Technical Handbook - Non-Domestic

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Energy

6.0 Introduction

6.0.1 Background

Within Scottish building regulations, improvements in energy standards have been made over many years, including in 2007, the move to a single carbon dioxide emission based methodology for assessing carbon and energy performance in new buildings.

The Sullivan Report - in 2007, Scottish Ministers convened an expert panel to advise on the development of a low carbon building standards strategy to increase energy efficiency and reduce carbon emissions. This resulted in The Sullivan Report – 'A Low Carbon Building Standards Strategy for Scotland' (http://www.scotland.gov.uk/Sullivanreport). A key recommendation of this Report was staged improvements in energy standards in 2010 and 2013, with the aim of net zero carbon buildings (emissions for space heating, hot water, lighting and ventilation) in 2016/17, if practical.

In May 2013 Scottish Ministers reconvened the Sullivan panel with a view to revisiting some of their original recommendations, taking account of the impact of the economic downturn on the construction sector. Whilst maintaining the level of ambition, the 2013 Update report [http://www.scotland.gov.uk/Publications/2013/11/8593/0] recommended a more moderate pace of change and offered recommendations in three areas:

- eventual and staged standards – Percentage improvements recommended in 2007
- process – Extending carbon compliance beyond site - related measures and
- costings – Recognising the value of new - build energy standards.

The Climate Change (Scotland) Act 2009 (http://www.legislation.gov.uk/asp/2009/12/pdfs/asp_20090012_en.pdf) creates a statutory framework for delivery of greenhouse gas emissions reductions in Scotland. The Act sets an interim target of a 42% reduction in emissions (compared to 1990) by 2020, and an 80% reduction target for 2050 with annual targets set in secondary legislation. The high level measures required in each sector to meet Scotland's statutory climate change targets, for 2022 and in the long term, were set out in the Scottish Government's Climate Change Delivery Plan. This includes recommendations for the delivery of low carbon new buildings.

The construction sector has a major role to play in this respect. Emissions from the burning of fossil fuels are contributing to climate change, with energy use in buildings being a significant source of such emissions. Increased energy efficiency and promotion of renewable energy are therefore an important element of Scotland's strategy to tackle climate change.

To deliver buildings that are more energy efficient and have fewer carbon dioxide emissions, a greater emphasis is needed on the overall effect that design and specification choices, construction and commissioning of new work can have on building performance.

6.0.2 Aims

The intention of Section 6 is to ensure that effective measures for the conservation of fuel and power are incorporated in buildings. In addition to limiting energy demand by addressing the performance of the building fabric and fixed building services, a carbon dioxide emissions standard obliges designers of new buildings to consider building design in a holistic way.

Improvements set out within this section will result in a greater need to consider the benefits which localised or building-integrated low carbon equipment (LCE) (e.g. photovoltaics, solar water heating, combined heat and power and heat pumps) can make towards meeting standards. Although the focus is primarily on lowering carbon dioxide emissions from buildings, the measures within this section are intended to reduce energy demand and continue to ensure that, for new buildings and new building work, use of energy and fuel costs arising from this are both minimised.

Guidance also recognises issues relevant to requirements within Articles 3, 4, 6-9 and 11 of the EU Directive 2010/31/EU [http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF] on the Energy Performance of Buildings (EPBD) and Article 13 of the EU Directive 2009/28/EC http://europa.eu/legislation_summaries/energy/renewable_energy/en0009_en.htm on the promotion of the use of energy from renewable sources.

The standards and guidance given in this section are intended to achieve an improvement, for new buildings reducing emissions by approximately 43% compared to the previous 2010 standards (60% compared to the 2007 Standards). However nothing here prevents a non-domestic building from being designed and constructed to be even more energy efficient or make greater use of low carbon equipment (LCE).

6.0.3 General guidance

This section covers the energy efficiency for non-domestic buildings. Such buildings include: factories, offices, shops, warehousing, hotels, hospitals, hostels and also buildings used for assembly and entertainment.

This section should be read in conjunction with all the guidance to the Building (Scotland) Regulations 2004, but in particular Section 3 Environment, which has a close affiliation with energy efficiency, regarding:

- ventilation
- condensation
- combustion appliances, and
- biomass fuel storage.

When determining how to follow the Section 6 guidance for energy efficiency in buildings, recognition should be given to the following:

a. an insulation envelope is only appropriate to those parts of a building that are intended to be heated or cooled. N.B. Heating rated at a maximum of 25W/m^2 of floor area and installed only for the purposes of frost protection should be disregarded for the purposes of this guidance

b. some concessions are given in annex 6C to modular and portable buildings (some of which could be stand-alone buildings). The flowchart in the annex gives guidance on possible compliance routes. Note there are no concessions for limited life buildings which are constructed in a conventional manner

c. stand-alone buildings that are heated (see paragraphs below), and

d. work on existing buildings (see paragraph below).

Heated stand-alone buildings - in 2007, the EU Directive 2002/91/EC [http://europa.eu/legislation_summaries/energy/energy_efficiency/l27042_en.htm] on the energy performance of buildings introduced the category ‘stand-alone building’, a definition of which is given and within appendix A of the Technical Handbooks. The Directive, now

recast as Directive 2010/31/EU [http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF], exempts such buildings, where less than 50m^2 in floor area, from both the need to use a methodology to calculate energy performance (Standard 6.1) and also the production of an Energy Performance Certificate (Standard 6.9). The defined term includes not only detached buildings, but also thermally divided parts of a building with separate heating shut-down control.

Stand-alone buildings that are less than 50m^2 in floor area, must still comply with Standards 6.2 to 6.8 and 6.10. The guidance to Standard 6.2 recommends that the insulation envelope of heated stand-alone buildings meets the level of performance applicable to an extension.

Examples - common examples of stand-alone buildings that could be less than 50m^2 and which would therefore be eligible for exemption are: a detached petrol filling station kiosk, associated with a supermarket; and heated office and toilet accommodation, within an otherwise unheated warehouse.

Work on existing buildings - as for other standards within Scottish building regulations, the energy standards apply to conversions and also work on existing buildings, such as extensions, alterations and fit-outs. However in some situations, individual standards may not apply or guidance on compliance with the standards may differ for such work. The latter is usually to recognise constraints that arise when working with existing buildings.

It is advisable in the first instance to check the functional standard as sometimes a limitation removes certain classes of this type of work. Where not excepted by a limitation to the standard, the provisions of the standard will apply in full to the new work on the existing building, the exception to this could be where the standards are brought into effect by conversion and this is identified in the introduction to the guidance supporting each standard.

6.0.4 U-values

Thermal transmittance (U-value) is a measure of how much heat will pass through one square metre of a structure when the temperature on either side differs by one degree Celsius. It is expressed in units of watts per square metre per degree of temperature difference (W/m^{2}K).

Measurements of U-values should be made in accordance with BS EN ISO:8990:1996 ‘Thermal insulation. Determination of steady-state thermal transmission properties. Calibrated and guarded hot box’. In calculation thermal bridging may be disregarded where the difference in thermal resistance between bridging and bridged material is less than 0.1m^{2}K/W. For example, normal mortar joints need not be taken into account in calculations for brickwork, but should be taken into account for lightweight insulating blockwork.

Taking into account guidance from BRE publication BR 443:2006 ‘Conventions for U-value calculations’ (http://www.bre.co.uk/filelibrary/pdf/rpts/br_443_(2006_edition).pdf), individual U-values of building elements forming the insulation envelope should be established:

a. by using insulation to a thickness derived from manufacturers’ data relating to thermal conductivities (W/mK) and thermal transmittances (U-values: W/m^{2}K) certified by a notified body

b. by calculation taking into account thermal bridging effects of, e.g. timber joists, structural and other framing and normal bedding mortar, by using the Combined Method set out in BS EN ISO 6946:2007 or CIBSE Guide Section A3, 2006 Edition (http://www.cibse.org/)

c. for floors adjacent to the ground and basements, by using the method set out in BS EN ISO 13370: 2007 or CIBSE Guide Section A3, 2006 Edition

d. for windows, doors and rooflights, by using BS EN ISO 10077-1: 2006 or BS EN ISO 10077-2: 2012 and, for rooflights, BS EN ISO 12567-2: 2005, or

e. for metal cladding systems using Finite Element Analysis, the method of calculation should be made in accordance with BS ISO 10211:2007.

6.0.5 Thermal conductivity

The thermal conductivity (the λ-value) of a material is a measure of the rate at which that material transmits heat and is expressed in units of watts per metre per degree of temperature difference (W/mK). Establishing the thermal conductivity of materials in a building element forming part of the insulation envelope will enable the thermal transmittance of the element to be calculated.

Measurements of thermal conductivity should be made in accordance with BS EN 12664: 2001, BS EN 12667: 2001 or BS EN 12939: 2001 (http://www.bsigroup.com/). There are a wide range of technical publications which give the thermal conductivity of common construction materials but, where available, preference should be given to values that are certified by a notified body. Additional guidance given in BRE publication BR 443 should also be followed.

6.0.6 Thermal transmittance through separating elements

Previously, thermal transmittance through separating walls or separating floors between heated parts of the same building (e.g. between an office and a protected zone with space heating) was not assessed. Accommodation on both sides of the separating element was expected to be at a similar temperature when the buildings are occupied.

This is no longer always the case. Whilst ‘no loss’ may still be assumed for solid walls, research has identified previously unanticipated heat losses from air movement in cavity separating walls. This ‘thermal bypass’ is now identified in the calculation methodology and guidance to Standard 6.1 and in guidance to Standard 6.2.

6.0.7 Buffering effects on the insulation envelope

If a building or part of a building is separated from an unheated enclosed area, (e.g. solid waste storage accommodation, a porch, garage, protected zone or underground car park) the U-values of the walls/floors (including doors and translucent glazing) may be calculated by:

a. disregarding the buffering effects and treating the element as if it is directly exposed to the outside

b. following the procedure in BS EN ISO 6946: 2007, or

c. following the procedure in BS EN ISO 13789: 2007.

6.0.8 Roofs that perform the function of a floor

A roof of a building that also performs the function of a floor or similar load-bearing surface (e.g. an access deck, escape route, roof garden or car park), should be considered as a roof for the purpose of assessment within this section.

6.0.9 Atria

In a building with an atrium the guidance given in clause 6.0.7 applies if the atrium is unheated and thermally divided from the remainder of the building by translucent glazing

and doors and, if appropriate, walls and floors. In other situations involving atria, where none of the above occurs, the continuity of the insulation envelope occurs at roof level (usually predominantly glazed with translucent material) and the atrium is considered to be a heated part of the main building.

6.0.10 Annexes to guidance

Annexes can be found at the back of this section. These give guidance in respect of various calculation procedures, modular and portable buildings and consequential improvement to fixed building services.

6.0.11 Performance of fixed building services

Unless otherwise identified in text, guidance given in support of Standards 6.3 to 6.6 now refers directly to information contained within the Non-domestic Building Services Compliance Guide for Scotland [http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/ndbscg]. The document replicates guidance published in support of building standards elsewhere in the UK and supports standardisation of the specification and expected performance of fixed building services throughout the UK.

Additional information, on the use of a range of low carbon equipment (LCE) such as solar thermal systems, photovoltaic panels and heat pumps, and application within building regulations can be found on the Technical Pages [http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks] of the Building Standards Division website.

6.0.12 Calculation of areas

When calculating areas for the purposes of this section and in addition to regulation 7, schedule 4, the following should be observed:

a. all areas should be measured in square metres (m^2), unless stated otherwise in this guidance

b. the area of a floor, wall or roof is to be measured between finished internal faces of the insulation envelope, including any projecting bays and in the case of a roof, in the plane of the insulation

c. floor areas are to include stairwells within the insulation envelope and also non-useable space (for example service ducts)

d. the area of an opening (e.g. window or door) should be measured internally from ingo to ingo and from head to sill or threshold.

6.0.13 Latest changes

The 2015 edition of Section 6 incorporates a number of changes whilst retaining the existing methodology introduced in 2007. The majority of these changes relate to improvement in specified performance to deliver the intended 43% aggregate reduction in carbon dioxide emissions on the 2010 standards (60% when compared to 2007 standards). Foremost, in guidance to Standard 6.1 is the move to use of a concurrent notional building specification to set the Target Emissions Rate for new buildings. A full summary of changes can be found on the Technical Handbooks [http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/publications/pubtech] page of the Building Standards Division section of the Scottish Government website.

The key changes that have been made to standards and guidance since 1 October 2013 include:

- Standard 6.1 - standard amended to apply to large extensions (over 100m² and more than 25% of the area of the existing building)
- Standard 6.1 – SBEM v5 now used to calculate carbon dioxide emissions; both changes to methodology and revised carbon factors for fuels apply
- Standard 6.1 – target Emissions Rate for new building now set using a concurrent (2015) notional building specification. Guidance comprehensively amended in support of this new approach (Revised NCM Modelling Guide for Scotland also published)
- Clause 6.2.5 – revisions to calculation options for heat loss from linear thermal bridging
- Clause 6.2.7 – revised list of situations where airtightness testing need not be undertaken
- Standard 6.9 - standard amended to cover display of EPC in public buildings over 250m^2 (note: applies from 9 July 2015)
- Standards 6.3 to 6.6 - reference is now made to the Non-domestic Building Services Compliance Guide for Scotland for detailed guidance in support of each standard; any situations not addressed in this document are noted within the guidance to the relevant standard
- Annex 6C – guidance for new modular and portable buildings update to reflect revised emissions targets; exemption for relocation of buildings under 30m² now expired
- Annex 6G now published as Annex 6D; incorporating more comprehensive guidance on consequential improvement of fixed building services, taken from the published Direction
- Annexes 6E and 6F deleted – information now within the Non-domestic Building Services Compliance Guide for Scotland.

6.0.14 Relevant legislation

EU Directive 2006/32/EC - reference should be made to UK legal requirements enforcing Article 13 of the Energy End-Use Efficiency and Energy Services Directive 2006/32/EC (http://europa.eu/legislation_summaries/energy/energy_efficiency/l27057_en.htm). When building work is carried to an existing building with a floor area of more than 1000m^2 or a new building is constructed, the energy supply companies providing services to such buildings should be notified.

EU Directive 2009/28/EC - Directive 2009/28/EC (http://europa.eu/legislation_summaries/energy/renewable_energy/en0009_en.htm) promotes the use of energy from renewable sources, including promotion within national legislation. It establishes a common framework for the use of energy from renewable sources in order to limit greenhouse gas emissions, including establishment of national action plans and targets which set the share of energy from renewable sources for 2020.

6.0.15 Certification

Scottish Ministers can, under Section 7 of the Building (Scotland) Act 2003, approve schemes for the certification of design or construction for compliance with the mandatory functional standards. Such schemes are approved on the basis that the procedures adopted by the scheme will take account of the need to co-ordinate the work of various designers and specialist contractors. Individuals approved to provide certification services

under the scheme are assessed to ensure that they have the qualifications, skills and experience required to certify compliance for the work covered by the scope of the scheme. Checking procedures adopted by Approved Certifiers will deliver design or installation reliability in accordance with legislation.

The Certification of Design (Section 6 – Energy) for Non-domestic Buildings scheme has been approved by Scottish Ministers to confirm compliance with Section 6. Details are available on the certification pages of the Building Standards Division website http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/profinfo/cert.

6.1 Carbon dioxide emissions

Mandatory Standard

Standard 6.1

Every building must be designed and constructed in such a way that:

a. **the energy performance is estimated in accordance with a methodology of calculation approved under regulation 7(a) of the Energy Performance of Buildings (Scotland) Regulations 2008, and**

b. **the energy performance of the building is capable of reducing carbon dioxide emissions.**

Limitation:

This standard does not apply to:

a. alterations and extensions to buildings, other than:

   i. alterations and extensions to stand-alone buildings having an area less than 50 square metres that would increase the area to 50 square metres or more

   ii. extensions to non-domestic buildings where the extension will have an area which is both greater than 100 square metres and greater than 25% of the area of the existing building, and

   iii. alterations to buildings involving the fit-out of the building shell which is the subject of a continuing requirement

b. conversions of buildings:

c. non-domestic buildings and buildings that are ancillary to a dwelling that are stand-alone having an area less than 50 square metres

d. buildings, which will not be heated or cooled, other than by heating provided solely for the purpose of frost protection, or

e. limited life buildings which have an intended life of less than 2 years.

6.1.0 Introduction

Standard 6.1 focuses on the reduction of carbon dioxide emissions arising from the use of heating, hot water, ventilation and lighting in new buildings and large extensions. The

guidance sets an overall level for maximum carbon dioxide emissions in buildings by use of a methodology which incorporates a range of parameters that influence energy use. This means a designer is obliged to consider energy performance as a complete package rather than looking only at individual elements such as insulation or boiler efficiency - a 'whole building approach' to energy, which offers a significant degree of design flexibility.

For the majority of new buildings, Standard 6.1 has the greatest influence on design for energy performance. Standards 6.2 to 6.6 and 6.10, in the main, recommend benchmark and backstop levels to be achieved for individual elements or systems. To achieve compliance with Standard 6.1, it will be necessary to improve upon some or all of these backstop levels, or incorporate additional energy performance measures, such as low carbon equipment (LCE).

The guidance given in support of Standards 6.2 to 6.8 for extensions and alterations should be followed when designing stand-alone buildings of less than $50m^2$.

Renewable technologies - Directive 2009/28/EC [http://europa.eu/legistlation_summaries/energy/renewable_energy/en009_en.htm] promotes the use of energy from renewable sources. Where a building design will include use of renewable energy for heating, Article 13 of the Directive recommends, amongst other measures, consideration of use of the following:

- for biomass equipment, conversion efficiencies of 85%
- for heat pumps, those that fulfil the minimum requirements of eco-labelling established in Commission Decision 2007/742/EC (amended in 2011 & 2013) establishing the ecological criteria for the award of the Community eco-label to electrically driven, gas driven or gas absorption heat pumps, and
- for solar thermal systems, those that are subject to EU standards, including eco-labels and other technical reference systems established by the European standardisation bodies.

High-efficiency alternative systems - Article 6 of Directive 2010/31/EU [http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF] requires that, for all new buildings, the technical, environmental and economic feasibility of high-efficiency alternative systems (such as decentralised energy supply systems using renewable energy, co-generation, district or block heating/cooling and heat pumps) are considered and taken into account in developing proposals.

This should be documented and available for verification purposes and a statement should therefore accompany the building warrant application. Further information on this process is available in the guidance note EPC 10 - 'Consideration of high-efficiency alternative systems in new buildings' www.scotland.gov.uk/Resource/0042/00427425.pdf.

Conversions - in the case of conversions as specified in regulation 4, this standard does not apply.

6.1.1 Simplified Building Energy Model (SBEM)

The Simplified Building Energy Model (SBEM) is a calculation tool which forms part of the UK National Calculation Methodology which conforms with Article 3 of Directive 2010/31/EU [http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF] on the Energy Performance of Buildings. It is approved for use in carbon dioxide emissions calculations. SBEM has a basic user interface, iSBEM, which includes Scottish compliance parameters for use with this guidance and is available on the National Calculation Methodology website (http://www.ncm.bre.co.uk/index.jsp).

Other tools may be used with the methodology (such as dynamic simulation modelling), particularly where the building is considered to be a complex design. A list of approved calculation tools can be found on the 'Section 6 software' [http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/sectsixprg] page of the Building Standards Division website. The guidance given here is written in terms of the SBEM calculation tool but the principles and procedures also apply to other calculation tools. Designers should be familiar with the NCM and their chosen software tool and be able to explain the input and calculation process in the context of the information submitted as part of the building warrant.

6.1.2 Summary of procedure

To comply with the requirements of Standard 6.1, designers should demonstrate that the calculated carbon dioxide emissions for the ‘actual’ building (Building Emissions Rate or BER) do not exceed those which are calculated for a ‘notional' building (Target Emissions Rate or TER). The carbon dioxide emissions are measured in kilograms of CO_2 per square metre of floor area per annum.

Outline of process - in broad terms, the way that this process works is described below:

- The data defining the actual building is input into an approved software tool and the notional building is generated automatically by applying the National Calculation Methodology (NCM) for Scotland. The notional building has the same size, shape, orientation, conditioning strategy and zone activities as the actual building.

- The Target Emissions Rate (TER) for the actual building is generated automatically, with SBEM applying prescribed fabric and services specifications to the notional building (see clause 6.1.4). These are applied to the individual building zones that make up the notional building. Values are assigned automatically based upon both the activity and the conditioning strategy for each zone of the actual building, as input by the designer.

- Application of these specifications defines a ‘concurrent notional building’, i.e. one from which a calculated emissions rate is deemed to meet the requirements of this standard. This calculated figure is the TER for the actual building.

- The Building Emissions Rate (BER) is generated by applying the designer’s chosen fabric and services specifications for the actual building on a zone by zone basis within the NCM for Scotland. In determining this specification, the fabric and services specifications for the actual building should meet or improve upon the benchmark and backstop levels identified in guidance to Standards 6.2 to 6.6.

- If, following full specification of the actual building, the BER is not more than the TER, then compliance with this standard is achieved. If the BER is more than the TER, then the designer should review and improve the construction and building services data in the actual building and determine what measures would be appropriate to reduce the BER. For example, by reducing the air permeability, improving services efficiency or incorporating some ‘enhanced management and control’ features such as power factor correction.

6.1.3 The 'Notional' building and SBEM calculation tool

The 'notional' building is created once the design of the actual building has reached the stage where layout, dimensions, site orientation, building services strategy, etc. are known.

At all stages, the conventions in the iSBEM User guide [http://www.ncm.bre.co.uk/] should be read in conjunction with the specific guidance for Scotland given in these clauses. SBEM has much of the input data already embedded in the calculation tool. When 'Scottish building regulations' is selected as the ‘purpose of analysis’ within SBEM,

Scottish weather data and the embedded values within the calculation tool are applied to the 'notional' building. The software will automatically generate the 'notional' building from the information provided for the actual building.

In the interests of transparency, key information on the specification used to create the 'notional' building (whether user defined or embedded in SBEM calculation tool) is summarised in the following clauses. Further information, including a full definition of the notional building and explanation of the assessment process is given in the 2015 'National Calculation Methodology (NCM) Modelling Guide for Scotland' http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/ncmg2015.

6.1.4 Fabric and fixed building services specification for ‘notional’ building

The fabric and services specification of the notional building are assigned on a zone by zone basis. There are two specification categories identified which are based upon the conditioning strategy assigned to the actual building by the designer:

- heated and naturally ventilated, or
- heated and mechanically ventilated or heated and cooled.

The zone by zone approach allows designers greater flexibility, assigning the mechanically ventilated or cooled specification only to those zones where such solutions are proposed or required in an otherwise heated/naturally ventilated building. This sets a TER which is moderated by a less heavily serviced strategy, encouraging buildings with a reduced overall energy use and carbon dioxide emissions.

The following table outlines the standard notional building zone specifications for fabric and fixed building services, depending on the zone conditioning strategy. Some elements are further varied based upon the activity type defined for each zone within SBEM. The full definition of the notional building and explanation of the assessment process is given in the 2015 'National Calculation Methodology (NCM) Modelling Guide for Scotland' http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/ncmg2015.

Table 6.1 'Notional' building - fabric and fixed building services values for TER

Element	Zone heated & naturally ventilated	Zone heated & mechanically ventilated/ cooled
Roof (U-value, W/m^2.K)	0.18	0.16
Wall (U-value, W/m^2.K)	0.23	0.20
Floor (U-value, W/m^2.K)	0.22	0.2
Window (U-value, W/m^2.K (g-Value, %) (transmittance, %)	1.8 (10% FF) 60% 71%	1.6 (10% FF) 50% 71%
Rooflight (U-value, W/m^2.K) (g-Value, %) (transmittance, %)	1.8(15% FF) 52% 57%	1.8 (15% FF) 52% 57%

Element	Zone heated & naturally ventilated	Zone heated & mechanically ventilated/ cooled
Vehicle access and similar large doors	1.50	1.50
Pedestrian doors and high usage entrance doors	2.20	2.20
Thermal capacity of element	Refer to NCM Modelling guide for details.	
Thermal bridging - Junctions	Refer to NCM Modelling guide for details.	
Air Permeability[1] (m^3/ $hr.m^2$)	5	3
Lighting Efficiency (Luminaire lumens/Circuit watt)	60	65
Occupancy control (Yes/No)	Yes	Yes
Daylight control (Yes/No)	Yes	Yes
Heating and DHW (% efficiency)	Fuel(s) for actual building applied to the notional building. Refer to NCM Modelling guide for details.	
Central Ventilation (SFP, W/ l/s)	N/A	1.8
Terminal Unit (SFP, W/l/s)	N/A	0.4
Cooling (SEER)	N/A	4.5
Heat recovery (% efficiency)	N/A	70%
Variable speed control of fans, pumps and circulators (Yes/No including multiple sensors)	Yes	Yes
Photovoltaic Panels (% of floor area)	4.5%	4.5%

Notes:

1. In certain buildings, air permeability is further differentiated by building size. Refer to NCM Modelling Guide http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/ncmg2015.

6.1.5 User defined information for 'notional' building

The following information should be input and should reflect the design of the actual building:

- size and shape, internal layout and dimensions (see clause 6.0.12)
- activity type and fixed building services for each building zone (and therefore the same activity type parameter values)
- orientation - the 'notional' and actual building have the same orientation
- areas of building envelope elements
- construction build-up of elements to complement U-values embedded in the SBEM calculation tool.

The following assertions are applied within the NCM when calculating the carbon dioxide emission rate for the 'notional' building:

- the heating fuel(s) specified for the actual building are applied to the 'notional' building
- the amount of glazing in the notional building is not the same as in the actual building. It is assigned on a zone by zone basis as a percentage of the external wall and roof based upon the glazing type for that activity within the NCM activity database. Information on this is set out in the NCM Modelling guide http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/ncmg2015
- any services not covered by Section 6 are not assessed (for example emergency escape lighting and specialist process lighting)
- thermal bridge heat loss is based upon the same geometry as for the actual building.

Low carbon equipment element of the TER - the concurrent specification for the 'notional' building includes an element of low carbon equipment (LCE) represented, as a proxy, by the inclusion of roof mounted photovoltaic panels, expressed as a fixed percentage of the building gross internal area. This is included to assist in reducing the TER, in recognition of both the recast Directive 2010/31/EU [http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF] on the energy performance of buildings and Directive 2009/28/EC [http://europa.eu/legislation_summaries/energy/renewable_energy/en0009_en.htm] which promotes the use of energy from renewable sources. It is intended to encourage designers to consider the incorporation of LCE within design proposals, where this is considered an appropriate and cost-effective part of the overall building solution.

Whilst there is no requirement for the actual building to include LCE, designers should be aware that other aspects of building specification would require to be improved should such an element be absent. Similarly, the presence of a larger LCE element within the actual building would enable other elements of specification to be lowered, subject to the minimum values for building fabric and services set out in guidance to Standards 6.2 to 6.6.

6.1.6 Calculating the building carbon dioxide emission rate (BER)

The BER is calculated by using the values and efficiencies input by the designer in the SBEM calculation tool. There are, however, provisions that limit the flexibility of design. These are:

- backstop measures given in the guidance to Standards 6.2 to 6.6, and
- when display windows are present in the actual building, they are not copied across into the 'notional' building.

The first of these measures is intended to limit energy demand, particularly where LCE may offset rather than reduce energy consumption. The second allows the provision of display glazing but requires designers to compensate for the additional heat loss from such elements by improving specification of other elements of the actual building.

6.1.7 Adjustment of BER

Certain management features offer improved energy efficiency in practice, while others have this potential if appropriate action is taken. Where these management features are provided in the proposed building, the BER can be reduced by an amount equal to

the product of the percentages given in the table below and the CO_2 emissions for the system(s) to which the feature is applied:

Table 6.2 BER Adjustment Factors

Feature	Adjustment factor
Central power factor correction to achieve a power factor of at least 0.9	0.010
Central power factor correction to achieve a power factor of at least 0.95	0.025
Automatic monitoring and targeting (AMT) with alarms for out of range values	0.050

For example, if the total CO_2 emissions in a gas heated building were 60kg/m^2/annum and 20kg/m^2/annum are due to electrical energy consumption without power factor correction, the provision of correction equipment to achieve a power factor (pf) of 0.95 would enable the BER to be reduced by 20 x 0.025 = 0.5kg/m^2/annum. The revised BER would then be 59.5kg/m^2/annum.

Credit can only be taken where the feature is applied.

6.1.8 Shell and fit-out buildings

Where, rather than making a staged warrant application, a new building shell and fit-out are the subject of separate building warrant applications, the final specification of building systems may not be known. However it remains important to ensure that such a building, if intended to be heated or cooled (other than by heating provided solely for the purpose of frost protection) will still be constructed to limit carbon dioxide emissions.

In such cases, the calculation methodology should still be used to show that the building shell, as proposed, can comply with Standard 6.1. This should be done by identifying an example specification for any uninstalled services needed for occupation and use of the building and using this in the calculation. This specification should:

- be compatible with the intended building end use and servicing strategy. Assessment should be based upon the most energy intensive solution associated with the proposed building use (e.g. that a shell building for commercial/office will be air conditioned), and
- recognise the available utilities provided to the site.

A TER/BER comparison can then be carried out. In specifying the building shell, reference should be made to the maximum U-values and air-tightness levels identified in clauses 6.2.4 and 6.2.6.

Whilst the NCM will assess shell and fit-out installations on a zone-by-zone basis, full details of the example specification, identifying uninstalled services, should form part of information with the building warrant and should identify, in particular, any installed low carbon equipment proposed to meet the Target Emissions Rate. This will provide information to any party considering subsequent fit-out work on the expected level of performance of remaining building services needed to demonstrate compliance of the finished building prior to occupation.

Use of continuing requirement - where Standard 6.1 applies to a building, the verifier can issue a continuing requirement with a building warrant for a shell building. This will mean that the subsequent fit-out, whether subject to a building warrant or not, demonstrates that the final building also complies with Standard 6.1 by having calculated emissions which do not exceed the TER declared for the shell building. In demonstrating

this, the same edition of the NCM used for the shell building calculation may be used for the BER calculation for the final building.

This will also result in the production, under Standard 6.9, of an Energy Performance Certificate on completion of the final building. This must be produced using the edition of the NCM which is current at the time works are completed.

Dependant upon the final specification of the building, additional provisions may be needed to meet the carbon dioxide emissions standard at building fit-out phase. Accordingly, those involved in the further development of a shell building are advised to consider early assessment of the building, as constructed, to determine the extent to which such provisions may be needed at fit-out.

Similarly, when considering either separate building warrants for shell and fit-out or a single, staged warrant, an early assessment of the implications each route may have on the design and specification of the initial building is recommended.

6.2 Building insulation envelope

Mandatory Standard

Standard 6.2

Every building must be designed and constructed in such a way that an insulation envelope is provided which reduces heat loss.

Limitation:

This standard does not apply to:

a. non-domestic buildings which will not be heated, other than heating provided solely for the purposes of frost protection

b. communal parts of domestic buildings which will not be heated, other than heating provided solely for the purposes of frost protection, or

c. buildings which are ancillary to dwellings, other than conservatories, which are either unheated or provided with heating which is solely for the purpose of frost protection.

6.2.0 Introduction

The levels set out in the guidance to this standard are robust backstops and these are necessary for the following reasons:

- to help reduce energy consumption, particularly in new buildings and large extensions, where low carbon equipment (LCE) may reduce carbon dioxide emissions but not energy consumption, and
- to ensure that a good level of fabric insulation is incorporated in building work especially to construction elements that would be difficult and costly to upgrade in the future.

Non-repeating thermal bridging at the junctions of building elements and around openings in the building envelope form part of the calculation of energy performance in the SBEM calculation tool (refer to clause 6.1.1). Heat loss through such junctions, if poorly

designed and constructed can contribute significantly to the overall heat loss through the insulation envelope.

As fabric insulation levels improve, the rate at which heat is lost by air infiltration through the building envelope (air permeability) becomes proportionally greater. For example, in a typical 1960's building with poorly fitted windows 20% of the total heat could be lost through air infiltration. If the same building was upgraded to 2002 levels of fabric insulation but no attempt was made to improve the air permeability then the heat loss through infiltration could represent over 40% of total heat losses. When addressing infiltration, the provision of adequate, controllable ventilation is essential if both energy efficiency and good indoor air quality are to be achieved.

Conversions - in the case of conversions as specified in regulation 4, the building as converted shall meet the requirements of this standard in so far as is reasonably practicable, and in no case be worse than before the conversion (regulation 12, schedule 6).

6.2.1 Maximum U-values for new buildings

Where a balanced and practical approach is taken to reducing energy demand in new buildings, a consistent and good level of fabric insulation will limit heat loss through the building envelope. Column (a) of the table below sets out robust backstop values for the thermal performance of building elements.

Localised areas of the same type of element may be designed to give poorer performance. These in turn will need to be compensated by the rest of the element being designed and built to a more demanding level. An example of this would be a meter box set into an external wall or a roof void access hatch. These areas should not be any worse than the figures given in column (b) of the table below. Repeating thermal bridges (e.g. timber studs in a timber frame wall) should not be considered as an individual element in this respect, as these are already taken into account within a BS EN ISO 6946: 2007 U-value calculation.

Table 6.3 New buildings - maximum U-values for building elements

Type of element	(a) Area weighted average U-value for all elements of the same type (W/m^2K) [1]	(b) Individual element U-value (W/m^2K)
Wall [2]	0.27	0.70
Floor [2]	0.22	0.70
Roof	0.2	0.35
Windows, doors, roof windows and rooflights [3, 4]	2.0	3.3

Notes:

1. For modular and portable buildings, refer to the maximum area-weighted U-values for new buildings identified in annex 6.C.

2. Excluding separating walls and separating floors between heated areas where thermal transmittance need not be assessed, provided measures are taken to limit heat loss arising from air movement within a cavity separating wall (see below).

3. Vehicle access doors and similar large doors should have a maximum U-value of 1.5W/ m² K.

4. There is no maximum U-value for display windows (refer to clause 6.2.2).

Cavity separating walls - unanticipated heat loss can arise via air movement, within a cavity separating wall, from heated areas to points outwith the insulation envelope. To limit this heat loss a separating wall cavity should have effective perimeter sealing around all exposed edges and in line with insulation layers in abutting elements which separate the building from another building or from an unheated space. Further reduction in heat loss can be achieved where the cavity separating wall is also fully filled with a material that limits air movement.

In considering this issue in residential buildings, it is important that solutions also address the need to limit noise transmission (see Section 5 Noise).

6.2.2 Display windows

A display window is an area of glazing, including glazed doors, intended for the display of products or services on sale within the building, positioned at the external perimeter of the building, at an access level and immediately adjacent to a pedestrian thoroughfare. Glazing that extends to a height of more than 3m above such an access level, or incorporates a fixed or opening light of less than $2m^2$, should not be considered part of a display window except:

- where the size of individual products on display require a greater height of glazing, or
- in cases of building work involving changes to the facade (including glazing) and requiring planning consent, where development control officers should have discretion to require a greater height of glazing, e.g. to fit in with surrounding buildings or to match the character of the existing facade.

There is no area limitation for display glazing in new buildings, however heat loss and solar gain through display windows need to be compensated for elsewhere in the building (see clause 6.1.6).

It is expected that display windows will be found in the type of buildings detailed below:

a. shops including retail warehouse, undertakers, show-rooms, post offices, hairdressers, shops for sale of cold food for consumption off premises

b. financial and professional services banks, building societies

c. estate and employment agencies

d. food and drink restaurants, pubs, wine bars, shops for sale of hot food for consumption off premises.

6.2.3 Areas of windows, doors and rooflights

Due to the carbon dioxide emissions Standard 6.1, there is no need for guidance on minimum or maximum areas for windows, doors and rooflights in new buildings. The use of a methodology for establishing compliance with Standard 6.1 provides an equitable approach to balancing the issues of heat loss versus solar gain and natural versus artificial lighting.

There is no area limit for windows, doors and rooflights for a shell building or for a fit-out subject to a continuing requirement (see clause 6.1.8) as this is considered within the TER calculation required under Standard 6.1.

6.2.4 Shell and fit-out buildings

If constructing a new building as a shell under one building warrant with further, separate fit-out work required prior to occupation, a greater emphasis should be placed on heat loss and the performance of the building envelope.

Column (a) of the table below sets out robust backstop values for the thermal performance of building elements. The application of these benchmark values when designing the shell building will give greater flexibility to the subsequent process of showing compliance with Standard 6.1 for fit-out of the building. Limits on individual element U-values, as discussed in clause 6.2.1, should not be any worse than identified in column (b) of the following table:

Table 6.4 Shell buildings - maximum U-values for shell building elements

Type of element	(a) Area weighted average U-value for all elements of the same type (W/m^2K)	(b) Individual element U-value (W/m^2K)
Wall [1]	0.23	0.70
Floor [1]	0.20	0.70
Roof	0.15	0.35
Windows, doors, roof windows and rooflights [2,3]	1.6	3.3

Notes:

1. Excluding separating walls and separating floors between heated areas where thermal transmittance need not be assessed, provided measures are taken to limit heat loss arising from air movement within a cavity separating wall (see clause 6.2.1).

2. Vehicle access doors and similar large doors should have a maximum U-value of 1.5W/ m² K.

3. There is no maximum U-value for display windows (see clause 6.2.2).

It is advisable to consult with the verifier on shell and fit-out issues at an early stage of the proposed development. In some instances it may be advisable to apply instead for a 'staged building warrant'.

6.2.5 Limiting heat loss through thermal bridging

As insulation values of new buildings improve, the need to limit heat loss through thermal bridging becomes increasingly important. Incorrect detailing at design stage or poor construction work can have a significant adverse effect on building performance.

The insulation envelope of any heated building should be designed and constructed to limit heat loss through thermal bridging. The key areas of concern are:

- repeating thermal bridging within building elements

- non-repeating or linear thermal bridging at the junction between building elements and at the edges of building elements where openings in the envelope are formed.

Whilst repeating thermal bridges are taken into account in the BS EN ISO 6946: 2007 U-value calculation, a separate assessment of non-repeating thermal bridging should be carried out for new buildings which are subject to Standard 6.1. Advice and further information on assessment of the effects of thermal bridging can be found in BRE Information paper IP 1/06 – ‘Assessing the effects of thermal bridging at junctions and around openings’ (http://www.brebookshop.com/).

The SBEM calculation tool referred to in the guidance to Standard 6.1 includes an assessment of heat loss arising from non-repeating thermal bridges in new buildings and large extensions. The overall heat loss is derived from numerical modelling of individual

Ψ values calculated in accordance with BS EN ISO 10211: 2007 ‘Thermal bridges in building construction - heat flows and surface temperatures - detailed calculations’. Guidance on this process is given in BR 497, ‘Conventions For Calculating Linear Thermal Transmittance and Temperature Factors’ [http://www.brebookshop.com/].

For the ‘actual’ building, heat loss is calculated automatically from the building geometry input by the designer, based upon the following options:

a. adoption of a default y-value of 0.10 (adding 10% to the calculated heat loss for all planar elements of the building)

b. input of default Ψ values for each junction assigned by SBEM (listed in the NCM Modelling Guide for Scotland) http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/ncmg2015

c. where construction of a junction follows the ‘Accredited Construction Details (Scotland) 2015’ http://www.gov.scot/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks or other published and substantiated construction detail sets, input of Ψ value of the relevant junction(s) from that document, or

d. input of Ψ values calculated by a person with suitable expertise and experience following the guidance set out in BR 497.

Note that a combination of Ψ values from (b), (c) & (d) can be used to produce the calculated heat loss.

Further commentary on this process and use of other published documents providing sources of pre-calculated values can be found within the ‘Accredited Construction Details (Scotland) 2015’ http://www.gov.scot/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks.

6.2.6 Limiting air infiltration

Addressing infiltration in new buildings can significantly reduce heat loss and result in lower carbon dioxide emissions. This can provide flexibility when applying the methodology used to meet the TER for carbon dioxide emissions (see Standard 6.1).

To limit heat loss, any heated building should be designed to limit air infiltration through the building fabric. This is done by providing a continuous barrier that resists air movement through the insulation envelope and limits external air paths into each of the following:

- the inside of the building
- the ‘warm’ side of insulation layers, and
- spaces between the component parts of exposed building elements, where such parts contribute to the thermal performance of the element.

Areas that need particular consideration in this respect include loading doors, entrance areas and shafts which extend through most of the floors (e.g. lift and stair enclosures).

Where a building warrant application is made for a new building shell only, air permeability should not exceed 7m³/h.m² @ 50 Pa. Where the shell is subject to a continuing requirement under Standard 6.1, testing should be carried out both at completion of the shell and, again when the fit-out is completed (see clause 6.2.7).

In all other cases, no backstop value is set for air permeability. However it is recommended that buildings are designed to achieve a value of 10m³/h.m² @ 50 Pa or better, to allow a balanced approach to managing building heat loss.

Limiting air infiltration to improve energy performance should not compromise ventilation required for:

- the health of the occupants of the building (Section 3), and
- the removal of moisture from building fabric (Section 3), and
- the safe operation of combustion appliances (Section 3), and
- any smoke control system (Section 2).

Lower infiltration rates may give rise to problems with internal air quality and condensation unless this is addressed through the appropriate ventilation strategy. Accordingly, where very low design infiltration rates are proposed, additional measures may be needed to ensure the air quality under Section 3 Environment.

Similarly, work to improve an existing building which includes measures which reduce infiltration should also consider the impact of such work on condensation risk and moisture movement within affected construction elements (see clause 6.2.12).

6.2.7 Air-tightness testing

Low air infiltration rates will contribute to energy performance but should not be so low as to adversely affect the health of occupants or the building fabric. There is, therefore, a need to establish building performance by test to demonstrate compliance in both these respects.

All new non-domestic buildings and large extensions which are subject to Standard 6.1 (carbon dioxide emissions) should be tested on completion, with the following exceptions:

a. multiple units, under the same building warrant, of not more than 150m² in floor area and of the same form and construction. A sample of 1 in 20 units or part thereof may be tested as it can be considered that all units will have a similar build standard. The verifier should select the units to be tested by the applicant

b. modular building of less than 500m² where no site work is needed other than connection of modules, provided test results for similar configuration of modules with the same connection details is available

c. large extensions subject to Standard 6.1, where a default infiltration rate of 10m³/h.m² @ 50 Pa is declared for the actual building, and

d. new buildings where due to size or complexity, it is impractical to carry out testing of the building, provided this has been demonstrated as part of the building warrant submission and evidence to support the declared infiltration rate is provided.

Testing should be in accordance with BS EN 13829:2001 – ‘Thermal performance of buildings - determination of air permeability of buildings - fan pressurisation method’. Practical advice on procedure for pressure testing is given in the ATTMA publication ‘Measuring Air Permeability of Building Envelopes’ (http://www.attma.org/).

Testing should be carried out by persons who can demonstrate relevant, recognised expertise in measuring the air permeability of buildings. This should include membership of a professional organisation which accredits its members as competent to test and confirm the results of testing.

Further advice on the application of these exceptions and on testing in general is provided in chapter 5 of the BSD publication ‘Sound and air-tightness testing, 2015 Edition’ http://

www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/ast2015.

Shell and fit-out buildings - where a shell building is subject to a continuing requirement under Standard 6.1, testing should be carried out both at completion of the shell and, again when the fit-out is completed.

6.2.8 Introducing heating to unheated buildings and conversion of unheated buildings

A building that was originally designed to be unheated has, in most instances, the greatest void to fill in terms of energy efficiency. The introduction of heating to such buildings will, if not accompanied by fabric insulation, result in disproportionate heat loss and wasteful use or fuel and power.

Where such a building is converted or heating is introduced to a building that was previously designed to be unheated, the building should achieve a level of performance similar to those for an extension to the insulation envelope of a non-domestic building and follow the guidance given in clauses 6.2.11 to 6.2.12.

In this context, existing buildings where heating is provided solely for the purpose of frost protection (rated at a maximum of 25W per m² of floor area) shall be treated as unheated buildings.

6.2.9 Conversion of heated buildings

In the case of a building that was previously designed to be heated, the impact on energy efficiency as a result of the conversion may be detrimental but could be negligible, or in some circumstances even an improvement. A less demanding approach than identified in clause 6.2.8 is applied which aims to ensure that some overall improvements are being made to the existing building stock.

Where an extension is formed and/or alterations are made to the building fabric at the same time as the conversion, the guidance given in clauses 6.2.11 to 6.2.13 should be also followed.

Where conversion of a heated building is to be carried out, the insulation envelope should be examined and upgraded following the table below:

Table 6.5 Conversion of heated buildings - maximum U-values for building elements

Type of element	(a) Area weighted average U-value (W/m^2K) for all elements of the same type	(b) Individual element U-value (W/m^2K)
Wall [1]	0.30	0.70
Floor [1] [2]	0.25	0.70
Roof [1] [2]	0.25	0.35
Windows, doors, roof windows and rooflights [3]	1.6	3.3

Notes:

1. Where upgrading work is necessary to achieve the recommended U-values, reference should be made to 'Reconstruction of elements' in clause 6.2.13 and more demanding U-values achieved, where reasonably practicable.

2. Excluding separating walls and separating floors between heated areas where thermal transmittance need not be assessed, provided measures are taken to limit heat loss arising from air movement within a cavity separating wall (see clause 6.2.1).

3. There is no maximum U-value for display windows (refer to clause 6.2.2).

6.2.10 Conversion of historic, listed or traditional buildings

With historic, listed or traditional buildings, the energy efficiency improvement measures that should be invoked by conversion can be more complex.

Whilst achieving the values recommended in clauses 6.2.8 and 6.2.9 should remain the aim, a flexible approach to improvement should be taken, based upon investigation of the traditional construction, form and character of the building in question and the applicability of improvement methods to that construction. Provisions under other legislation (e.g. planning consent for listed buildings or those within conservation areas, where there is a need to maintain character, form or features) are also relevant. The manner in which proposed improvements may affect moisture movement or the permeability of existing constructions will also require assessment to address the risk of adverse consequences.

For all buildings, it would be advisable to consider the feasibility of upgrading fabric to at least the U-values given in column (b) in clause 6.2.11 (individual element U-values). In many cases, specialist advice will help ensure that, in improving energy efficiency, there is no other, adverse effect to the building fabric.

Accordingly, each building will have to be dealt with on its own merits. Improvements to the fabric insulation of the building will often depend on factors such as whether or not improvement work can be carried out in a non-disruptive manner without damaging existing fabric (for example, insulating the ceiling of an accessible roof space), or whether potential solutions are compatible with the existing construction.

In certain cases, buildings are given historic or listed status because of specific features present in certain parts of the building. In these circumstances, it may be possible to make greater improvements to other less sensitive areas.

In all cases the ‘do nothing’ approach should not be considered initially. Innovative but sympathetic and practical solutions to energy efficiency, which are beyond the scope of this guidance, can often result in an alternative package of measures being developed for a building. For example, carbon dioxide emissions can be reduced without affecting building fabric through improvements to the heating system (refer to Standards 6.3 and 6.4), the lighting system (refer to Standard 6.5) or incorporation of low carbon equipment (such as biomass boilers, heat pumps or CHP). Consultation on such matters at an early stage with both the verifier and the planning officer of the relevant authority is advised.

Further guidance on issues that merit consideration and potential approaches to improvement can be found in the Historic Scotland Document ‘Guide for Practitioners 6 - Conversion of Traditional Buildings’ http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/hsg6ctb.

6.2.11 Extensions to the insulation envelope

Other than for large extensions where Standard 6.1 applies, measures to limit energy demand and carbon dioxide emissions rely primarily upon the performance of the new building fabric.

As the majority of the construction work for an extension will be new, there will seldom be a need to consider construction to a lesser specification as is sometimes the case for

conversions and alterations. The exception to this is at the junction between existing and new building work, for example the need for proprietary metal ‘wall starter’ ties where the existing brickwork stops and new cavity blockwork begins. However other building standards should still be met with regard to such transitional construction elements.

Where the insulation envelope of a building is extended, the new building fabric should be designed in accordance with the following table:

Table 6.6 Extensions - maximum U-values for building elements

Type of element	(a) Area weighted average U-value for all elements of the same type (W/m^{2}K)[1]	(b) Individual element U-value (W/m^{2}K)
Wall [2]	0.25	0.70
Floor [2]	0.20	0.70
Roof	0.15	0.35
Windows, doors, roof windows and rooflights [3]	1.6	3.3

Notes:

1. For extensions to modular and portable buildings, refer to the maximum area-weighted U-values for new buildings identified in annex 6.

2. Excluding separating walls and separating floors between heated areas where thermal transmittance need not be assessed, provided measures are taken to limit heat loss arising from air movement within a cavity separating wall (see clause 6.2.1).

3. There is no maximum U-value for display windows (refer clause 6.2.2).

Where the insulation envelope of a building is extended, the new opening areas should be designed in accordance with the table below:

Table 6.7 Extensions - Maximum windows, doors and roof-light areas

Building Type	Windows and doors as % of the area of exposed wall	Roof-lights as % of area of roof
Residential buildings, offices, shops and buildings for entertainment and assembly purposes	40	20
Industrial and storage buildings	15	20

‘Compensatory approach' using a notional extension - the U-values for the elements involved in the building work may be varied provided that the overall heat loss of all the elements in the extension is no greater than that of a 'notional' extension. The ‘notional’ extension should be the same size and shape as the proposed extension, with U-values for elements as in column (a) of the table above, where the area of openings in the walls (excluding separating walls where it is considered that zero heat loss occurs) and roof of the 'notional' building extension are as the percentages given above. An example of this approach is given in annex 6B.

Alternative approach - an alternative to the use of the area-weighted U-values described above is use of SBEM to demonstrate compliance with Standard 6.1 for:

- the extension alone, where assessment of fabric and the energy efficiency of the building services systems can be considered in isolation from the existing building, or
- the entire building, as extended where detailed information exists of the original construction and building services. This option will be most viable where both extension and existing building are built to the same, current edition of the standards.

6.2.12 Thermal bridging and air infiltration for existing buildings

Where works are to alter, extend or convert a building, the elements involved in the building work should follow the guidance given in clauses 6.2.5 and 6.2.6 on limiting heat loss from thermal bridging and air infiltration and reference should be made to the principles set out in the BSD document ‘Accredited Construction Details (Scotland) 2015' http://www.gov.scot/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks. Calculation of heat loss from linear thermal bridging is not necessary unless the SBEM methodology is being used to demonstrate compliance.

In addition the recommendations within the Building Research Establishment (BRE) report 262 'Thermal Insulation, avoiding risks' 2002 edition, can be followed (http://www.brebookshop.com/).

It should be noted that, unless the SBEM methodology is being used to demonstrate compliance, air-tightness testing is not necessary for work to existing buildings. In such cases, a default value of 10m³/h.m² @ 50Pa can be assumed or testing carried out as identified in clause 6.2.7.

6.2.13 Alterations to the insulation envelope

For alterations, it is more than likely that the existing construction will be from a different era, in building regulation terms. In many instances each building will need to be considered on its own merits. Some of the guidance given in this clause is written in specific terms, but in certain cases (e.g. historic or traditional buildings), it may be necessary to adopt alternative energy efficiency measures which are appropriate to the amount of alteration work being undertaken.

The extent to which improvement can be delivered will be affected by a range of issues, such as:

- the form and construction of the existing envelope and the scope of works
- the extent to which improvement is technically feasible without the risk of adverse consequences, and
- the impact of any other statutory requirements to which the building is subject (e.g. listing, conservation area).

Extending the insulation envelope - reference should be made to the guidance on extensions to the insulation envelope (clause 6.2.11) for alterations that involve increasing the floor area and/or bringing parts of the existing building that were previously outwith the insulation envelope into the conditioned part of the building. Examples of such work could be, changing a roof space, part of an unheated warehouse, or a deep solum space into office accommodation:

- in the case of a roof space, this will usually involve extending the insulation envelope to include the gables, the collars, part of the rafters and the oxters, as well as any new or existing dormer construction. The opportunity should be taken at this time to upgrade any remaining poorly performing parts of the roof which are immediately adjacent to the alterations, for example, insulation to parts of the ceiling ties at the eaves

- in the case of an unheated warehouse, this will usually involve extending the insulation envelope to include the existing floor, perimeter walls and the roof/ceiling to the new office area, and

- in the case of a deep solum space, this will usually involve extending the insulation envelope to include, the solum/existing floor and perimeter walls to the new office area.

Alterations to the insulation envelope of a building should be considered using the guidance in the following paragraphs.

Infill of small openings - the infill of an existing opening of approximately $4m^2$ or less in the building fabric should have a U-value which matches at least that of the remainder of the surrounding element. In the case of a wall or floor however it should not be worse than $0.70W/m^2K$ and for a roof, not worse than $0.35W/m^2K$.

Infill of large openings - the infill of an existing opening of greater area (than approximately $4m^2$) in the building fabric should have a U-value which achieves those in column (a) of the table to 6.2.11. Another way would be to follow the guidance in the paragraph above, but compensate for the energy efficiency deficit by improving the overall U-value of other parts of the insulation envelope.

Internal elements which become part of the insulation envelope - alteration can cause an existing internal element of a building to become part of the insulation envelope. This will most likely occur where a part of a building is permanently removed as a phase of the alteration work. Where this occurs, that part of the building (including any infill construction) should meet the maximum U-values recommended under clause 6.2.11. Another approach would be to follow the guidance given in the previous paragraph, but compensate for the energy efficiency deficit by improving the overall U-value of other parts of the insulation envelope.

However, where this occurs at a boundary, no upgrading is necessary if the element is a wall that is exclusively the property of the adjoining building.

Windows, doors and rooflights - where windows, doors and rooflights are being created or replaced, they should meet the maximum U-values recommended in clause 6.2.11. An example of a compensatory approach for windows, doors and rooflights is given in annex 6A.

Where the work relates only to 1 or 2 replacement windows, each window may have a centre pane U-value of no worse than $1.2W/m^2K$. For secondary glazing, an existing window, after alteration should achieve a maximum U-value of $3.5W/m^2K$.

There are no limits imposed on U-values for display windows (refer to clause 6.2.2).

Reconstruction of elements - where the build-up of an element forming part of the insulation envelope is to be altered or dismantled and rebuilt, the opportunity should be taken to improve the level of thermal insulation.

Column (a) of the table to clause 6.2.11 gives benchmark U-values and in many cases these can be achieved without technical risk, within the constraints of the existing construction. It is recognised however that certain constructions are easier to upgrade than others and these values should be met as far as is reasonably practicable.

A building that was in a ruinous state should, after renovation, be able to achieve almost the level expected of new construction. It may not however be reasonably practicable for a building to have its internal space significantly reduced in area or height in order to accommodate insulation, or for excessive enabling alterations to be caused by the fitting of external thermal insulation, unless the owner/occupier of the building intends that these changes are to be made. Other building standards and the impact that they will have when upgrading thermal insulation should be taken into account.

In the majority of cases however after an alteration of this nature to the insulation envelope, a roof should be able to achieve at least an average U-value of 0.35W/m²K and in the case of a wall or floor, 0.70W/m²K.

For older buildings of traditional construction, further guidance to assist in this assessment can be found in the Historic Scotland Document ‘Guide for Practitioners 6 - Conversion of Traditional Buildings’ http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/hsg6ctb.

Thermal bridging and sir infiltration - when alterations are carried out, attention should still be paid to limiting thermal bridging at junctions and around windows, doors and rooflights and also limiting air infiltration (clause 6.2.12). As far as alterations are concerned, only the work that forms the alteration and the impact of that work on the existing building need be considered.

6.3 Heating system

Mandatory Standard

Standard 6.3

Every building must be designed and constructed in such a way that the heating and hot water service systems installed are energy efficient and are capable of being controlled to achieve optimum energy efficiency.

Limitation:

This standard does not apply to:

a. buildings which do not use fuel or power for controlling the temperature of the internal environment, or

b. heating provided solely for the purpose of frost protection.

6.3.0 Introduction

In the design of buildings, the energy efficiency of the heating plant is an important part of the package of measures which contributes to the overall building carbon dioxide emissions. In practice the backstop levels for appliance efficiencies and controls will normally be exceeded to achieve compliance with Standard 6.1. for new buildings.

Good control of space heating is essential for conservation of energy in buildings, as without it, the potential of energy efficient heating plant cannot be realised. Generally the system should have sufficient zone, time and temperature controls to ensure that the heating system only provides the desired temperature when the building is occupied. Such operating controls can be overridden however when heating is needed to protect the building's structure, services or contents from frost or condensation damage.

There are efficiency issues which go beyond the guidance to the standard. These include:

- a heating system boiler should be correctly sized to ensure energy efficiency
- where future heating capacity may be required consideration should be given to providing additional space for extra plant. The pipe-work or ductwork should be configured to allow for the future loading, and

- other efficiency targets which may be appropriate for a system, to achieve improved performance under the requirements of government climate change and energy saving schemes.

Renewable Technologies - Directive 2009/28/EC (http://europa.eu/legislation_summaries/energy/renewable_energy/en0009_en.htm) promotes the use of energy from renewable sources. Where the building design will include use of renewable energy for heating, Article 13 of the Directive recommends, amongst other measures, consideration of use of the following:

- for biomass equipment, conversion efficiencies of 85%
- for heat pumps, those that fulfil the minimum requirements of eco-labelling established in Commission Decision 2007/742/EC (amended in 2011 & 2013) establishing the ecological criteria for the award of the Community eco-label to electrically driven, gas driven or gas absorption heat pumps, and
- for solar thermal systems, those that are subject to EU standards, including eco-labels and other technical reference systems established by the European standardisation bodies.

Conversions - in the case of conversions, as specified in regulation 4, the building as converted shall meet the requirements of this standard in so far as is reasonably practicable, and in no case be worse than before the conversion (regulation 12, schedule 6).

6.3.1 Performance of fixed heating systems in new and existing buildings

The minimum performance of, space heating and hot water systems, heating appliances and controls is set out in the Non-domestic Building Services Compliance Guide for Scotland http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/ndbscg.

The document replicates guidance published in support of building standards elsewhere in the UK and supports standardisation of the specification and expected performance of fixed building services throughout the UK. The guidance applies to new systems and replacement, in whole or in part, of existing systems. It also addresses improvement work to existing systems as a consequence of replacing components.

Clause 6.3.2 provides information on situations not addressed in that document.

Older buildings - in many cases heating system improvements to historic buildings will be more feasible than any other energy efficiency measures, for example improving wall insulation. Where this is the case, systems which go beyond these minimum backstop levels may help offset the deficiency in other areas of energy efficiency and carbon dioxide emissions.

6.3.2 Consequential improvement

Where work to an existing building is subject to a building warrant and includes the provision of new fixed building services or alters or extends the capacity of existing fixed building services, the opportunity should be taken to review and improve the performance of fixed building systems.

Guidance on the extent to which improvement should be made is given in annex 6.D – ‘Improvement to the energy performance of existing building services when carrying out building work’.

6.4 Insulation of pipes, ducts and vessels

Mandatory Standard

Standard 6.4

Every building must be designed and constructed in such a way that temperature loss from heated pipes, ducts and vessels, and temperature gain to cooled pipes and ducts, is resisted.

Limitation:

This standard does not apply to:

a. buildings which do not use fuel or power for heating or cooling either the internal environment or water services

b. buildings, or parts of a building, which will not be heated, other than heating provided solely for the purpose of frost protection, or

c. pipes, ducts or vessels that form part of an isolated industrial or commercial process.

6.4.0 Introduction

Thermal insulation to heating and cooling pipes and ducts and hot water storage vessels will improve energy efficiency by preventing:

- uncontrolled heat loss or heat gains from such equipment, or
- an uncontrolled change in the temperature of the parts of the building where such equipment is situated.

For cooling systems it is important to ensure the risk of condensation is adequately controlled.

Conversions - in the case of conversions, as specified in regulation 4, the building as converted must be improved to as close to the requirement of this standard as is reasonably practicable, and in no case be worse than before the conversion (regulation 12, schedule 6).

6.4.1 Insulation of pipes, ducts and vessels into new and existing buildings

Guidance on the insulation of pipes, ducts and vessels is set out, in the context of the systems of which they form a part, in the Non-domestic Building Services Compliance Guide for Scotland http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/ndbscg.

The document replicates guidance published in support of building standards elsewhere in the UK and supports standardisation of the specification and expected performance of fixed building services throughout the UK. The guidance applies to new systems and replacement, in whole or in part, of existing systems. It also addresses improvement work to existing systems as a consequence of replacing components.

Clauses 6.4.2 & 6.4.3 provide information on situations not addressed in that document.

6.4.2 Work on existing buildings

Where a new boiler or hot water storage vessel is installed, or where existing systems are extended, new or existing pipes, ducts and vessels that are accessible or exposed as part of the work should be insulated as for new systems. This will not be necessary where the pipes or ducts always contribute to the heating or cooling demands of the room or space and the pipes or ducts are located at a height of 3m or less above the floor. Replacement hot water storage vessels should be insulated as for new systems.

It is recognised that complete insulation will sometimes not be possible, where such services pass through or around structural building components, floor joists, for example, or where existing systems are wholly or partially retained as part of conversion works. In such cases, insulation should be fitted as for new systems as far as is reasonably practicable.

6.4.3 Consequential improvement

Where work to an existing building is subject to a building warrant and includes the provision of new fixed building services or alters or extends the capacity of existing fixed building services, the opportunity should be taken to review and improve the performance of fixed building systems.

Guidance on the extent to which improvement should be made is given in annex 6.D –'Improvement to the energy performance of existing building services when carrying out building work'.

6.5 Artificial and display lighting

Mandatory Standard

Standard 6.5

Every building must be designed and constructed in such a way that the artificial or display lighting installed is energy efficient and is capable of being controlled to achieve optimum energy efficiency.

Limitation:

This standard does not apply to:

a. process and emergency lighting components in a building, or

b. alterations in dwellings or a building ancillary to a dwelling.

6.5.0 Introduction

Artificial and display lighting can account for a substantial proportion of the electricity used within a building. Appropriate lighting design (including daylighting) can not only reduce CO_2 emissions and associated running costs, but also reduce internal heat gains and lessen any need for mechanical cooling.

There are issues which go beyond the guidance that designers may wish to consider:

- when designing a lighting system consideration should be given to the advances in lighting technology, particularly with light emitting diodes technology (LED), and
- the system design should accommodate future upgrading with minimal disruption to the building fabric and services.

Conversions - in the case of conversions, as specified in regulation 4, the building as converted shall meet the requirements of this standard in so far as is reasonably practicable, and in no case be worse than before the conversion (regulation 12, schedule 6).

6.5.1 Lighting efficiency and controls

Guidance on the efficiency of fixed internal and external lighting is given in the Non-domestic Building Services Compliance Guide for Scotland http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/ndbscg.

The document replicates guidance published in support of building standards elsewhere in the UK and supports standardisation of the specification and expected performance of fixed building services throughout the UK. The guidance applies to new systems and replacement, in whole or in part, of existing systems. It also addresses improvement work to existing systems as a consequence of replacing components.

Clause 6.5.2 provides information on situations not addressed in that document.

6.5.2 Consequential improvement

Where work to an existing building is subject to a building warrant and includes the provision of new fixed building services or alters or extends the capacity of existing fixed building services, the opportunity should be taken to review and improve the performance of fixed building systems.

Guidance on the extent to which improvement should be made is given in annex 6.D – ‘Improvement to the energy performance of existing building services when carrying out building work’.

6.6 Mechanical ventilation and air conditioning (MVAC)

Mandatory Standard

Standard 6.6

Every building must be designed and constructed in such a way that:

a. **the form and fabric of the building minimises the use of mechanical ventilating or cooling systems for cooling purposes, and**

b. **the ventilating and cooling systems installed are energy efficient and are capable of being controlled to achieve optimum energy efficiency.**

Limitation:

This standard does not apply to buildings which do not use fuel or power for ventilating or cooling the internal environment.

6.6.0 Introduction

Mechanical ventilation is a primary energy intensive process and air conditioning is even more so. When considering the installation of mechanical ventilation (not including refrigeration) and air conditioning (including heating and cooling elements) (MVAC), attention should therefore be given to the following:

- form and fabric of the building
- energy efficiency of the equipment, and
- control of the equipment.

For new buildings the zone by zone approach explained in the guidance to Standard 6.1 allows designers the flexibility to assign cooling only to those zones of an otherwise heated only building, where heating and cooling is required, therefore reducing the overall energy use and carbon dioxide emissions of the building.

Designers may wish to design beyond the current guidance and consider the risks of higher internal temperatures occurring more often due to solar gains. CIBSE Technical Memorandum 36 (TM36) 'Reducing overheating – a designer's guide' (http://www.cibse.org/) gives guidance on this issue.

The designer should consider natural ventilation strategies appropriate for the building geometry (which could include a combination of brise soleil, natural ventilation controls and daylight controls). Particular attention should be paid to limiting solar gains by ensuring that areas of the external building fabric which are susceptible to solar gain have appropriate areas of solar shading. A ventilation strategy that incorporates night cooling and the thermal mass of a building should also be considered.

Free cooling should be optimised in order to minimise the need for mechanical ventilation and air conditioning. When the external air temperature is higher than the space temperature the system design should allow the provision of a minimum level of fresh air. Enthalpy control should also be considered to improve free cooling.

Should natural ventilation fail to achieve the required occupied period temperature, the designer could consider mixed-mode ventilation. A mixed-mode building integrates the use of air conditioning when and where it is necessary, with use of natural ventilation whenever it is feasible or desirable, to maximise occupant comfort whilst reducing energy use (compared to 'year round' use of air conditioning).

Conversions - in the case of conversions, as specified in regulation 4, the building as converted shall meet the requirement of this standard in so far as is reasonably practicable, and in no case worse than before the conversion (regulation 12, schedule 6).

6.6.1 Form and fabric in relation to MVAC equipment

The form and fabric of the building should mitigate solar gains and result in minimum installed capacity of mechanical ventilation and cooling equipment. When considering the proportions of glazing in the building, the designer should also consider the provision of daylight controls and adequate levels of daylight – refer to BS 8206-2: 2008 'Lighting for buildings. Code of Practice for daylighting' for guidance on daylighting. For example, CIBSE suggest that for office type spaces, the number of occupied hours above 28ºC should not exceed 1% of the annual occupied period. CIBSE Technical Memorandum 37 (TM37) 'Design for Improved Solar Shading Control' (http://www.cibse.org/) provides a method for assessing the risks of excessive temperatures occurring in the building.

6.6.2 MVAC equipment efficiency, distribution systems and controls in new and existing buildings

Guidance on the efficiency of mechanical ventilation and air conditioning systems is given in the Non-domestic Building Services Compliance Guide for Scotland http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/ndbscg.

The document replicates guidance published in support of building standards elsewhere in the UK and supports standardisation of the specification and expected performance of fixed building services throughout the UK. The guidance applies to new systems and replacement, in whole or in part, of existing systems. It also addresses improvement work to existing systems as a consequence of replacing components.

Clause 6.6.3 provides information on situations not addressed in that document.

6.6.3 Consequential improvement

Where work to an existing building is subject to a building warrant and includes the provision of new fixed building services or alters or extends the capacity of existing fixed building services, the opportunity should be taken to review and improve the performance of fixed building systems.

Guidance on the extent to which improvement should be made is given in annex 6.D – 'Improvement to the energy performance of existing building services when carrying out building work'.

6.7 Commissioning building services

Mandatory Standard

Standard 6.7

Every building must be designed and constructed in such a way that energy supply systems and building services which use fuel or power for heating, lighting, ventilating and cooling the internal environment and heating the water, are commissioned to achieve optimum energy efficiency.

Limitation:

This standard does not apply to:

a. major power plants serving the National Grid

b. the process and emergency lighting components of a building

c. heating provided solely for the purpose of frost protection, or

d. energy supply systems used solely for industrial and commercial processes, leisure use and emergency use within a building.

6.7.0 Introduction

Commissioning in terms of this section means, raising the building services systems covered by this guidance from a level of static completion to full working order and achieving the levels of energy efficiency that the component manufacturers expect from their product(s). Commissioning however should also be carried out with a view to enabling the safe operation of the installation.

Although there is no requirement within Section 6 for minimum efficiency levels of either, building-integrated or localised energy supply systems (e.g. diesel generators, micro wind turbines or photovoltaic arrays), there is a need for commissioning to be carried out to enable efficient use, unless they are exempt under schedule 1, regulation 3. Power plants which serve a number of buildings (e.g. an industrial estate) and only export surplus electricity to the National Grid will also need to be commissioned, unless exempt in terms of schedule 1, regulation 3. Automatic monitoring and targeting systems, when present, should also be commissioned to deliver the required outputs.

Conversions - in the case of conversions, as specified in regulation 4, the building as converted shall meet the requirement of this standard (regulation 12, schedule 6).

6.7.1 Inspection and commissioning

A building services installation in a building should be inspected and commissioned in accordance with manufacturers' instructions to enable optimum energy efficiency. The building and services should have facilities such as test points, inspection hatches and measuring devices to enable inspection, testing and commissioning to be carried out. The commissioning report should include meters and the metering system as a separate item.

One way that can be considered as following the guidance would be to use the CIBSE Commissioning Codes (http://www.cibse.org/) and BSRIA Commissioning Guides (http://www.bsria.co.uk/).

6.7.2 Ductwork leakage testing

One way that can be considered as following the guidance would be by confirming that the leakage testing has achieved the equivalent leakage performance standards specified in BES DW/143 – 'Guide to good practice ductwork air leakage testing' [http://www.b-es.org/].

6.7.3 Work on existing buildings

Ductwork leakage testing (see above clause) can only be carried out on ducts that are completely new and where it is possible to isolate the new duct from the existing.

6.8 Written Information

Mandatory Standard

Standard 6.8

The occupiers of a building must be provided with written information by the owner:

a. **on the operation and maintenance of the building services and energy supply systems, and**

b. **where any air-conditioning system in the building is subject to regulation 17, stating a time-based interval for inspection of the system.**

Limitation:

This standard does not apply to:

a. major power plants serving the National Grid

b. buildings which do not use fuel or power for heating, lighting, ventilating and cooling the internal environment and heating the water supply services

c. the process and emergency lighting components of a building

d. heating provided solely for the purpose of frost protection

e. lighting systems in a domestic building, or

f. energy supply systems used solely for industrial and commercial processes, leisure use and emergency use within a building.

6.8.0 Introduction

Correct use and appropriate maintenance of building services equipment is essential if the benefits of enhanced energy efficiency are to be realised from such equipment. The intention of this standard is to make the information that will help achieve this, available to the occupier of the building.

Although there is no requirement within Section 6 for minimum efficiency levels of either, building-integrated or localised energy supply systems (e.g. diesel generators, micro wind turbines or photovoltaic arrays), there is a need for user and maintenance instructions to enable efficient use unless they are exempt under schedule 1, regulation 3.

Power plants which serve a number of buildings (e.g. an industrial estate) and only export surplus electricity to the National Grid will also need to have user and maintenance instructions, unless exempt in terms of schedule 1, regulation 3.

Instructions on taking readings from the automatic monitoring and targeting systems (AM&T), when present, should be provided to ensure the benefits of the installation are realised.

Conversions - in the case of conversions, as specified in regulation 4, the building as converted shall meet the requirement of this standard (regulation 12, schedule 6).

6.8.1 Logbook information

A logbook should be provided and contain information about all aspects of energy system operation and maintenance to enable the building user to optimise the use of fuel. This should include detailed information on building services plant and controls.

CIBSE Technical Memorandum 31 (TM31) (http://www.cibse.org/) provides guidance on the presentation of a logbook, and the logbook information should be presented in this or a similar manner.

6.8.2 Work on existing buildings

It is recognised that some alterations to building services, because they are done on a piecemeal basis, will not result in optimum energy efficiency being attained for the entire system. Where this occurs, the person responsible for the commissioning of that part of the system should make available to the owner and occupier, a list of recommendations that will improve the overall energy efficiency of the system.

On completion of the extension or alteration to the building services system, the commissioning information should be updated in the logbooks.

6.9 Energy performance certificates

Mandatory Standard

Standard 6.9

Every building must be designed and constructed in such a way that:

a. **an energy performance certificate for the building is affixed to the building, and ***

c. **the energy performance certificate is displayed in a prominent place within the building.**

Limitation:

a. this standard does not apply to:

   i. buildings which do not use fuel or power for controlling the temperature of the internal environment

   ii. non-domestic buildings and buildings that are ancillary to a dwelling that are standalone having an area less than 50 square metres

   iii. conversions, alterations and extensions to buildings other than—

      (aa) alterations and extensions to stand-alone buildings having an area less than 50 square metres that would increase the area to 50 square metres or more, and

      (bb) alterations to buildings involving the fit-out of the building shell which is the subject of a continuing requirement, or

   iv. limited life buildings which have an intended life of less than 2 years

b. Standard 6.9(c) only applies to buildings:

   i. with a floor area of more than 250 square metres

   ii. into which members of the public have an express or implied licence to enter, and

   iii. which are visited by members of the public on at least a weekly basis

* Standard 6.9(b) removed by the Building (Scotland) Amendment Regulations 2008 (http://www.legislation.gov.uk/ssi/2008/310/contents/made).

6.9.0 Introduction

Article 12 of Directive 2010/31/EU (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF) on the Energy Performance of Buildings requires that, when buildings or building units are constructed, sold or rented out, an energy performance certificate (EPC) or a copy thereof is shown to the prospective new tenant or buyer and handed over to the buyer or new tenant. Standard 6.9 ensures the continued presence of such information for buyers and tenants by also making EPCs fixtures within buildings.

EPCs must be produced in an independent manner and be carried out by qualified/ accredited experts. With the exception of EPCs produced in relation to a building warrant applied for before 9 January 2013, EPCs must be produced by members of an Approved Organisation. Scottish Ministers have appointed a number of Approved Organisations (AO) to deliver certification services, with each AO following an Operating Framework which is published on the Building Standards Division website. Information on this framework and Approved Organisations can be found at www.scotland.gov.uk/epc (http://www.scotland.gov.uk/epc).

Scottish Ministers have directed local authorities to apply Standard 6.9 (a) to all existing buildings using Section 25 (2) of the Building (Scotland) Act 2003. The Energy Performance of Buildings (Scotland) Regulations 2008, as amended, place a duty on owners to make EPCs available to prospective buyers and tenants. There are also requirements in those regulations for display of an EPC in buildings exceeding 250m^2 floor area, for both public buildings and buildings frequently visited by the public.

Definitions in application of this standard 'energy performance certificate' has the same meaning as given in The Energy Performance of Buildings (Scotland) Regulations 2008 (http://www.legislation.gov.uk/ssi/2008/309/contents/made).

Guidance leaflets are available on the Building Standards Division website (http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/publications/pubepc) explaining the action that building owners need to take in order to comply.

Conversions - in the case of conversions, as specified in regulation 4 Standard 6.9 does not apply.

6.9.1 Calculating the carbon dioxide emissions for a certificate

The EU Directive allows energy performance to be reflected in one or more numeric indicators. For this to be done in a transparent manner that is meaningful in terms of Scottish building regulations, the measure to be used is carbon dioxide.

Methodology and calculation tool - the certification must be carried out using the Directive compliant methodology and the calculation tool which was used to assess compliance with Standard 6.1. In many cases the SBEM calculation tool (http://www.ncm.bre.co.uk/index.jsp) will have been used for the new building. However if an approved detailed simulation model has been used to comply with Standard 6.1 it is acceptable to use it to do the energy performance calculation to produce the certificate. Scottish climate data should be used in preference to generic UK data.

Use of actual values, Non-domestic buildings - for the purpose of a establishing a rating for the energy performance certificate for a new building, the values and specifications used to obtain building warrant (as varied by any subsequent amendments to warrant) should be adopted. Where a building contains multiple units a rating can be produced for either the whole building or for each individual unit. However if a non-domestic building incorporates within it a dwelling (e.g. a caretaker's flat), a separate certificate should always be provided for the dwelling and reference should be made to the Domestic Technical Handbook.

6.9.2 Information to be provided for buildings

The energy performance certificate must display the following information:

- the postal address of the building for which the certificate is issued
- a unique reference number (other than for an EPC produced in support of a building warrant applied for before 9 January 2013)

- the date of the assessment
- the date of the certificate
- the building type
- the calculation tool used for certification
- the conditioned floor area of the building
- a primary energy indicator
- the current and potential building energy performance rating expressed on a seven band scale representing the following bands of carbon dioxide emissions; A, B, C, D, E, F and G, where A = excellent and G = very poor
- the approximate current CO_2 emissions expressed in kg of CO_2 per m^2 of floor area per annum
- the approximate current energy use expressed in kWh per m^2 of floor area per annum
- the building energy performance rating of the building if built to building regulations current at the date of issue
- a statement indicating that more detailed information on the recommendations made in the EPC is contained in the recommendations report, and
- a statement to the effect that the EPC must be affixed to the building and not to be removed unless it is replaced with an updated version.

The recommendations report, which must accompany the EPC, but which does not have to be affixed to the building or displayed, includes the following additional information:

- further information on recommended improvement measures and sources of further advice
- the main type of heating and fuel
- the type of electricity generation
- whether or not there is any form of building integrated renewable energy generation
- the type of ventilation system, and
- the name and contact details of the party who carried out the assessment and (if applicable) Approved Organisation membership number.

An example of the EPC and recommendations report is available on the Building Standards Division website (http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/enerperfor).

Cost-effective improvement - there are limited cost-effective, energy-efficiency improvements that can be made to the fabric of a building (when no other work is proposed) such as upgrade insulation in an accessible roof space. However there are several low cost measures that can be done to the building services. Examples are:

- fitting low energy lamps throughout the building
- installing lighting management systems
- insulating pipe-valves, and

- fitting variable speed motor control for fans and pumps.

Measures presented on the certificate and recommendations report must meet Scottish building regulations, be relevant to the individual building and be technically feasible.

Additional advice - the recommendations report may give additional advice on projected energy costs and improvements that are cost-effective only when additional work is being carried out e.g. providing insulation when replacing flat roof coverings. Assessors may also wish to identify improvements with longer payback periods and are either aspirational (e.g. photovoltaics) or enhanced management and control features (e.g. automatic monitoring and targeting with alarms for out of range values). Sources of further energy saving advice and funding options are also noted in the recommendations report.

6.9.3 Location of an energy performance certificate

Public buildings over 250m^2 - new buildings with an area over 250m^2 occupied by public authorities and by institutions providing public services to a large number of persons and therefore frequently visited by these persons, must have an energy performance certificate displayed in a prominent place. A suitable location would be an area of wall which is clearly visible to the public in the main entrance lobby or reception.

The public buildings referred to in the paragraph above are described and characterised by meeting all of the following criteria:

a. the area of the building is over 250m^2

b. the building is occupied by public authorities or provides public services to a large number of persons

c. the building is frequently visited, at least weekly, by members of the general public

d. the public have a right of access to the building or the parts thereof providing services directly to the public, and

e. public funding, even in part, is used in the operation of the building, or in the general upkeep of the building or in funding costs of staff employed therein.

Examples of such buildings are:

- colleges (further education, higher education), universities
- community centres
- concert halls, theatres
- crematoria
- day centres
- education centres, schools (nursery, primary, secondary, special)
- exhibition halls (multi-function centres)
- headquarters' buildings (of local authorities such as district councils, health & social services trusts and boards, education and library boards, etc.) where the public have an unqualified right of access (for example to attend council meetings, parliamentary meetings or other events to which the public have access)
- health centres, hospitals
- hostels, halls of residence

- law courts
- leisure centres, swimming pools, sports pavilions
- libraries, museums, art galleries
- offices (passport office, motor tax office, benefits office, etc.) having a public counter and providing services directly to the public
- outdoor centres
- passenger terminals (rail, bus, sea, and air)
- police stations (with a public counter)
- residential care buildings
- visitor centres, and
- youth centres.

The above list is not comprehensive, but indicates the type of buildings which should display an energy performance certificate.

Buildings over 250m^2 frequently visited by the Public - where a new building, other than a public building, has a floor area of more than 250 square metres, members of the public have an express or implied licence to enter and it is so visited on at least a weekly basis, the EPC produced on completion must be displayed as for a public building (noted above).

The types of buildings which would fall into this category include:

- Supermarkets
- Banks
- Sports clubs
- Shopping centres

The requirement for owners and occupiers of existing buildings to display of an EPC is now addressed under regulation 9 of the Energy Performance of Buildings (Scotland) Regulations 2008, as amended. This was introduced through The Energy Performance of Buildings (Scotland) Amendment (No.2) Regulation 2012 (http://www.legislation.gov.uk/ssi/2008/309/contents/made).

Other building types - for all other buildings, the energy performance certificate should be indelibly marked and located in a position that is readily accessible, protected from weather and not easily obscured. A suitable location could be in a cupboard containing the gas or electricity meter or the water supply stopcock.

6.9.4 Small stand-alone buildings

For stand-alone ancillary buildings of less than 50m^2 floor area, an energy performance certificate need not be provided. A stand-alone building may be detached, or attached but thermally separated from a main building. Examples are, in the case of the former, a kiosk for a petrol filling station which is associated with a supermarket and for the latter, one or two offices and a toilet located in an otherwise unheated warehouse. For stand-alone buildings of a floor area of 50m^2 or more that are heated or cooled which are ancillary or subsidiary to the main building, a certificate should be provided, in addition to the one for the main building.

6.10 Metering

Mandatory Standard

Standard 6.10

Every building must be designed and constructed in such a way that each building or part of a building designed for different occupation is fitted with fuel and power meters.

Limitation:

This standard does not apply to:

a. domestic buildings

b. district or block heating systems where each part of the building designed for different occupation is fitted with heat meters, or

c. heating fired by solid fuel or biomass.

6.10.0 Introduction

To enable building operators to measure and manage energy use within a building effectively, a building should be fitted with meters to allow the use of fuel and power to be monitored.

Areas of further good practice in this respect, which building operators can consider include:

- as part of any metering strategy adopted within larger buildings, consideration can be given to the benefits the facility for automatic meter reading and data collection can offer
- where solid mineral fuel or biomass is used, recording the volume of fuel used and calorific value can assist in assessing performance.

Conversions - in the case of conversions, as specified in regulation 4, the building as converted shall meet the requirement of this standard (regulation 12, schedule 6).

6.10.1 Metering

All buildings should be fitted with meters to record fuel and power use. These should be located where they can be easily accessed by the building operator. Information provided under Standard 6.8 should enable building occupiers to be familiar with the metering installation and the locations of meters.

Each area divided by separating walls and separating floors and designed for different occupation, including common areas, should be provided with fuel and power meters to measure energy use in each area.

Where multiple buildings or fire separated units are served on a site by a communal heating appliance, metering shall be installed both at the communal heating appliance and heat meters at the individual buildings served.

Where a combined heat and power installation is present, metering should be provided which measures the hours run, electricity generated, and the fuel supplied to the unit.

CIBSE Technical Memorandum 39 (TM39) 'Building energy metering' provides guidance on preparing a metering strategy.

6.10.2 Sub-metering

In all but the simplest buildings, information on the use of fuel and power, broken down into various end uses, will assist building operators in assessing and improving energy efficiency. To enable this, sub-metering should be provided to allow monitoring of fuel and power consumption to the various end-uses (heating, lighting etc).

The extent to which sub-metering will be beneficial will vary with the size and complexity of fixed building services within the building. Installation of sub-metering should be based upon guidance on the development and implementation of a metering strategy within CIBSE TM 39 - 'building energy metering' (2009) (http://www.cibse.org/). A metering strategy should consider the cost, practicality, and value of the information gained by detailed metering against potential future energy savings.

Low carbon equipment - as part of any strategy, meters should be provided to enable the performance of LCE systems to be separately monitored.

6.10.3 Metering and sub-metering in existing buildings

Where the creation of two or more units in different occupation occurs, each unit should have metering installed. The guidance in the clauses 6.10.1 and 6.10.2 should be applied.

If a new fuel type or new boiler (where none existed previously) is installed, metering should be installed, where not already present.

Annex 6.A Compensating U-values for windows, doors and roof-lights

6.A.0 Introduction

This annex gives guidance on how to calculate the average U-values for windows, doors, and roof-lights and supports the guidance to Standard 6.2. It may be used in the following cases:

a. where it is not possible to input the individual U-values for all the windows, doors and roof-lights for the proposed new building into the calculation methodology

b. for work to existing non-domestic buildings, namely replacements, alterations, extensions, and conversions (Standard 6.2), and

c. for small stand-alone buildings such as one or two offices and a toilet located in an otherwise unheated warehouse.

Individual windows, doors or roof-lights may have U-values that exceed the relevant area-weighted U-values in the guidance to Standard 6.2 provided that the average U-value calculated for all the windows, doors and roof-lights is not greater than that relevant U-value.

The example which follows below illustrates how this trade off can be calculated.

6.A.1 Example of trade-off between windows, doors and roof-lights

An extension to a building has a total window area of 16.9m^2 (including frames) and a total door area of 3.8m^2. It is proposed to use two external quality timber doors with a U-value of 1.9W/m^2K.

In order to meet Standard 6.2, the additional heat loss due to the use of the external doors should be compensated for by more demanding U-values in the windows and/or roof-lights so that the average overall U-value of such elements does not exceed 1.6W/m^2K (see table to clause 6.2.11).

Specifying windows with a U-value of 1.5W/m^2K can achieve this, as shown by the following calculation:

Table 6.8 U-value calculation

Element	Area (m^2)		U-value (Wm^2K)		Rate of heat loss per degree (W/K)
Windows	16.9	x	1.5 [1]	=	25.35
Doors	3.8	x	1.9	=	7.22
Roof-lights	0.9	x	1.8 [1]	=	1.62
Total	21.6				34.19

Notes:

1. Note that although the windows and rooflights have the same U-value, for the purpose of calculation the rooflight value is 0.3W/m^2K poorer due to inclination from the vertical plane (see BR 443 - 'Conventions for U-value Calculations' http://www.bre.co.uk/filelibrary/pdf/rpts/br_443_(2006_edition).pdf).

This gives an average U-value of 34.19 ÷ 21.6, or 1.58W/m^2K, which is below 1.8Wm^2K. The windows, doors and rooflights therefore meet the performance required for the insulation envelope under Standard 6.2.

Annex 6.B Compensatory approach - heat loss example

6.B.0 Introduction

This annex gives an example of the compensatory approach which can be used in the design of conversions, extensions and alterations. This is likely to be of use where there is a need to specify one or more constructions with a U-value higher than the recommended maximum area-weighted average U-values given in column (a) of the table to clause 6.2.11.

The example given in this instance is for an extension. However the same principles are relevant to a conversion or to substantial alterations.

Note that this method cannot be used in conversions, if recommended U-values are only being met as far as is reasonably practicable.

Separate work under the same building warrant - a single compensatory approach calculation can be carried out to cover separate areas of work to an existing building

provided the same assessment criteria (maximum U-values, etc) are applicable to each area of work.

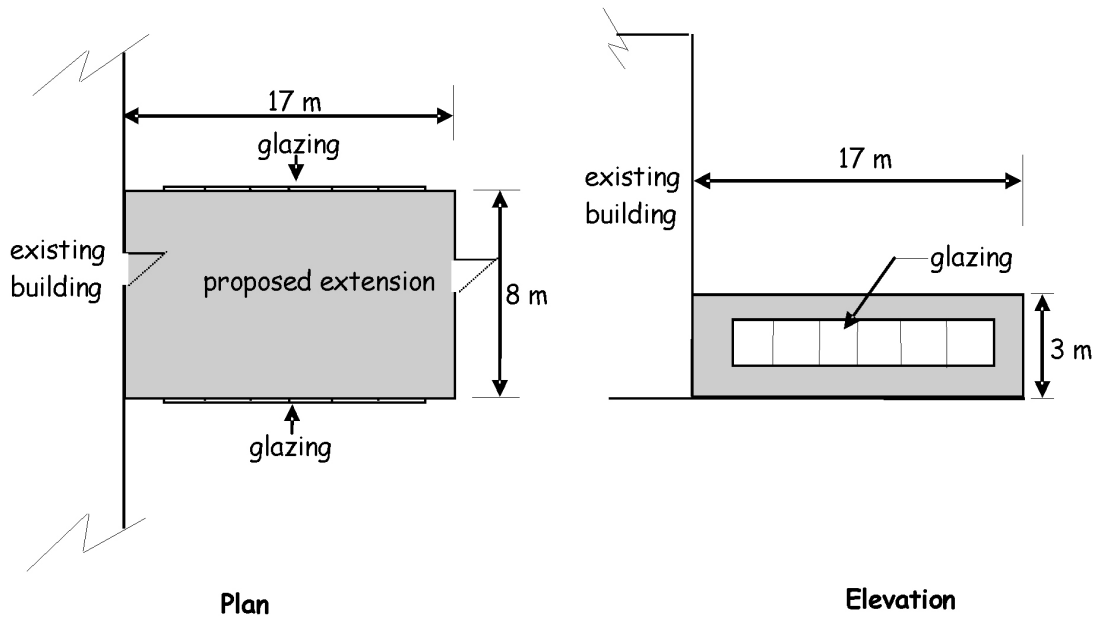
6.B.1 Example - extension to an existing building

It is proposed to form a 3m high extension onto an existing single storey office building. The extra floor area created will be 136m^2. A plan of the proposed layout is shown in the figure below. In this example the principle compensatory measure is the omission of roof-lights, as the designer considers that it is easier to provide solar shading to slightly larger windows. The existing building and extension will be heated to a similar degree so there is no heat loss considered between these 2 areas.

Procedure:

- The internal exposed surface areas of each of the elements of the proposed building insulation envelope that have different area weighted U-values are calculated.
- The heat loss for the proposed extension is calculated using proposed U-values for building elements, which may be higher or lower than those recommended in column (a) of the table to clause 6.2.11. The percentage area of windows and doors area as proposed may be greater than the maximum percentage area of the exposed wall area noted in clause 6.2.11.
- The heat loss for a ‘notional’ extension (i.e. a building of the same size and shape as the proposed but with its area window and doors at the maximum percentage area noted under clause 6.2.11) is calculated using the maximum area-weighted average U-values in the table to clause 6.2.11.
- Finally, the heat loss calculated for the proposed building should be not more than that for the 'notional' one.

Figure 6.1 Extension example



6.B.2 Proposed extension

From the information in 6.B.1 the rate of heat loss from the proposed extension is then calculated as follows:

Table 6.9 Proposed extension heat loss calculation

Exposed Element	Exposed surface area (m^2)	U-value (W/ m^2 K)	Rate of heat loss (W/K)
External wall	126-63 = 63	x 0.22 =	13.86
Roof	136.0	x 0.16 =	21.76
Floor	136.0	x 0.22 =	29.92
External Door	3.0	x 1.8 =	5.4
Window	2 of (15x2m) = 60.0	x 1.8 =	108
Roof-light	Not applicable		
Total rate of heat loss		=	**178.94**

6.B.3 'Notional extension'

The rate of heat loss from the notional extension is then calculated as follows:

Table 6.10 Notional extension heat loss calculation

Exposed Element	Exposed surface area (m^2)	U-value (W/ m^2 K)	Rate of heat loss (W/K)
External wall	126 - 50.4 = 75.6	x 0.25 =	18.90
Roof	136 - 27.2 =108.8	x 0.15 =	16.32
Floor	136	x 0.20 =	27.20
Window + Ext. Door	50.4 (40%)	x 1.6 =	80.64
Roof-light	27.2 (20%)	x 1.6 =	43.52
Total rate of heat loss		=	**186.58**

6.B.4 The comparison

The rate of heat loss from the proposed extension (178.94) is less than that from the ‘notional extension’ (186.58). Proposals will comply.

Annex 6.C Energy performance of modular and portable buildings

6.C.0 Introduction

Modular and portable buildings are prefabricated buildings which are designed for delivery to site as sub-assemblies, connected together and completed on site. These buildings can be disassembled into their sub-assemblies when no longer required and transported to another location and reassembled.

Sub-assemblies are clearly identifiable elements manufactured from a number of components but not the components or raw materials themselves. They can be single or multiple volumetric modules or external wall pack modules.

An alternative compliance route is provided to recognise both the common manufacturing base for UK sub-assemblies and the benefits reuse of existing sub-assemblies offers in respect of embodied energy savings (subject to a specified minimum performance).

For the purpose of this guidance, a modular or portable building is defined as a building which has more than 70% of its external envelope created from sub-assemblies. Sub-assemblies can be manufactured and supplied to order, obtained from a centrally held stock or from the disassembly of existing modular buildings on other premises.

This annex provides guidance and offers an alternate means of meeting Standards 6.1 and 6.2, where a building is categorised as a modular or portable building. Reference should be made to the main text within Section 6 (Energy) for application of Standards 6.3 to 6.10.

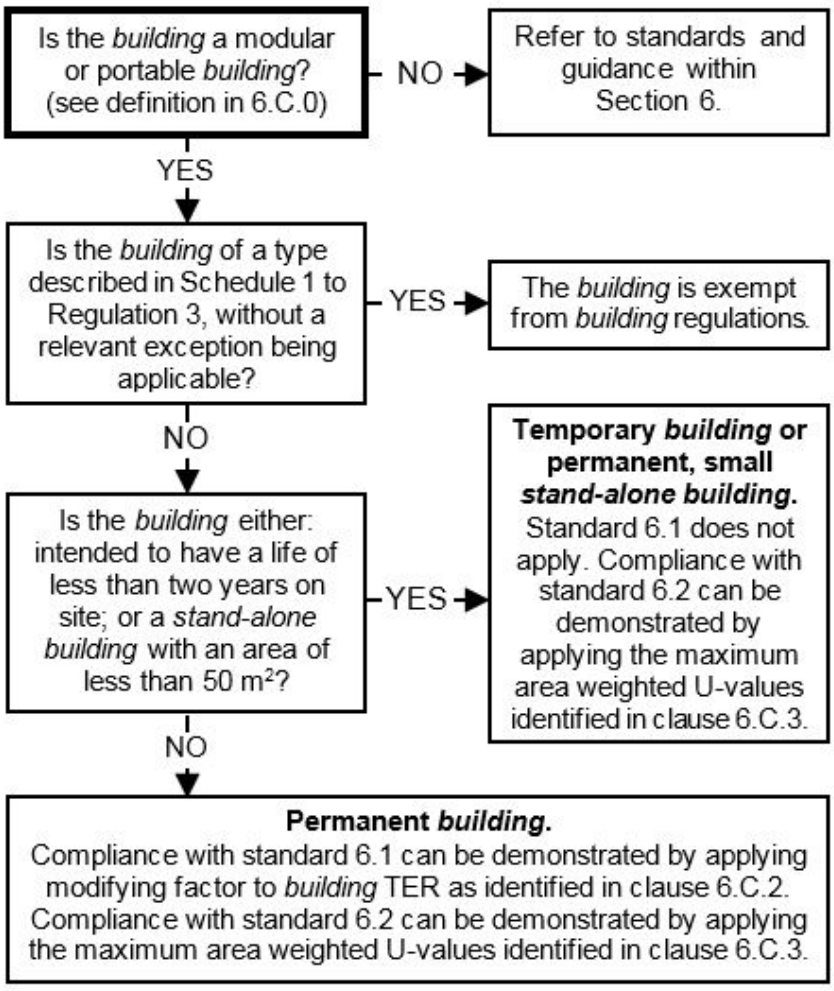
Note that, where the intended life of such a building is less than 2 years or the building is a stand-alone building having an area less than 50m^2, Standard 6.1 does not apply.

6.C.1 Compliance flowchart

The following flowchart will assist designers and verifiers to determine the measures which should be applied to a modular or portable building to demonstrate compliance with Standards 6.1 and 6.2.

Figure 6.2 Compliance flowchart

6.C.1 Compliance flowchart
The following flowchart will assist designers and verifiers to determine the measures which should be applied to a modular or portable *building* to demonstrate compliance with standards 6.1 and 6.2



6.C.2 Determining the Target Emissions Rate for permanent modular and portable buildings

To enable the continued use of existing stocks of building modules and sub-assemblies, subject to fabric insulation meeting the U-values noted in clause 6.C.3, a modifying factor can be applied to increase the Target Emissions Rating (TER) for the building. Calculate TER as noted in guidance to Standard 6.1 and apply the relevant modifying factor from the table below to give the permitted emissions rate for the modular or portable building.

Table 6.11 TER Modification

Date of manufacture of module/sub-assemblies	TER modifying factor
after 1 October 2015	1.00
1 October 2010 – 30 September 2015	1.75
Prior to 1 October 2010	2.50

6.C.3 Fabric U-values for modular and portable buildings

For modular or portable buildings, reference should be made to the guidance provided under Standard 6.2, with the exception of area weighted average U-values for a new building or an extension to an existing building. These should be in accordance with the values set out in the table below, in substitution for the corresponding values within tables to clauses 6.2.1 and 6.2.11.

Table 6.12 Maximum area weighted average U-values for building elements of the insulation envelope

Type of element	New building - area weighted average U-value for all elements of the same type (W/m^2K) [1]	Extension - area weighted average U-value for all elements of the same type (W/m^2K)
Wall	0.35	0.28
Floor	0.25	0.22
Roof	0.25	0.16
Windows, doors, and rooflights	2.2	1.8

Notes:

1. This column should also be used for buildings, including extensions, with an intended life of less than two years.

Annex 6.D Improvement to the energy performance of existing building services when carrying out building work

6.D.0 Introduction

Scottish Ministers have powers under section 25 of the Building (Scotland) Act 2003 to make a Direction to local authorities where they consider that buildings of any description to which building regulations apply ought to comply with a provision of the regulations.

This power is now exercised to direct local authorities to secure improvement to the energy performance of existing non-domestic buildings. The Direction to local authorities, which enable the following measures, is published on the Building Standards Division website.

6.D.1 Application of Direction

Made under section 25 of the Act, the effect of 'The Building (Scotland) Act 2003 Improvement to the Performance of Fixed Building Services for Existing Non-Domestic Buildings Direction 2010' http://www.gov.scot/Topics/Built-Environment/Building/Building-standards/publications/pubverletts/cel1102 is to introduce a requirement to make proportionate and cost-effective improvements to the energy performance of existing fixed building services when proposing new work to an existing non-domestic building.

For the Direction to apply, the following three conditions must be met. The proposed new work (alteration or extension) must:

a. be of a scope that would require an application for building warrant (to enable verification of proposals), and

b. have an estimated value of works, excluding improvement works, of **£50,000** or more (to avoid a disproportionate administrative burden on smaller works), and

c. include work to provide completely new fixed building services or to alter or extend the capacity of existing fixed building services to which Standards 6.3, 6.4, 6.5 or 6.6 apply (to enable improvement without the need to engage additional contracting expertise).

If any of the above are not applicable, improvement of existing building services is not required to demonstrate compliance with Standards 6.3 to 6.6.

Where these three conditions are met, there are also specific exceptions to the need to carry out improvement work. These are:

- the Direction is not applied to proposed works which are primarily to improve the carbon or energy performance of an existing building (as the intent of the Direction is already met by such work), or

- existing fixed building services which already meet specific provisions within building regulations applicable since 4 March 2002 need not be improved further (see clause 6.D.7 for further information). This exclusion does not apply to replacement of boilers or existing air-conditioning chiller units as improvement is based on the age of the current installation, not a specified performance standard.

Reference can be made to the application checklist (Table 1) below, which outlines the key questions in the assessment and verification of this process.

6.D.2 Scope of improvements (types of installations which should be assessed)

Applicants should assess the potential for cost-effective improvement in the following areas, each of which is addressed in guidance on compliance to Standards 6.3, 6.4, 6.5 or 6.6 within the 2015 Non-domestic Technical Handbook:

1. upgrading of heating controls and system components (Standard 6.3)

2. upgrading of insulation to hot water storage vessels (Standard 6.4)

3. upgrading of lighting controls and luminaires (Standard 6.5)

4. upgrading of ventilation or cooling controls or system components (Standard 6.6)

5. replacement of existing boiler, if more than 15 years old (Standard 6.3)

6. replacement of existing air-conditioning chiller units, if more than 10 years old (Standard 6.6).

Assessment need only consider the types of fixed building services within the existing building that also form part of proposed works (for example, if no water services or plumbing element under proposed works, there is no need to consider improvement to insulation of vessels and work to circulatory elements to wet heating systems). The intent of this is to avoid the need to engage specialist contractors that are not already involved in a project. However, the applicant may broaden the scope of improvements considered if they choose to (for example, where the applicant considers such improvements to be more relevant to the building in question).

6.D.3 Extent of improvement required (assessing cost and practicality)

Improvement should be proportionate to the extent of proposed works. It is recommended that the cost of improvement works should amount to approximately **5%** of the cost of proposed work. In this respect, assessment should be based upon cost of carrying out improvement works, exclude any design or consultancy fees. Where proposed improvements amount to less than this percentage, the applicant should, in scheduling the assessment process, provide evidence to support any reduced level of improvement.

It is the intent that improvement works proposed should be cost-effective, with a short to medium payback period. Assessment need only consider improvements that, when combined, have a payback period of **five years** or less. The exception to this is the replacement of a boiler or chiller unit, where near the end of its useful life, as there will be additional cost benefit where replacing such equipment as part of more extensive works.

The cost of any improvement works should be included in the estimated value of works used to determine the level of building warrant fee. The value of improvement works and proposed works should be identified separately to allow the proportion of improvement works to be verified.

Work to improve fixed building services should be neither overly disruptive to the operation of the existing building nor require costly or extensive intervention to the building fabric. However, it is recognised that work chosen by the applicant (see clause 6.D.4) may be of such a nature. Where such enabling work is required, it should not be counted as part of the cost of improvement work.

6.D.4 Assessment by applicant

To deliver improvements that are both cost-effective and relevant to the building being assessed, the types of improvement taken forward should be determined by the person responsible for the building (the relevant person/applicant) in consultation with any appointed agent or consultant. Recognising the complexity of the existing building and its systems, assessment should be carried out by persons with the necessary expertise to identify and assess cost-effective and energy efficient improvement.

The intent of the Direction is to deliver cost-effective improvement to the performance of the existing building services. Applicants should be aware that it is therefore in their best interests for existing fixed building services to be examined and assessed, to enable the most effective and beneficial improvements to be identified for consideration.

As noted in clause 6.D.2, whilst specific fixed building service issues are identified, the applicant may propose alternative improvements where they consider these more relevant to the building and can demonstrate that such improvement will deliver broadly equivalent benefit.

Where an Energy Performance Certificate or similar assessment exists for the building, it would be good practice to check any recommendations on existing fixed building services amongst the cost-effective improvements already identified.

For buildings with air conditioning systems, applicants should be aware of the need for inspection of systems over 12kW under regulation 17 of the Building (Scotland) Regulations 2004 and, where applicable, should consider instructing such an inspection where such systems are present. Information from this report will assist in assessing potential improvement to such systems under this Direction.

To maximize benefit to the building, improvements should meet current performance levels recommended in the guidance to Standards 6.3, 6.4, 6.5 and 6.6 where this is reasonably practicable. Where not reasonably practicable, for technical reasons or for reasons of cost or level of disruption to the building, improvement should still be made to the extent that can be achieved. The applicant should take advice on the impact which a lower level of improvement may have on the cost effectiveness of such work and may choose to not make such improvements where payback periods are longer than five years. The case for this should be presented to the verifier.

6.D.5 Review by verifier

The primary role of the verifier is to check that the process outlined above is observed and that proposed improvements to existing building services are of a scale appropriate to the proposed works or, if not, that substantiation for a reduced level of improvement is provided and is justifiable.

Whilst the verifier may question the extent of proposals and request further evidence to support such enquiries, it is not expected that they should direct the types of improvement which are to be carried out for a particular case.

On acceptance of proposals by the verifier, works arising under this Direction are subject to the same process as all other works requiring a building warrant, where the responsibility of the relevant person/applicant is to carry out works in accordance with the issued building warrant and the requirements of the building regulations in general. The verifier will make reasonable enquiry to establish this, prior to accepting a completion certificate.

6.D.6 The role of the Local Authority

Due to the checking integral to the building warrant process, the local authority should generally have no direct role in this process other than as verifier. However, under section

25 of the Act, the local authority may serve a building regulations compliance notice on the building owner, if the improvement work is not carried out. Where the building owner fails to comply with the notice they are guilty of an offence.

However, it should be noted that, if none of the proposed building warrant work is carried out on the building, no improvement work to existing fixed building services need be carried either.

6.D.7 Supplementary information - Exclusion by compliance with previous standards

The performance of components in installations less than 13 years old (post 4 March 2002) need not be improved further where the minimum performance meets levels set within building regulations. The intent of this limitation is to avoid replacement of elements where installations are both recent and relatively energy efficient as this will generally be less cost-effective.

Applicants should note that, as a wider range of building services issues are now addressed within building regulations (an example in 2010 being the introduction of a minimum efficiency for circulators and pumps), it will be necessary to measure performance of some elements against the current edition of the standards, where a level of performance is not identified in previous editions of the building regulations.

Table 6.13 Process checklist

Figure 6.3 Table 6.13 Process checklist

Process checklist

Checklist item	Yes	No	Notes
Applicant			
Does the scope of proposed works require a building warrant?			This can be checked against works in schedule 3 to regulation 5.
Is the estimated value of works £50,000 or more?			For guidance on assessing value of works, see Procedural Handbook.
Do proposed works provide new or alter/extend capacity of existing building services?			Minor replacement works are excluded from assessment.
If all three answers are 'yes' continue with assessment. Otherwise Direction does not apply			
Are works primarily to improve the energy performance of the existing building?			If Yes, evidence to support this should be recorded to support any enquiry made by the verifier.
Do building services already meet relevant standards applicable from 2002 onwards?			
If both answers are 'no', continue with assessment. Otherwise Direction does not apply			
Carry out assessment and determine which elements of fixed building services offer the most cost-effective improvements to the building.			This process and issues to consider are noted in items 6.D.2 to 6.D.4
Is information from any previous assessment (e.g. EPC) considered?			If Yes, consider recommendations as part of assessment. If No, applicant may consider instructing report to assist in assessing improvement.
If building has air conditioning system over 12 kW, is air-con inspection/report available?			
Do proposed improvements amount to approximately 5% of proposed works?			If Yes, schedule costs. If No, give evidence to support lesser amount.
Proposals for improvement should be scheduled to allow assessment by Verifier			
Verifier			
Are proposals submitted by applicant acceptable in respect of the scope of the Direction? Whilst nature of improvements is applicant-led, verify extent of improvement proposed against items 4 - 6.			If Yes, compliance with standard 6.3 to 6.6 in respect of the Direction is achieved. If No, identify concerns, for further review by Applicant.
Improvement identified and agreed prior to issue of building warrant will form part of works subject to reasonable inquiry prior to acceptance of a Completion Certificate			

6.D.8 Examples of the process

Example 1

A primary school building, completed in 2000 is being extended to acquire a new staff room. The estimated value of the new work is £50,000. Proposed works include power, lighting, heating and ventilations systems. The capacity of the existing boilers is sufficient to cater for the heating and hot water requirements of the extension. The building already has an EPC which offers recommendations for cost-effective improvement.

After further assessment of the fixed building services in the existing school, the following improvement measures are identified:

- Installation of variable speed drives (VSDs) to the heating system at a cost of £1,800, with annual fuel cost savings of £244 giving a payback period of 7 years.
- Installation of T5 retrofit kits to general lighting at a cost of £700, with annual fuel cost savings of £200 giving a payback period of 3.5 years.
- Installation of lighting daylight sensors at a cost of £2,400, with annual fuel cost savings of £777 giving a payback period of 3 years.

The third option (installation of the daylight sensors) has a short payback period and a higher annual fuel cost saving which may make it the preferred option in isolation, if there were no preference for the type of improvement to be carried out in the existing building.

The combined cost of the two first options is £2,500, with a total annual fuel saving of £488 and a (combined) 5.6 year payback and therefore could qualify if the slightly long payback period is acceptable.

In this case, the building owner is advised that the saving from combining daylight sensors and T5 retrofit would be reduced (as sensors would act to improve a lighting load already reduced by the T5 retrofit) and, having experienced increased heating bills over recent years, elects to improve the performance of the heating system instead of installing sensors. On that basis, the first two improvement options, which constitute around 5% of the proposed value of works, are scheduled as part of the submission to the verifier.

Example 2

A primary health care building, completed in 2001, is extended to provide a café at a cost of £55,000. The existing building services are to be extended to supply the new café. The building already has an EPC which offers recommendations for cost-effective improvement. The building contains an air conditioning system over 12kW and an inspection of the system and report was prepared previously. The report includes some minor recommendations that will improve performance.

Following on from further assessment of the fixed building services in the existing building, the following improvement measures are identified:

- Installation of T5 retrofit kits to general lighting at a cost of £3,900, with annual fuel cost savings of £493 giving a payback period of 8 years
- Replacing GLS with CFL lighting at a cost of £2,200, with annual fuel cost savings of £3,250 giving a payback period of less than 1 year
- Installation of variable speed drives (VSDs) to the heating system at a cost of £2,300, with annual fuel cost savings of £59 giving a payback period of 40 years.

The first option (installation of T5 retrofit kits) is above the 5% cost and the payback period (in isolation) is long. The third option (installation of variable speed drives), while within

the identified 5% cost margin, has an unrealistically long payback period which would not make it a suitable choice for improvement.

The remaining improvement item has a short payback period and amounts to less than 5% of the proposed value of works. The recommendations to improve the air conditioning systems are low cost but would contribute to assessment under the Direction.

The building owners choose to implement the second option (replacing GLS with CFL) which has a short payback period and a high annual fuel cost saving, even though the initial cost is below the identified 5% works cost. They also identify improvement to the air conditioning system and the small cost this incurs. As works remain below the identified 5% works cost, evidence is provided to show that no other cost-effective improvements are applicable to the building. Proposed work and evidence of further assessment carried out are scheduled as part of the submission to the verifier.