **Const.** | **Notes** | **Minimal Survey Data Set** | **Method of post-construction assessment** |
| | | | **IRE** | **UK** | | | | **Sc** | **Nl** | **Es** | **De** | **NL** | **PH** | **I** | **Fr** | | | | | |
| 20 | Thermal Bridging Psi value | Thermal image, Past 12 hours (internal temperature, external temperature, wind speed, solar radiation, rainfall) | X | Number in W/mK, expected range of 0-1, 2dp | | Number in W/mK, expected range of 0-1, 2dp | | X | X | | X | | X | X | | | X | Specified limit on maximum Psi value. Normally by testing standard detail or computer simulation. It could be measured in situ using thermal imaging | Have accredited details been used? Or advanced testing procedure | Thermal imaging with calculation of Psi value from surface temperatures in corners, around openings and thermal bridges. Accredited details have known psi values. |
| 21 | Thermal Bridging 'Y' value | Thermal image, as for Psi | X | 0.08 to 0.15 W/m²K | | | | X | X | | X | | | X | X | | X | Relates to the sum of Psi values multiplied by the length of detail where | Calculation from Psi values and building dimensions | Calculation from Psi values and building dimensions. Y= (ΣL x Ψ) / As where As = heat loss surface area |
| 22 | Internal Surface Temperature | Thermal image, as for Psi | | See Tables 1&2 in BRE IP 1/06 or manufacturer's data | See Tables 1&2 in BRE IP 1/06 or manufacturer's data | See Tables 1&2 in BRE IP 1/06 or manufacturer's data | See Tables 1&2 in BRE IP 1/06 or manufacturer's data | X | X | | | | X | X | | | X | Surface temperature factor (Tsi-To)/(Ti-To) specified to limit risk of condensation. Can be from computer simulation or thermal imaging in situ | Surface temperature spot checks using thermal imaging | Thermal imaging with calculation of TI or Fsi value from surface temperatures. Acceptable ranges are >0.9 for swimming pools, >0.75 for dwellings or schools and >0.5 for commercial buildings |

| | | | Minimal Survey Data Set | | | | | | | | | | | | | | | | |
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| **N** | **Target** | **Parameters** | **Country requirement** | | | | | | | | | | | | **Design** | **Const.** | **Notes** | **Minimal Survey Data Set** | **Method of post-construction assessment** |
| | | | **IRE** | **UK** | | | | **Sc** | **Nl** | **Es** | **De** | **NL** | **PH** | **I** | **Fr** | | | | | |
| 25 | Solar gain | Design calculation | X | Number in degrees C, expected range 0-35, 1dp | Number in degrees C, expected range 0-35, 1dp | Number in degrees C, expected range 0-35, 1dp | Number in degrees C, expected range 0-35, 1dp | | | | | | | | | X | X | From dynamic thermal simulation using specified software | Spot Check surface temperature of internal surfaces againt thermal model | Limits on solar gain are usually expressed as an upper temperature limit so the spot check should be done when there is maximum solar gain on the façade of the room being tested. |
| 26 | Basement floor U-value | Design calculation | 0.21 | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | X | 0.4 | X | X | | X | min. 0,24-0,44 | X | X | X | W/m²K. Complex range of limits dependant on building type in each country. Normally assessed by computer model, but in situ checks by thermal imaging or heat flux meter are possible | Heat flux meter reading or thermal imaging in accordance with ISO9869:2 | If required, U values can be measured, but method is time consuming, taking between 5 and 20 days |
| 27 | Basement wall U-value | Design calculation | 0.21 | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | X | 0.4 | | X | | X | min. 0,24-0,43 | X | X | X | | | |
| 28 | Ground Floor U-value | Design calculation | 0.21 | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | X | 0.4 | | X | | X | min. 0,24-0,44 | X | X | X | | | |
| 29 | Wall U-value | Design calculation | 0.21 | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | X | 0.4 | | X | | X | min. 0,24-0,43 | X | X | X | | | |

| | | | Minimal Survey Data Set | | | | | | | | | | | | | | | | |
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| **N** | **Target** | **Parameters** | **Country requirement** | | | | | | | | | | | | **Design** | **Const.** | **Notes** | **Minimal Survey Data Set** | **Method of post-construction assessment** |
| | | | **IRE** | **UK** | | | | **Sc** | **Nl** | **Es** | **De** | **NL** | **PH** | **I** | **Fr** | | | | | |
| 30 | Door U-value | Design calculation | 1.6 | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | X | 4.2 | | X | | X | min. 1,10-3,00 | X | X | X | | Heat flux meter reading or thermal imaging in accordance with ISO9869:2 | If required, U values can be measured, but method is time consuming, taking between 5 and 20 days |
| 31 | Window U-value | Design calculation | 1.6 | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | X | 4.2 | | X | | X | min. 1,10-3,00 | X | X | X | | | |
| 32 | Pitched roof U-value | Design calculation | 0.16 | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | X | 0.4 | | X | | X | min. 0,2-0,35 | X | X | X | | | |
| 33 | Flat roof U-value | Design calculation | 0.2 | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | X | 0.4 | | X | | X | min. 0,2-0,35 | X | X | X | | | |
| 34 | Roof window U-value | Design calculation | 1.6 | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | Number in W/m²K, expected range 0-1, 2dp | X | 4.2 | | X | | X | min. 1,10-3,00 | X | X | X | | | |

| | | | Minimal Survey Data Set | | | | | | | | | | | | | | | | |
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| **N** | **Target** | **Parameters** | **Country requirement** | | | | | | | | | | | | **Design** | **Const.** | **Notes** | **Minimal Survey Data Set** | **Method of post-construction assessment** |
| | | | **IRE** | **UK** | | | | **Sc** | **Nl** | **Es** | **De** | **NL** | **PH** | **I** | **Fr** | | | | | |
| 40 | Heating Controls | Check capability to control on basis of time and temperature | X | x | x | x | x | | | | | | | | X | X | X | | Check functional capability of control system for control by time, temperature, occupancy etc | Does control system switch on and off at the right thresholds and times? |
| 41 | Renewable energy - total | Manufacturer data | X | | | | X | | | | | | X | | X | X | | | Spot check generation meters | Take spot readings of kW and kWh and check that they are in acceptable range |
| 42 | Renewable thermal energy | Manufacturer data | X | | | | X | | | X | X | | X | | | X | | | Spot check generation meters | Take spot readings of kW and kWh and check that they are in acceptable range |
| 43 | Renewable electricity | Manufacturer data | X | | | | X | | | | X | | X | | | X | | | Spot check generation meters | Take spot readings of kW and kWh and check that they are in acceptable range |
| 44 | Airborne sound insulation Separating Walls | Sound level in adjacent room, Sound level in room, room dimensions, background noise level | DnT, w ≥ 53 | DnT,w + Ctr ≥ 45, Air bourne sound insulation expressed as a single number | DnT,w + Ctr ≥ 45, Air bourne sound insulation expressed as a single number | | | X | R'w + C ≥ 52 | DnT,A ≈ DnT,w+ C ≥ 50 | R'w ≥ 53 for multistorey or 57 for row housing | | | . R'w = 50 dB $D_2$m,nT, w = 40 dB; L'nw = 63 dB; LASmax = 35 dB; Laeq = 35 dB" | DnT, w + C ≥ 53 | | X | Definitions vary. See 'COST Action TU0901: Integrating and Harmonizing Sound Insulation Aspects in Sustainable Urban Housing | Sound test of separating wall insulation | Sound insulation test report showing acceptable result. Test methods and criteria differ between countries |

| | | | Minimal Survey Data Set | | | | | | | | | | | | | | | | |
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| **N** | **Target** | **Parameters** | **Country requirement** | | | | | | | | | | | | | **Design** | **Const.** | **Notes** | **Minimal Survey Data Set** | **Method of post-construction assessment** |
| | | | **IRE** | **UK** | | | | **Sc** | **Nl** | **Es** | **De** | **NL** | **PH** | **I** | **Fr** | | | | | |
| 45 | Airborne sound insulation Separating Floors | Measurement as for airborne sound | DnT, w ≥ 54 | DnT,w + Ctr ≥ 45, Air bourne sound insulation expressed as a single number | DnT,w + Ctr ≥ 45, Air bourne sound insulation expressed as a single number | | | X | R'w + C ≥ 52 | DnT,A ≈ DnT,w+ C ≥ 50 | R'w ≥ 54 | | | | DnT, w + C ≥ 53 | | X | Constructions Building acoustics throughout Europe Volume 1: Towards a common framework in building acoustics throughout Europe | Sound test of separating floor insulation | Sound insulation test report showing acceptable result. Test methods and criteria differ between countries |
| 46 | Sound level of ventilation unit and other equipment | Manufacturer's data | | | | | <30dBA in bedrooms and <35dBA in living rooms | X | <30dBA in dwellings, NTR5076 | Daytime <40dBA in living rooms and admin offices, <35dBA in bedrooms and professional offices. Residential 10dB lower at night | | | <25dB(A) in habitable rooms | | | | X | | Decibel reading when equipment operating | Sound insulation test report showing acceptable result. Test methods and criteria differ between countries |

| | | | Minimal Survey Data Set | | | | | | | | | | | | | | | | |
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| **N** | **Target** | **Parameters** | **Country requirement** | | | | | | | | | | | | **Design** | **Const.** | **Notes** | **Minimal Survey Data Set** | **Method of post-construction assessment** |
| | | | **IRE** | **UK** | | | | **Sc** | **Nl** | **Es** | **De** | **N L** | **PH** | **I** | **Fr** | | | | | |
| 47 | Indoor Air Quality | Design calculation | X | | | | X | | | | | | | | | X | | | IAQ sensor check or VOC measurement to EN 13649:2002 | VOC measurement by approved method and acceptable result. Eg BREEAM requires 1. The Formaldehyde concentration level is measured post construction (but pre-occupancy) and is found to be less than or equal to 100µg/m³ averaged over 30 minutes. 2. The total volatile organic compound (TVOC) concentration is measured post construction (but pre-occupancy) and found to be less than 300µg/ m³ over 8 hours, in line with the Building Regulation requirements. |

| | | | Minimal Survey Data Set | | | | | | | | | | | | | | | | |
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| **N** | **Target** | **Parameters** | **Country requirement** | | | | | | | | | | | | | **Design** | **Const.** | **Notes** | **Minimal Survey Data Set** | **Method of post-construction assessment** |
| | | | **IRE** | **UK** | | | | **Sc** | **Nl** | **Es** | **De** | **NL** | **PH** | **I** | **Fr** | | | | | |
| 48 | VOC concentration | Measurement of VOC concentration and Formaldehyde concentration | X | | | | TVOC< 500 micrograms /cu. m | | | | | | | | X | | X | | IAQ sensor check or VOC measurement to EN 13649:2003 | As above |
| 49 | Total power of Lighting | Design calculation | | | | | | | | X | | | | | | | X | | Electricity consumption of lighting when all switched on | Meter reading |
| 52 | Pipe insulation effectiveness | | | | | | Domestic Building Services Compliance Guide, Non-Domestic Building Services Compliance Guide | | | Tables 1.2.4.2.1 to 1.2.4.2.5 of Reglamento de instalaciones térmicas en los edificios (RITE) | | | | | | X | X | | Check insulation type and thickness against EN ISO 12241:2008. In UK the Non-Domestic Compliance Guide 2013 recommends BS 5422 | Visual inspection and certificate |
| 53 | Smart Marterials | | | | | | | | | | | | | | | X | X | | Functional test of any smart materials used | |