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Building Standards Non-domestic Technical Handbook (extract)

Consultation proposals – Section 6 'Energy'

July 2021

The Building Standards Technical Handbooks provide guidance on achieving the standards set in The Building (Scotland) Regulations 2004.

Further information on the Scottish building standards system can be found at: www.gov.scot/policies/building-standards/.

This document sets out proposed changes to the mandatory standards and supporting guidance issued in support of **section 6 'energy'** within the Building Standards **Non-domestic Technical Handbook**.

Where text is amended from the current, published 2015 edition of the handbook, this is shown by highlighting relevant passages in yellow.

The subjects matter of these changes is set out in more detail within sections 2 & 3 of the consultation document 'Scottish Building Regulations – Proposed Changes to Energy Standards and associated topics', published online at: https://consult.gov.scot/local-government-and-communities/building-regulations-energy-standards-review/.

Contents

Section 6 – Energy

6.1 Limiting energy demand and associated greenhouse gas emissions

Mandatory Standard

Standard 6.1

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

a) the energy performance is calculated in accordance with a methodology of calculation approved under regulation 7(a) of the Energy Performance of Buildings (Scotland) Regulations 2008;

b) energy demand which is within the scope of the methodology is reduced to a defined level;

c) greenhouse gas emissions associated with the calculated energy demand are reduced to a defined level; and

d) it is a nearly zero-energy building.

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.

The defined level in standard 6.1c shall not apply where all heat and cooling within a building is supplied from zero direct emissions sources.

6.1.0 Introduction

Standard 6.1 focuses on the reduction of energy demand and associated greenhouse gas emissions arising from the use of heating/cooling, hot water, ventilation and lighting in new buildings and large extensions.

The guidance which supports this standard sets a target for overall energy and emission performance in buildings by use of a calculation methodology which assesses performance at a building system level, considering a wide range of parameters which 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 heat generator 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, setting two challenging performance targets for both energy and building emissions which both must be met.

Standards 6.2 to 6.6 and 6.10, in the main, recommend minimum performance 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 minimum levels, or incorporate additional energy performance measures, such as generation of renewable heat or power to offset energy demand.

Nearly zero energy buildings

Initially introduced in response to a European Directive, "nearly zero-energy building" means a building that has a very high energy performance, as determined in accordance with the methodology cited in this standard, where the 'nearly zero' or very low amount of energy required by the building should be covered, to a very significant extent, by energy from renewable sources, produced on site or nearby.

Review of standards in 2021 is the first improvement since this provision was introduced into regulation as part of standard 6.1 in March 2016. Standards now set, via the approved methodology and supporting guidance, should result in buildings with very low energy demand at levels which are more widely associated with the concept of 'nearly zero'.

In this context, "energy from renewable sources" means energy from renewable non-fossil sources, namely wind, solar, aero-thermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases. In this context, current and ongoing decarbonisation of grid electricity is also now considered to contribute as a renewable source, as noted in our draft Heat in Buildings Strategy.

High-efficiency alternative systems

For all new buildings, it remains the case that 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. Further information

on this process is provided in Annex 6.C -'Consideration of High-Efficiency Alternative Systems in New Buildings'.

Zero Direct Emissions solutions

It is proposed that, from 2024, all new buildings will be heated with 'zero direct emission' (ZDE) sources.

> *"Zero direct emissions from heating and cooling will ensure that no greenhouse gas emissions are produced at all from the heating or cooling system contained within a building at the point of use. We propose that electricity and thermal energy from heat networks would, therefore, be considered 'zero-rated' (i.e. considered to produce zero direct emissions at the point of heat consumption)".*

In advance of this change, all buildings heated or cooled only from ZDE sources do not require to undertake a target emissions calculation under standard 6.1.

Where the heat demand in a new building is not met from ZDE sources, information must be provided to illustrate how such a source can be retrofitted to the building. This should be both part of the building warrant application and be provided to the building owner as part of the written information required under standard 6.8.

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 and is the methodology of calculation for non-domestic buildings approved under standard 6.1(a) for use in calculation energy demand and greenhouse gas emissions for new buildings. SBEM has a basic user interface, iSBEM, which includes Scottish compliance parameters for use with this guidance and a more detailed NCM Modelling Guide for Scotland, also 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 'Approved Energy Assessment Software' 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

NOTE: proposals for the new energy target are expressed in terms of Primary Energy in the following text.

To comply with the requirements of Standard 6.1, designers should demonstrate that the calculated greenhouse gas emissions (Building Emissions Rate or BER) and primary

energy demand (Building Primary Energy Rate or BPER) for the 'actual' building do not exceed those which are calculated for a 'notional' building.

A specification is implemented within calculation software which will determine a Target Emissions Rate or TER and Target Primary Energy Rate or TPER).

Greenhouse gas emissions are calculated and reported in kilograms of carbon dioxide (equivalent) per square metre of floor area per annum. $Kg.CO_{2e}/m^2/yr$.

Primary energy demand is calculated and reported in kilowatt hours per square metre of floor area per annum. $kWh_{pe}/m^2/yr$.

Outline of process - in broad terms, for both targets, the calculation process 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 Rates (TER/TPER) for the actual building are 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 rate is deemed to meet the requirements of this standard. These two calculated values are the emissions and primary energy targets which the actual building must not exceed.
- The Building Emission and Primary Energy Rates (BER/BPER) are 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 minimum levels identified in guidance to Standards 6.2 to 6.6.
- If, following full specification of the actual building, the BER and BPER are both not more than the TER and TPER, then compliance with this standard is achieved. If one or both of the BER or BPER is more than the relevant target, then the designer should review and improve the construction and building services data in the actual building and determine what measures would be most appropriate to reduce the calculated totals to not exceed the target values. Additional provisions apply to 'limited life' modular buildings – see Annex 6.C.

Exemption from TER/DER calculation

Where the only heat supplied to a new dwelling is from 'zero direct emissions' sources (electricity or thermal energy from a heat network), Standard 6.1c does not apply and the Target and Dwelling Emission Rate calculation need not be undertaken. The operation of

the dwelling is deemed to produce 'zero direct emissions'. Compliance with Standard 6.1 will still be demonstrated by the energy target calculation.

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, fuel choice, building services strategy, etc. are known.

At all stages, the conventions in the iSBEM User guide 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 2021 'National Calculation Methodology (NCM) Modelling Guide for Scotland' – the draft document is also available for download via the UK NCM website.

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 is one specification but certain elements are varied based upon the choice of main heating fuel and system for the actual building, as determined by the designer. The specification assigned to the notional building for space and water heating and assignment of PV differs between electric heat pump solutions and other solutions.

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 2021 'National Calculation Methodology (NCM) Modelling Guide for Scotland'.

Measures to calculate target rates for the 'notional dwelling'

The measures identified in the tables below are set to deliver, on aggregate, a 16% (Option 1) and 25% (Option 2) reduction in emissions over application of the 2015 standards. Whilst a building can be constructed using these packages of measures, it is stressed that the following specifications are provided solely for the purpose of setting the targets (TER/TPER) for the 'notional' building. Designers will find more cost-effective and relevant solution when considering the nature of the new building they propose.

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

Element	Option 1 – 16% emissions reduction	Option 2 – 25% emissions reduction
Roof (U-value, W/m^2.K)	0.15	0.11
Wall (U-value, W/m^2.K)	0.18	0.15
Floor (U-value, W/m^2.K)	0.15	0.13
Window (U-value, W/m^2.K	1.4 (10% FF)	0.9 (10% FF)
(g-Value, %)	29%	29%
(transmittance, %)	60%	60%
Rooflight (U-value, W/m^2.K)	1.5(15% FF)	1.5 (15% FF)
(g-Value, %)	29%	29%
(transmittance, %)	60%	60%
Vehicle access and similar large doors	1.5	1.5
Pedestrian doors and high usage entrance doors	2.0	2.0
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)@50Pa)	4	3
Lighting Efficiency (Luminaire lumens/Circuit watt)	125	125
Occupancy control (Yes/No)	Yes	Yes
Daylight control (Yes/No)	Yes	Yes
Space Heating Refer to NCM Modelling guide for further details.	Electric heat pump (400%) if actual building uses electric heat pump. Otherwise natural gas boiler (93%)	Electric heat pump (435%) if actual building uses electric heat pump. Otherwise natural gas boiler (93%)
Water Heating Refer to NCM Modelling guide for further details.	Electric heat pump (250%) if actual building uses electric heat pump. Otherwise natural gas boiler (93%) Point-of-use electric (100%) for low DHW demand	Electric heat pump (270%) if actual building uses electric heat pump. Otherwise natural gas boiler (93%). Point-of-use electric (100%) for low DHW demand
Central Ventilation (SFP, W/l/s)	1.8	1.8
Terminal Unit (SFP, W/l/s)	0.3	0.3
Cooling (SEER) (where present)	6.4	7.1
Heat recovery (% efficiency)	76%	76%
Variable speed control of fans, pumps and circulators (including sensors)	Yes	Yes
Photovoltaic Panels (% of floor area)[1]	13%	13%

Notes:

1. Assignment of PV to notional building is reduced proportionately with the percentage of space heating demand met by an electric heat pump. Assigned value is also limited by excluding any assessed export component. Refer to NCM Modelling Guide.
2. A building with heat supplied from a District Heating Network is assessed against a notional building heated by mains gas. An adjustment is made to the emissions and energy targets – see clause 6.1.6.

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 on the basis of 'electric heat pump in actual = electric heat pump in notional' and 'any other solution in actual = natural gas boiler in notional'
- 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.
- 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/TPER (generation of power)

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 overall delivered energy total for the building and thus the target emissions and primary energy rates.

This PV element is applied only to that portion of the actual building where space heating demand is not met by an electric heat pump. This is in recognition of the higher efficiency of heat pump solutions which will reduce the delivered energy total. Accordingly, a building

where heat demand is met 100% by electric heat pump will have no assigned PV in the notional building calculation.

The incorporation of LCE within design proposals, is encouraged where this is considered an appropriate and cost-effective part of the overall building solution and the generating capacity can be shown to be utilised on site. Noting that, from 2021, the calculation of notional and actual building will no longer include any component of generated power which is identified as exported from the building. This change in approach seeks to reinforce the need for design choices to be effective in reducing the total delivered energy needed at a building, to the benefit of those using the building.

6.1.6 Calculating the building carbon dioxide emission rate (BER) and building primary energy rate (BPER)

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 capacity of on-site generation to offset energy demand is limited to that which can be demonstrated to be used at the building, discounting any exported component.

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. The third seeks to increase assurance that energy produced on site is used on site.

As noted in clause 6.1.2, where the only heat supplied to a new dwelling is from 'zero direct emissions' sources the Target and Dwelling Emission Rate calculation need not be undertaken.

Demonstrating compliance for buildings with a supplied heat connection

Compliance with standard 6.1 for a building supplied with heat from an external network source will be demonstrated against the 'gas' notional building (as noted in clause 6.1.4), but the calculated energy demand totals for the actual building will have the primary energy and emissions factors for grid electricity applied to the calculated heat demand rather than default or network-specific values for supplied heat.

This recognises that supplied heat can be utilised with 100% efficiency at the building, with adjustment only needed to recognise any standing losses from heat interface units that do not contribute usefully to reduce the heating demand at the building. Application of these factors enables the designer to demonstrate an equivalent outcome in terms of limiting energy demand at the building, for supplied heat solutions compared to on-site heat solutions.

6.1.7 Adjustment of BER/BPER

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/TPER can be reduced by an amount equal to the product of the percentages given in the table below and the emissions and energy demand for the system(s) to which the feature is applied:

Table 6.2. 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

BER example: if the total emissions in a gas heated building were 60 kg/m^2/annum and 20 kg/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 = 0.5 kg/m^2/annum. The revised BER would then be 59.5 kg/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 comparison to demonstrate compliance with the emissions and primary energy targets can then be carried out. In specifying the building shell, designers are encouraged to take a robust approach to fabric elements but the maximum values for such elements are the same for a shell building as for any other new building.

Note: under the 2015 standards, more challenging fabric values were set for shell building to offer greater flexibility in fit-out specification. This is no longer the case and is now encouraged but at the discretion of the applicant.

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, shall form part of information with the building warrant and should identify, in particular, any installed low carbon equipment proposed to meet the Target Rates. 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 **should** issue a continuing requirement with a building warrant for the shell building. This will ensure that the subsequent fit-out, whether subject to a building warrant or not, demonstrates that the building, once completed, continues to comply with Standard 6.1 by not exceeding either TER or TPER. In demonstrating this, the same edition of the NCM used for the shell building calculation may be used for the BER/TPER calculation for the final building.

Deferral of EPC production until fit-out

The continuing requirement should also require 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. Where this is specified in the continuing requirement, **no EPC is needed** on completion of the shell building. Such a document is of little relevance as it relates to a building which cannot yet be occupied and has building services which are, in whole or in part, illustrative rather than installed.

Dependent upon the final specification of the building, additional provisions may be needed to meet the emissions and primary energy 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 purpose of frost protection

b) communal parts of domestic buildings which will not be heated, other than heating provided solely for the purpose 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 elements of the building envelope.

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.

Table 6.3 below sets out robust minimum standards for the thermal performance of building elements. For new buildings, meeting Standard 6.1 may result in even better levels of thermal insulation being achieved unless the design of a building involves improved specification of building services or use of on-site generation of heat or power.

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. It is recommended that variation on the performance of elements be limited where practicable to enable a consistent level of reduction in heat loss throughout a dwelling and maintain continuity of insulation across accommodation.

Any localised areas (individual elements) should have a U-value no worse than 0.70 (walls and floors) or 0.35 (roofs). Glazing with a U-value poorer than 3.3 should not be used. This is particularly important with regard to the control of surface and interstitial condensation (see Section 3: Environment). To minimise such risks, designers should seek to specify and maintain individual element values significantly better than the above figures where practical to do so.

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. Maximum U-values for building elements of the insulation envelope

Type of element	Area-weighted average U-value (W/m²K) for all elements of the same type [1]	
	Option 1 – 16% emissions reduction	Option 2 – 25% emissions reduction
Wall [2]	0.23	0.18
Floor [2]	0.18	0.15
Roof	0.18	0.13
Windows and roof windows [3]	1.6	1.2
Rooflights [4]	2.1	1.9
Pedestrian doors [5]	1.4	1.0

Notes:

1. For 'limited life' 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. There is no maximum U-value for display windows (refer to clause 6.2.2).
4. U-Value for rooflights is given for the horizontal plane.
5. Vehicle access doors and similar large doors should have a maximum U-value of 1.5 W/m² K.

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 3 m above such an access level, or incorporates a fixed or opening light of less than 2 m^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 is considered in the calculation of the performance of the actual building and will need to be compensated for elsewhere in the building (see clause 6.1.6).

It is expected that display windows may 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 in new buildings

Due to 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.

6.2.4 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: 2017 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: 2017 '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'.

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

a. input of default Ψ values for each junction assigned by SBEM (listed in the NCM Modelling Guide for Scotland)

b. where construction of a junction follows a published and substantiated construction detail sets, input of Ψ value of the relevant junction(s) from that document, or

c. 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 these options can be used to produce the calculated heat loss.

If none of these options are applied, the calculation will adopt a conservative Alpha value of 0.25 (adding 25% to the calculated heat loss for all planar elements of the building).

For new building work which is not subject to standard 6.1 (alterations, extensions and conversion), the designer should demonstrate that the principles for reducing heat loss at junctions have been applied in the creation of the insulation envelope and the detailing of constructions, providing continuity of the insulation layer and of the air and vapour control layer.

Further commentary on this process and use of other published documents providing sources of pre-calculated values can be found within the introductory volume of 'Accredited Construction Details (Scotland) 2021'.

Note that no updated construction details are published by the Scottish Government. Reference should instead be made to recognised industry publications for independently calculated and validated examples.

6.2.5 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).

Whilst, no maximum value is set for air permeability for new construction, it is recommended that buildings are designed to achieve a value of not more than 7 $m^3/(h.m^2)$@50Pa, 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 6.2.10).

6.2.6 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 should be tested on completion, with the following exceptions:

a. modular building of less than 150 m² 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.

b. new buildings where due to size or complexity, it is impractical to carry out full 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 in the form of sectional testing.

Air pressure tests should be performed following the guidance set out in CIBSE TM23: 'Testing buildings for air leakage'.

Note: An amended edition of TM23 is awaiting publication at the time of writing. This will extend the methodology to cover both fan pressurisation and pulse testing.

Testing should only 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, 2021 Edition'.

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 (in support of the initial completion certificate) and, again when the fit-out is completed (when discharging the continuing requirement on the shell warrant).

6.2.7 Introducing heating to unheated buildings and conversion of 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.

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

Where such a building, or part of 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 that expected for new construction and follow the guidance in clause 6.2.1.

In the case of a building that was previously designed to be heated, the impact on energy efficiency as a result of the conversion will generally be less significant but the act of conversion should still trigger an assessment of the capacity to improve the building fabric and follow the guidance given in clause 6.2.1.

In each case, the provisions set out in clause 6.2.1 should be met in full or, if not, evidence provided to demonstrate the extent to which an equivalent level of overall heat loss can be delivered to the extent that such work is reasonably practicable. Such evidence should clearly set out the options considered and the justification for the best values that the designer has arrived at, identifying any limitations arising from factors such as conflicting statutory requirements (e.g listing/historic status), lack of space, cost or issues of technical risk arising from the nature of the retained elements of building envelope.

6.2.8 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 clause 6.2.1 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 for individual elements noted in clause 6.2.1. 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, energy demand and 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 renewable heating or on-site generation of heat or power. 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'.

6.2.9 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 the maximum U-values set out in clause 6.2.1. 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 area weighted average U-values from the guidance to clause 6.2.1, 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.

6.2.10 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 6.2.4 and 6.2.5 on limiting heat loss from thermal bridging and air infiltration and reference should be made to the principles set out in the introductory volume of the BSD document 'Accredited Construction Details (Scotland) 2021'. Calculation of heat loss from linear thermal bridging is not necessary unless the SBEM methodology is being used to demonstrate compliance.

Calculation of heat loss from linear thermal bridging is not necessary unless the SBEM methodology is being used to demonstrate compliance. Instead, as noted in clause 6.2.4, the designer should demonstrate that the principles for reducing heat loss at junctions have been applied in the creation of the insulation envelope and the detailing of constructions, providing continuity of the insulation layer and of the air and vapour control layer.

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

6.2.11 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 6.2.9) 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 4 m^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 0.70 W/m^2K and for a roof, not worse than 0.35 W/m^2K.

Infill of large openings - the infill of an existing opening of greater area (than approximately 4 m^2) in the building fabric should have a U-value which achieves those in the table to 6.2.1. 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 6.2.1. 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 6.2.1. 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 1.2 W/m²K. For secondary glazing, an existing window, after alteration should achieve a maximum U-value of 3.5 W/m²K.

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.

The table to clause 6.2.1 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 0.35 W/m²K and in the case of a wall or floor, 0.70 W/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'.

Thermal bridging and air 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 6.2.10). 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.

Zero Direct Emissions solutions

It is proposed that, from 2024, all new buildings will be heated with 'zero direct emission' (ZDE) sources. In advance of this change, where the heat demand in a new building is not met from ZDE sources on initial construction, we have introduced a requirement that information must be provided to illustrate how such a source can be retrofitted to the building. Such information is necessary to support a simple and cost-effective transition to such heat solutions in the future.

This information should be documented and available for verification purposes and a statement should therefore accompany the building warrant application. The ZDE assessment should be provided to the building owner as part of the written information required under standard 6.8.

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

Note: Link below is to the consultation version of the Non-domestic Building Services Compliance Guide.

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.

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

Note: Link below is to the consultation version of the Non-domestic Building Services Compliance Guide.

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.

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 3 m 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

Note: Link below is to the consultation version of the Non-domestic Building Services Compliance Guide.

Guidance on the efficiency of fixed internal and external lighting is given in the Non-domestic Building Services Compliance Guide for Scotland.

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) **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 37 (TM37) 'Design for Improved Solar Shading Control' (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 28 ºC 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

Note: Link below is to the consultation version of the Non-domestic Building Services Compliance Guide.

Guidance on the efficiency of mechanical ventilation and air conditioning systems is given in the Non-domestic Building Services Compliance Guide for Scotland.

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, control 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 Commissioning Plan at design stage

A schedule of proposed building systems should be provided as part of the building warrant application, setting out the following:

- the systems to test and the nature of commissioning tests applied;
- a schedule of commissioning tests and who will undertake them; and
- The documentation which will be provided as an output from commissioning.

6.7.3 Commissioning Report on completion of construction

On completion of building works, a document setting out the commissioning undertaken, including any changes made to the original design, should be provided to the verifier. This should record the actions taken to complete the design stage commissioning plan, confirming all services listed were commissioned and present the output from the commissioning work, confirming successful commissioning and operation of systems in accordance with the specified design intent. Any issues encountered and actions taken to rectify them should also be recorded.

A copy of this commissioning report should be appended to the building logbook provided under standard 6.8.

6.7.4 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' .

Ductwork leakage testing 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.**

c) **where zero direct emissions heating or cooling is not provided to a new building, information to enable simple and low cost retrofit of such a solution is provided.**

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.

From 2024, new buildings will be required to use 'zero direct emissions' (ZDE) heat solutions. There is a similar intent for the for deployment of low and zero emissions heat within our existing building stock. To assist building owners understand what such an

alteration will entail, information should be provided which sets this out. For most buildings, it is expected that information on the practical implementation of such an option at the point of initial construction would be developed as part of considering the use of 'high-efficiency alternative systems'.

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.

6.8.3 Information to enable future retrofit of zero direct emissions heating

Where a new building is not constructed with a recognised Zero Direct Emission heat solution meeting all heat needs, the occupier shall be provided with information that sets out the process and work involved to deliver that future adaptation, simply and without disruption beyond the immediate vicinity of the current heat source.

In this respect, where the current heat source is a combustion appliance (boiler), information on a zero direct emission replacement heat source shall include a solution in addition to any information on the direct replacement of the combustion appliance with an electric boiler.

The information provided shall include, but not be limited to:

- A specification which defines or would enable selection of a new heat source based upon the current calculated heat demand, heat distribution and hot water.
- Other information sufficient to enable a quotation for such a replacement heat source to be sought from an installer.
- Written advice on the impact of the suggested replacement heat source on the energy and emission performance of the dwelling and the comparative running costs for heating and hot water.

6.8.4 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:

g) 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:

d) 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 stand alone 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.

e) Standard 6.9(c) only applies to buildings:

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

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

vii. 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).

Note: Standard and Guidance not updated as part of this review.

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. A document setting out that strategy should form part of the building warrant application and a document recording the implementation and application of the strategy be provided as part of the written information required under standard 6.8.

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.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).

It offers an alternate means of meeting both 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.

6.C.1 Application of alternative route

For the purpose of applying building regulations, the location of a modular or portable building on a site is treated as the construction of a new building.

To be within the scope of this alternative means of compliance, a modular or portable building must:

- be described in the building warrant application as a 'limited life building' – with an intended time on site of not more than five years; and
- have more than 70% of its external envelope created from modules or sub-assemblies with a date of manufacture before the date on which this current set of regulations came into force.

  These sub-assemblies would be obtained from a centrally-held stock, or from the disassembly of existing modular buildings.

Note that, where the intended life of a building is less than 2 years or the building is a stand-alone building having an area less than 50 m^2, Standard 6.1 does not apply. Standard 6.2 will apply and the provisions in clause 6.C.3 may be used where the above conditions are met.

6.C.2 Determining the Target Emissions Rate and Target Primary Energy 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) and Target Primary Energy Rate (TPER) for the building. Calculate TER/TPER as noted in guidance to Standard 6.1 and apply the relevant modifying factor from the table below to give the amended targets a qualifying modular or portable building.

Table 6.11. TER Modification

Date of manufacture of module/sub-assemblies	TER modifying factor
On or after date these regulations come into force	1.00
Prior to the date these regulations come into force	1.25

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 clause 6.2.1.

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

Type of element	area weighted average U-value for all elements of the same type (W/m²K)
Wall	0.27
Floor	0.22
Roof	0.2
Windows and doors	2.0
Rooflights [1]	2.3

Notes:

1. U-value for rooflights is calculated on the horizontal plane.

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