F

Technical Document

Part 1

Minimum Energy Performance Requirements for buildings in Malta

Building Regulation Office
Ministry for Transport
and Infrastructure
Malta

Preamble

The Energy Performance of Building Directive (10/31/EU) has been transposed into Maltese law by means of Legal Notice 376/12. According to this legal framework, the Building Regulation Board has been tasked with updating current Minimum Energy Performance Requirements as informed by cost-optimality studies. This document has been drafted by a working group consisting of members from the Building Regulation Board, the Building Regulation Office and the Ministry of Energy and Health. This document is to be regarded as a compilation of advice being extended by this working group towards the Building Regulation Board.

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The Requirement
Document F – Conservation of Fuel, Energy and Natural Resources (Minimum Requirements on the Energy Performance of Buildings Regulations, 2015)

Conservation of Fuel, energy and natural resources

(I) A building shall be so designed and constructed as to secure, insofar as is reasonably practicable, the conservation of fuel, energy and other natural resources, while contributing to the improvement of internal comfort levels in terms of temperature, humidity and natural lighting.

Control of heat, power and lighting.

(II) Reasonable provision shall be made for the conservation of fuel and energy in a building by:-

(A) Limiting the heat loss in winter and the heat gain in summer through the fabric of the building;

(B) Controlling the operation of the space heating, and hot water systems;

(C) Controlling the operation of the space cooling systems;

(D) Limiting the energy loss from water storage vessels and water service pipework;

(E) Limiting the energy loss or gain from water pipes and air ducts used for space heating and cooling;

(F) Installing artificial lighting systems that use no more fuel and power than is reasonable in the circumstances and making reasonable provisions for controlling such systems;

(G) Providing sufficient information with the heating and cooling services so that building occupiers can operate and maintain the services in such a manner as to use no more energy than is reasonable in the circumstances.

(H) Making use of passive or natural measures to maintain comfort level conditions and ventilate the indoor environment during periods of the year when this is possible.

Rain water collection.

(III) A building shall incorporate in its design and construction a cistern of adequate size and proportions for the storage of rainwater run-off.

Exploitation of climatic variables

(IV) A building shall incorporate measures to reduce adverse effects of solar radiation, wind and rain while exploiting the benefits of these climatic variables, according to the seasons.

Limits on applications

(V) (A) All building categories mentioned in *Legal Notice 376 of 2012 or any such law or regulation revoking, amending or replacing it.*

(B) Requirements (II) (A), (B), (C), (D), (E), (H) and (III) apply only to dwellings and other buildings whose floor area exceeds forty square metres. (II) (F) applies only to buildings and parts of buildings including their external areas where more than one hundred square metres of floor area is to be provided with artificial lighting and does not apply within dwellings.

Parameters of application

(VI) In the case of premises that fall under the category of terraced buildings, it should be assumed that adjacent buildings are already constructed when providing evidence satisfying the requirements of these guidelines.

In addition to the above, in those cases where different building heights result from impositions made by permits or other regulations and site conditions, the exposed walls, or parts thereof, are to be considered as exposed elements.

Provisions meeting the Requirement Document F – Conservation of Fuel, Energy and Natural Resources (Minimum Requirements on the Energy Performance of Buildings Regulations, 2015)

0. Definitions

0.01 Definitions of other words and phrases

Definitions of words and phrases in this Document that are not included in the following list of definitions shall have the meanings commonly assigned to them in the context in which they are used.

0.02 Definition of terms

In this Document,

Air-conditioning means a combination of the components required to provide a form of indoor air treatment, by which temperature is controlled or lowered.

Basement means a storey or storeys of a building located in part or in its entirety below the ground floor.

Boiler means the combined boiler body-burner unit, designed to transmit to fluids the heat released from burning;

Building means a roofed construction having walls, for which energy is used to condition the indoor climate.

Building element means a technical building system or an element of the building envelope.

Building envelope means the integrated elements of a building which separate its interior from the outdoor environment.

Building unit means a section, floor or apartment within a building which is designed or altered to be used separately.

Cogeneration means simultaneous generation in one process of thermal energy and electrical and/or mechanical energy,

Dwelling or dwelling unit means a suite operated as a house-keeping unit used, or intended to be used as a domicile and usually containing cooking, eating, living, sleeping and sanitary facilities.

Effective rated output means the maximum calorific output, expressed in kW, specified and guaranteed by the manufacturer as being deliverable during continuous operation while complying with the useful efficiency indicated by the manufacturer.

Exposed Element means an element forming part of the building envelope which is permanently exposed to the outside air.

Energy performance of a building means the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting;

Semi-exposed element means an element separating a heated or cooled space from one that is unheated or uncooled and which has exposed elements that do not meet the requirements of these guidelines.

Floor area means the space or any storey of a building between exterior walls including the space occupied by interior walls.

Useful floor area means the floor area of the building needed to carry out the activities of the building in question including waiting and circulation spaces and excluding garages, and unconditioned spaces.

Heat pump means a machine, a device or installation that transfers heat from natural surroundings such as air, water or ground to buildings or industrial applications by reversing the natural flow of heat such that it flows from a lower to a higher temperature. For reversible heat pumps, it may also move heat from the building to the natural surroundings.

Industrial building means a building which is used wholly or in part for the assembling, fabricating, manufacturing, processing, repairing or storing of goods and materials.

Mechanical Ventilation is used to describe systems that use fans to supply outdoor air and/or extract indoor air to meet ventilation requirements. Systems may be extensive and can include air, filtration, air handling units and heat reclamation, but they do not provide any active cooling from refrigeration equipment. The definition would not apply to a naturally ventilated building, which makes use of individual wall or window mounted extract fans to improve the ventilation of a small number of rooms.

Other building means any building which is not a dwelling, industrial or residential building and includes places of assembly, offices and shops.

Primary energy means energy from renewable and non- renewable sources which has not undergone any conversion or transformation process;

Primary energy balance for a building means the primary energy required for heating, cooling, lighting, ventilation and hot water use within the building after the energy produced on site from renewable energy sources forming part of the building have been subtracted.

Roof means an external building element which is either horizontal or if sloping has a slope of less than 60 degrees to the horizontal.

Solid parts in relation to exposed elements means those parts which are not rooflights or other openings being glazed or unglazed.

Storey means that part of a building which is situated between the top of a floor and the top of the next floor above it, or the ceiling if there is no floor above it.

Technical building system means technical equipment for the heating, cooling, ventilation, hot water, lighting or for a combination thereof, of a building or building unit.

Thermal Conductivity Thermal conductivity (i.e. the lambda – value) of a material is a measure of the rate at which that material will pass heat per unit time and is expressed in units of watts per metre per degrees of temperature difference (W/mK).

Unconditioned space means an enclosed space where no energy is used to control the indoor air-temperature of that space.

U-value means the thermal transmittance coefficient, that is a measure of how much heat per unit time will pass through one square metre of a structure when the air temperatures on either side differ by one degree. U value is expressed in units of watts per square metre per degree of temperature difference (W/m^2K).

Wall means a solid element of the building fabric which is either vertical or has a slope greater than 60 degrees to the horizontal.

1. Conservation of Fuel and Power

1.01 Design consideration

1.01.1 In designing a building the designer shall take into account all relevant factors that will make that building efficient in the consumption of heating, cooling, ventilation, lighting, and the production of domestic hot and cold water, and creates an appropriate environment within the building.

1.01.2 In particular, the designer shall take account of the:

- External environment (climatic data): Buildings shall be designed to take account of the climate through the year, variations through the day, and any characteristics specific to the site.
- Orientation of the building: Careful siting of the building shall optimise the requirements for the conservation of energy with those of the use and function of the building. Special consideration is to be given to its shape and glazing ratio.
- Actual and probable adjacent properties: Consideration shall be given not only to the actual developments that may affect the design of a building, but also to potential adjacent developments.
- Internal environment: Consideration shall be given in the design of the building to the various cycles of use of the building over the full year.

(i) Temporal variations in use: Variations in use through a variety of time cycles as indicated below, shall be considered in order to conserve energy;

- twenty-four hour cycle
- weekly cycle
- other patterns of use through the full year

(ii) Hygrothermal conditions in use: Consideration shall be given to the environmental characteristics which determine comfort:

- ventilation energy loads, including specific ventilation, background ventilation and infiltration.
- solar loading
- lighting, including background, task, and other.
- space heating and cooling, both seasonal and diurnal.
- domestic hot and cold water production and distribution.
- internal energy gain, including metabolic, mechanical and electrical.
- humidity characteristics and control
- Indoor air quality

1.02 Design of the work

1.02.1 Components and elements of the building shall be carefully considered in determining the design response required within the need to conserve energy.

1.02.2 Advantage shall be taken of design techniques to permit fenestration, openings and other elements of the design to respond to the comfort requirements within the building whilst complying with the relevant requirements of *Provisions meeting the Requirements of Safety in Case of Fire, Provisions meeting the Requirements of Accessibility and Safety in use, and Provisions meeting the Requirements of Environmental Aspects.*

1.02.3 In detailing buildings care shall be taken to avoid, as much as possible, heat or cold bridges across the construction. The effect of cold bridges in the design of building elements should be taken into consideration when calculating the relevant thermal conductivity of specific building elements.

1.02.4 Air-conditioned and Mechanically ventilated buildings (ACMV) should be designed and constructed such that:

- The form and fabric of the building do not result in a requirement for excessive installed capacity of ACMV equipment. In particular, the suitable specification of glazing ratios and external solar shading are an important way to limit cooling requirements.
- Components such as fans, pumps and refrigeration equipment are reasonably efficient and appropriately sized to have no more capacity for demand and standby than is necessary for the task.
- Suitable facilities are provided to manage, control and monitor the operation of the equipment and the systems.
- Whenever it is possible to use passive means to condition the building or a part of the building, the systems enable the users to shut down the system or part of the system as the case may be.
- Whenever it is functionally, economically and technically feasible, it is possible to recover heat from exhaust air.

1.03 Characteristics of building materials and components

1.03.1 The materials, components and systems from which the building is constructed shall be designed, selected, manufactured and assembled in such a way as to contribute to the energy efficiency of the building.

1.03.2 The following characteristics of building materials and components shall be considered in the selection of appropriate designs:

(i) transmittance or thermal resistance of building elements, such as:

- walls – including the effects of screening, shutters or blinds
- roofs – including the effects of screening, shutters or blinds
- ground floors

(ii) thermal conductivity and resistance of masonry,

(iii) moisture transfer,

(iv) driving rain resistance,

(v) air permeability,

(vi) thermal inertia characteristics,

(vii) solar energy transmission, Orientation of the building with regards to solar paths

(viii) daylight transmission, and

(ix) effective areas and flow characteristics of openings for ventilation purposes

2. Calculation of the energy demands

2.01 General

2.01.1 Where a new building, a building undergoing major renovation or an existing building is required to be designed in such a way as to have a minimum energy performance level, such a performance level shall be calculated according to a national calculation methodology

2.01.2 The national calculation methodology shall be set in such a way as to determine within a reasonable level of accuracy the amount of energy which will be used for the heating, cooling, lighting, ventilation and hot water within the building if the building is used in a manner and during such periods as is typical for buildings used for the same function.

2.01.3 For the purposes of determining the overall energy demand for the building, the national calculation methodology shall take into consideration the internal temperature and other indoor environment characteristics typically found within buildings which serve the same function as that building for which the energy demand is being calculated.

2.02 Energy demand aspects

2.02.1 The national calculation methodology for both dwellings and non-dwellings shall take into consideration the thermal characteristics of all the components of the building including building envelope, internal partitions, installed equipment and expected occupancy.

2.02.2 The installed equipment taken into consideration should include: heating installation, natural and mechanical ventilation or a combination of both, calculated air tightness, air-conditioning installations, built-in lighting installation and hot water supply including their insulation characteristics,

2.02.3 The thermal characteristics taken into consideration when calculating the overall energy demand should as a minimum include: thermal capacity, insulation, passive heating, internal loads, cooling elements and thermal bridges,

2.02.4 The national calculation methodology shall calculate the overall energy demand for the building performance of the building or building unit on a yearly basis taking into consideration typical climatic conditions in Malta. The methodology should be able to assess the effect of:

(i) the design, positioning and orientation of the building, including outdoor climate.

(ii) passive solar systems and solar protection.

(iii) indoor climatic conditions, including the designed indoor climate.

2.02.5 Where an maximum overall energy use requirement is mandatory for the building the calculated value shall take into consideration the influence of the following positive aspects wherever they are relevant.

(i) local solar exposure conditions,

(ii) active solar systems

(iii) all energy from renewable sources in electricity or other forms;

(iv) electricity produced by cogeneration;

(iv) natural lighting

3. Requirements for Dwellings

3.01 General

The envelope of all buildings shall be designed to resist heat loss or gain or, where appropriate, to encourage heat gain or loss.

3.01.1 Building extensions of 14sq.m or less, to existing dwellings may be assumed to fulfil the requirements of this section provided that this construction is similar to the un-extended building.

3.01.2 Care must be taken in insulating elements of buildings in order not to create difficulties such as interstitial condensation.

3.01.3 In calculating the measurement of windows and rooflights the following rules shall apply:

(i) the area of a wall used to calculate the area of openings shall include all openings in the wall, and exclude trickle vents,

(ii) any external door with more than 1.0sq.m of glazing will be treated as a window.

(iii) areas of walls, roofs and floors shall be measured to the inside faces of the building.

3.01.4 The background ventilation rate will be calculated according to the national calculation methodology and will take into account the fresh air intake requirements for the occupants according to occupant intensity and activity levels. The fresh air background ventilation shall in no case be less than 10 litres per second per person.

3.02 Overall Energy performance

3.02.1 All new dwellings are to be constructed according to a maximum primary energy demand. Such energy demand shall be calculated according to the national calculation methodology for the particular building typology when the building design is commissioned.

3.02.2 Dwellings undergoing major renovation will be required to have a maximum yearly overall energy demand per square metre not exceeding that for the dwelling typology with the highest maximum overall energy demand requirement.

3.02.3 Where a building element forming part of the building envelope is being replaced or a building is being extended to a degree which may not be described as a major renovation, the building shall not be required to have a minimum overall energy performance level. Each new element forming part of the building envelope shall however not be exempted from compliance with maximum thermal conductivity requirements for that element.

3.02.4 The total primary energy balance for dwellings required for heating, cooling, lighting, ventilation and domestic hot water as defined in the national calculation methodology shall not exceed the values in Table 1.

Table 1: Overall Energy Performance Requirement for Dwellings					
Building Category	Flatted Dwellings	Terraced Houses	Semi-detached Housing	Fully detached Housing	Indicative Mean Energy Requirement
Overall Primary energy demand requirement	140kWh/m^{2}yr	90kWh/m^{2}yr	55kWh/m^{2}yr	55kWh/m^{2}yr	85kWh/m^{2}yr

3.03 Minimising heat loss through the building fabric

3.03.1 The calculated rate of heat loss per unit time through the solid parts of the exposed elements shall not be greater than those given in Table 2

Table 2: Dwellings: Limitation of the passage of heat through the building fabric. Maximum U-Values	
Exposed walls	1.57W/m^{2}K
Exposed Floors	1.57W/m^{2}K
Non-exposed floors	1.97W/m^{2}K
Roofs	0.59W/m^{2}K
Exposed walls of bathrooms, sanitary conveniences and utility rooms having an area of 5.6sq.m or less are excluded from this requirement. Exposed building elements of washrooms, storage rooms, garages, or other spaces with no space conditioning system and not internally connected to dwellings are excluded from this requirement.	

3.03.2 The calculated rate of heat loss per unit time through any windows and rooflights shall not be greater than what it would be if the conditions of Table 3 are met.

3.03.3 - Design Flexibility - The designer can use his creativity to meet the requirements of these guidelines by taking the following trade-offs:

(i) Enclosed draughtproof areas between two glazed panes such as is formed when a glazed window or door is installed behind or in front of an existing glazed unit within the same wall opening may be assumed to have a U value of double-glazing for the purpose of these design guidelines.

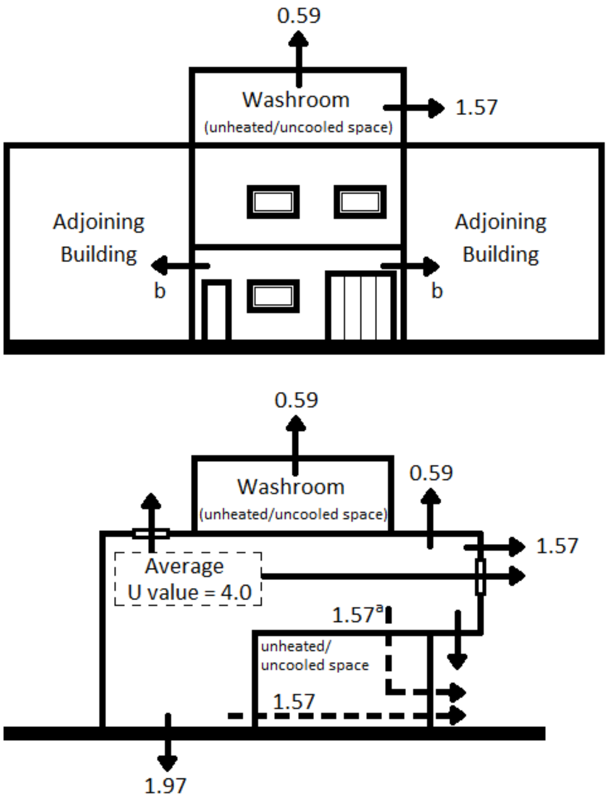
(ii) If in the proposed building, the U values of the exposed elements in Table 2 are improved, the requirements stipulated in Table 3 can be adjusted to reflect such values provided that the aggregate heat loss of the whole building shall be no greater than if the trade-off had not been applied.

3.03.4 In any building the maximum percentage of glazed area allowed in Table 3 may be increased provided that windows and rooflights with better U values are provided and that the calculated heat loss through such windows and rooflights is not greater than what it would be if the conditions of Table 3 are met.

Table 3: Limitations for windows and rooflights

Building Type	Windows and rooflights with the following U-Values in W/m^{2}K	Aggregate area as % of the area of the exposed walls bounding the building.	
		Windows & doors	Roof lights
All Dwellings	4.0W/m^{2}K	20%	10% of roof area

Windows and doors of bathrooms, sanitary conveniences and utility rooms having an area of 5.6sq.m or less are excluded from this requirement.



NOTE:

"a" - includes the effect of the unheated/ uncooled space

"b" - for calculation purposes only, in the case of adjoining buildings the U value of "would-be" unexposed party walls is to be taken as equal to the value of the exposed walls

Diagram 1: Standard U values for buildings

3.04 Solar Overheating

3.04.1 General

In designing dwellings the designer shall take into all relevant factors so that:

- Those occupied spaces or buildings that rely on natural ventilation do not overheat when these are subject to moderate level of internal heat gain.
- Those spaces or buildings that incorporate mechanical ventilation or cooling do not require excessive cooling plant capacity to maintain the desired space comfort conditions
- Those buildings that incorporate mechanical means for cooling and fresh air supply have the ability to use free cooling and natural ventilation during the periods of the year when this is possible.

The requirements above would be met through:

- The appropriate specification of the building envelope especially the areas and type of glazing and the surface finishes to be used
- The incorporation of passive measures such as external shading, form of building and the strategic positioning and orientation of glazing.

and

- The use of high thermal capacity combined.

3.04.2 Compliance

Compliance with overheating requirement can be shown to be achieved by:

(i) Providing for a building fabric that meets the provisions for the *limitation of the passage of heat through the building fabric* and in addition, in cases of spaces with glazing facing only one orientation, limiting the area of the glazed openings to the values given in table 4. In spaces where the glazing faces more than one orientation, compliance may be demonstrated by limiting the total area of glazing to the largest proportion, as set out in table 4, between the proportions applicable for the orientation of the external walls bounding that space.

Alternatively,

(ii) Showing by detailed calculation procedures such as those described in section 5 of 2 ”Environment Design, Guide A”, 2006 published by the Chartered Institution of Building Services Engineers (CIBSE) or otherwise, that in the absence of mechanical cooling or mechanical ventilation and subject to an internal heat gain of $10W/m^2$, The space will not overheat more than if the requirements of clause 3.04.2 (i) were applied.

Table 4: Maximum allowable area of glazing

Orientation of opening	Maximum allowable unprotected area of opening (%) Assuming 0.2 frame factor.
N	25
S	20
NE	17
E/SE/SW/NW	12
W	9
Horizontal (rooflights)	7

The maximum allowable area of glazing for windows with an orientation falling in between the compass directions should be taken as the highest allowable area for the two directions.

4. Requirements for Non-Dwellings

4.01 General

The envelope of all non-dwellings shall be designed to resist heat loss or gain or, where appropriate, to encourage heat gain or loss.

4.01.1 Building extensions of 14sq.m or less, to existing non-dwellings may be assumed to fulfil the requirements of this section provided that this construction is similar to the un-extended building.

4.01.2 Care must be taken in insulating elements of buildings in order not to create difficulties such as interstitial condensation.

(i) the area of a wall used to calculate the area of openings shall include all openings in the wall, and exclude trickle vents,
(ii) any external door with more than 1.0sq.m of glazing will be treated as a window.
(iii) areas of walls, roofs and floors shall be measured to the inside faces of the building.

4.01.3 The background ventilation rate will be calculated according to the national calculation methodology and will take into account the fresh air intake requirements for the occupants according to occupant intensity and activity levels. The fresh air background ventilation shall in no case be less than 10 litres per second per person.

4.02 Overall energy performance

4.02.1 Energy performance requirements for non-dwellings are set according to the building typology. All new non-dwellings are subject to specific requirements for elements forming part of the building envelope. Together with these requirements, an overall energy performance level is set for offices and buildings where offices occupy more than 50% of the useful floor area. The maximum primary energy demand for such buildings shall be calculated according to the national calculation methodology. The total primary energy be energy balance required for heating, cooling, lighting, ventilation and hot-water is shown in Table 5.

Table 5: Overall Energy Performance Requirement for new non-dwellings.

Building Category	Buildings used exclusively as Offices	Buildings with Offices occupying >50% of useful floor area
Overall Primary energy demand requirement	290kWh/m^{2}yr	350kWh/m^{2}yr

4.02.2 Non-dwellings undergoing major renovation which will be used as Offices or which will be occupied by offices over 50% or more of the useful floor area will be required to have a maximum yearly overall energy demand per square metre not exceeding that for the non-dwelling typology having the highest yearly overall energy demand requirement.

4.02.3 Where a building element forming part of the building envelope is being replaced or a building is being extended to a degree which may not be described as a major renovation, the building shall not be required to have a minimum overall energy performance level. Each new element forming part of the building envelope shall however not be exempted from compliance with maximum thermal conductivity requirements for that element.

4.03 Minimising heat loss through the building fabric

4.03.1 The calculated rate of heat loss per unit time through the solid parts of the exposed elements shall not be greater than those given in Table 6

Table 6: Non-Dwellings: Limitation of the passage of heat through the building fabric. Maximum U-Values	
Exposed walls	1.57W/m^{2}K
Exposed Floors	1.57W/m^{2}K
Non-exposed floors	1.97W/m^{2}K
Roofs	0.4W/m^{2}K
Exposed walls of bathrooms, sanitary conveniences and utility rooms having an area of 5.6sq.m or less are excluded from this requirement. Exposed building elements of washrooms, storage rooms, plant rooms, garages, or other spaces with no space conditioning system and not internally connected to the main conditioned space are excluded from this requirement.	

4.03.2 The calculated rate of heat loss per unit time through any windows and rooflight shall not be greater than what it would be if the conditions of Table 7 are met.

4.03.3 - Design Flexibility - The designer can use his creativity to meet the requirements of these guidelines by taking the following trade-offs:

(i) Display windows in shops and showrooms with single glazed panels protected by unheated or uncooled, enclosed draughtproof spaces may be assumed to have a U value of double-glazing for the purpose of these design guidelines.

(ii) If in the proposed building, the U-values of the exposed elements in Table 6 are improved, the requirements stipulated in Table 7 can be adjusted to reflect such values provided that the aggregate heat loss of the whole building shall be no greater than if the trade-off had not been applied.

4.03.4 In any building the maximum percentage of glazed area allowed in Table 7 may be increased provided that windows and rooflights with better U-values are provided and that the calculated heat loss through such windows and rooflights is not greater than what it would be if the conditions of Table 7 are met.

Table 7: Limitations for windows and rooflights for non-dwellings

Building Type	Windows and rooflights with the following U-Values in W/m^2K	Aggregate area as % of the area of the exposed walls bounding the building.	
		Windows & doors	Roof lights
Industrial and storage buildings	$4.0W/m^2K$	15%	10% of roof area
Offices, places of assembly	$4.0W/m^2K$	25%	10% of roof area
Showrooms, shops	$4.0W/m^2K$	50%	10% of roof area
Windows and doors of bathrooms, sanitary conveniences and utility rooms having an area of 5.6sq.m or less are excluded from this requirement.			

4.04 Solar Overheating

4.04.1 General

In designing non-dwellings the designer shall take into all relevant factors so that:

- Solar gains are limited through the use of any of the following methods or a combination of any of such methods: Geometry of the building, strategic positioning of glazing, external shading and careful selection of glazing type.
- Those occupied spaces or buildings that rely on natural ventilation do not overheat when these are subject to moderate level of internal heat gain.
- Those spaces or buildings that incorporate mechanical ventilation or cooling do not require excessive cooling plant capacity to maintain the desired space comfort conditions.

4.04.2 Compliance

Compliance with overheating requirement can be shown to be achieved by:

(i) Providing for a building fabric that meets the provisions for the *limitation of the passage of heat through the building fabric* and in addition, in cases of spaces with glazing facing only one orientation, limiting the area of the glazed openings to the values given in table 8. In spaces where the glazing faces more than one orientation, compliance may be demonstrated by limiting the total area of glazing to the largest proportion, as set out in table 8, between the proportions applicable for the orientation of the external walls bounding that space.

Alternatively,

(ii) Showing by detailed calculation procedures such as those described in section 5 of 2 ”Environment Design, Guide A”, 2006 published by the Chartered Institution of Building Services Engineers (CIBSE) or otherwise, that in the absence of mechanical cooling or mechanical ventilation and subject to an internal heat gain of $10W/m^2$, The space will not overheat more than if the requirements of clause 5.04.2(i) were applied.

Table 8: Maximum allowable area of glazing

Orientation of opening	Maximum allowable unprotected area of opening (%) Assuming 0.2 frame factor.
N	25
S	20
NE	17
E/SE/SW/NW	12
W	9
Horizontal (rooflights)	7

The maximum allowable area of glazing for windows with an orientation falling in between the compass directions should be taken as the highest allowable area for the two directions.

5. Calculation of U-values

5.01.1 U values calculated using the methods in the standards and codes of practice given below will meet the requirement of provisions in these design guidelines;

For walls and roofs: LVS EN ISO 6946:2008 A Building components and building elements - Thermal resistance and thermal transmittance - Calculation method.
For ground floors: *EN ISO 13370: 2007 Thermal performance of buildings – Heat transfer via the ground – Calculation methods.*

For windows and doors: *EN ISO 10077 – 1: 2006 Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 1: General*

Or

EN ISO 10077 – 2: 2012 Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 2: Numerical method for frames.

Or

EN ISO 12567 – 1: 2010 Thermal performance of windows and doors – Determination of thermal transmittance by hot box method – Complete windows and doors EN ISO 12567 – 2: 2005 - Thermal performance of windows and doors – Determination of thermal transmittance by hot box method - Roof windows and other projecting windows.

For basements: *EN ISO 13370: 2007 Thermal performance of buildings – Heat transfer via the ground – Calculation methods.*

5.01.2 For building elements not covered by the above-mentioned documents, the following may be appropriate alternatives:

for curtain walling: *EN ISO 10211 –: 2007 Thermal bridges in building construction – heat flows and surface temperatures: Detailed Calculations.*

5.01.3 U values for common building materials can be obtained from *EN 12524: 2000 Building materials and products - Hygrothermal properties – Tabulated design values*, but for ease of reference, *APPENDIX A – Tables of U values:* Table A.1, Table A.2 and Table A.3 give indicative U values for various types of windows, doors and rooflights. For specific insulation products, data should be obtained from the manufacturers.

5.01.4 When calculating U values, the thermal bridging effects of, for instance, structural and other framing, normal mortar bedding and window frames should generally be taken into account using the procedure given in *EN ISO 6946*. Thermal bridging can be disregarded however where the difference in thermal resistance between the bridging material and the bridged material is less than $0.1m^2K/W$. Where, walls contain in-built meter cupboards, and ceilings contain loft hatches, recessed light fittings, etc, area-weighted average U values should be calculated.

5.01.5 Thermal resistance of a component is obtained by:

- dividing the wall thickness in metres of a material by its thermal conductivity, and
- In the case of an air space, by using the standards given in Table 9.

Table 9: Thermal resistance of air spaces and surfaces

Exposed walls	outside surface*	$0.06m^2K/W$
	air space (cavity)	$0.18m^2K/W$
	inside surface	$0.10m^2K/W$
Roofs	Roof space (pitched)	$0.18m^2K/W$
	Roof space (flat)	$0.16m^2K/W$
	outside surface	$0.04m^2K/W$
	inside surface	$0.14m^2K/W$
Exposed floors	inside surface	$0.14m^2K/W$
	outside surface	$0.04m^2K/W$

***Note:**

Outside surface resistance depends on the irradiative and convective heat transfer coefficient which is dependent on both the building orientation and its exposure.

5.01.6 A typical calculation can be seen in *APPENDIX B – Calculating U values*.

6. Conservation of Rain water

6.01 Rainwater that falls on roofs

Rainwater that falls on roofs shall not be allowed to drain into the public sewer or onto a public place or thoroughfare but shall be collected in suitable wells or cisterns within the site of the building. Such wells or cisterns shall have an overflow facility which will prevent the cistern from being filled more than its designed capacity and which drains to a public place, thoroughfare or underground public rain collection system where the latter is available.

6.02 Rainwater that falls on areas of a property other than roofs

6.02.1 Where a building or site incorporates an area other than a roof which is exposed to rainfall and which has a total aggregate area larger than $200m^2$, the rainwater falling onto this roof shall not be allowed to drain into the public sewer or onto a public place or thoroughfare but shall be collected in suitable wells or cisterns within the site of the building. Areas occupied by soil or planters may be excluded from the calculation of such area.

6.02.2 Except for areas that fall within the provision of 6.02.01, rainwater that falls on areas of a property other than roofs may be drained onto a public place or thoroughfare provided that appropriate provision is made to avoid nuisance and damage.

6.03 Rainwater drainage

6.03.1 The capacity of the system shall be adequate to carry the anticipated flows at each part of the system.

6.03.2 The system shall be of appropriate materials to conduct water from roofs or other areas to a cistern without contributing to dampness in any part of the building or adjoining buildings.

6.03.3 Roof falls shall be sufficient to prevent the build-up of water on roofs and shall direct the water to sufficient channels and outlets as appropriate. Falls of between 1:80 to 1:100 are recommended

6.03.4 Rainwater pipes may discharge onto another gutter or surface provided that the latter is also drained, and has the capacity to deal with the combined runoff.

6.03.5 Rainwater pipes and their fittings shall be appropriate to their purpose and shall be fixed to the external face of the walls of buildings.

6.03.6 Where it is necessary to introduce rainwater pipes within buildings they shall be completely accessible, and shall not be embedded within walls or passed through inaccessible wall cavities.

6.04 Wells and cisterns

6.04.1 All buildings shall incorporate a cistern or well for the storage of rainwater.

6.04.2 The size and number of cisterns, or wells shall conform to the requirements of Table 10 or better.

Table 10: Size of well or cistern

Building Type	Size of cistern (m^3)
1. Domestic dwellings (inc. Apartment blocks)	Total roof area (m^2) x 0.6m
2. Hotels, Schools, Offices, Factories, Industrial buildings and Hospitals	Total roof area (m^2) x 0.6m
3. Shops and showrooms, and places of public gathering and entertainment not integrated in 2 above	Total roof area (m^2) x 0.45m
4. External paved areas (inc. open terraces and balconies) *	Total paved area (m^2) x 0.6m

***Note:**

This requirement applies only if the total open paved area is greater than 300sq.m

6.04.3 The well or cistern shall be located within the site in such a position as to ensure its structural integrity and proper maintenance.

6.04.4 The cistern or well shall be designed and constructed to be watertight and meeting all requirements of structural stability.

6.04.5 The containing walls or wellhead shall:

- prevent surface water from draining directly into the well, and
- provide safety to users of the site

6.05 Interception traps

6.05.1 Rainwater shall be led into the well or cistern through an interception trap consisting of one or more chambers designed to settle out pollutants from the rainwater prior to its being stored within the cistern or well.

6.05.2 Where rainwater is taken from an area in which petrol or oil are prevalently located, then a petrol interceptor is to be installed as the collecting gully and the water led away to the public street.

6.06 Access

6.06.1 Safe access for inspection and cleaning the well or cistern is to be provided by means of suitable non-ferrous step irons, ladders or steps incorporated into the structure.

6.07 Use of rainwater collected in wells and cisterns

6.07.1 For every newly constructed building, a separate water circulation system together with associated draw off points for providing water for flushing of toilets and watering of planted areas should be provided.

6.07.2 In those buildings with multi-owner occupancies, the requirement of paragraph 6.07.1 should be provided to at least one of the occupancies.

APPENDIX A – Tables of U values

The following tables provide indicative U values for windows, doors and rooflights. Table A.1 applies to windows and rooflights with wood or PVC-U frames. Table A.2 applies to windows with metal frames, to which (if applicable) the adjustments for thermal breaks and rooflights in Table A.3 should be applied. The tables do not apply to curtain walling or to other structural glazing not fitted in a frame. For the purpose of these design guidelines a roof window may be considered as a rooflight. The U value of a window or rooflight containing low-E glazing is influenced by the emissivity, *En,* of the low-E coating.

Low-E coatings are of two principal types, known as 'hard' and 'soft'. Hard coatings generally have emissivities in the range 0.15 to 0.2, and the data for ε*n* = 0.2 should be used for hard coating, or if the glazing is stated to be low-E but the type of coating is not specified. Soft coatings generally have emissivities in the range 0.05 to 0.1. The data for ε*n* = 0.1 should be used for a soft coating if the emissivity is not specified.

When available, manufacturers' certified U-values should be used in preference to the data given in these tables.

Indicative U values (W/m^2K) for windows and rooflights with wood or PVC-U frames, and doors — Table A.1

	Gap between panes			
	6mm	**12mm**	**16mm or more**	**Adjustment for rooflights in dwellings**[3]
Single glazing	4.8			+0.3
Double glazing (air filled)	3.1	2.8	2.7	+0.2
Double glazing (low-E, ε*n* = 0.2)[1]	2.7	2.3	2.1	
Double glazing (low-E, ε*n* = 0.15)	2.7	2.2	2.0	
Double glazing (low-E, ε*n* =0.1)	2.6	2.1	1.9	
Double glazing (low-E, ε*n* = 0.05)	2.6	2.0	1.8	
Double glazing (argon filled)[2]	2.9	2.7	2.6	
Double glazing (low-E ε*n* = 0.2, argon filled)	2.5	2.1	2.0	
Double glazing (low-E ε*n = 0.1, argon filled)*	2.3	1.9	1.8	
Double glazing (low-E ε*n* = 0.05, argon filled)	2.3	1.8	1.7	
Triple glazing	2.4	2.1	2.0	
Triple glazing (low-E, ε*n* = 0.2)	2.1	1.7	1.6	
Triple glazing (low-E, ε*n* = 0.1)	2.0	1.6	1.5	
Triple glazing (low-E, ε*n* = 0.05	1.9	1.5	1.4	
Triple glazing (argon filled)	2.2	2.0	1.9	
Triple glazing (low-E, ε*n* = 0.2 argon filled)	1.9	1.6	1.5	
Triple glazing (low-E, ε*n = 0.1, argon filled)*	1.8	1.4	1.3	
Triple glazing (low-E ε*n* = 0.05 argon filled)	1.7	1.4	1.3	
Solid wooden door[4]	3.0			------

Notes:

1. The emissivities quoted are normal emissivities. (Corrected emissivity is used in the calculation of glazing U values). Uncoated glass is assumed to have a normal emissivity of 0.89
2. The gas mixture is assumed to consist of 90% argon and 10% air.
3. No correction need be applied to rooflights in buildings other than dwellings.
4. For doors which are half-glazed the U value of the door is the average of the appropriate window U value and that of the non-glazed part of the door (e.g. $3.0W/m^2K$ for a wooden door)

Indicative U values (W/m²K) for windows with metal frames (4mm thermal break) — Table A.2

	Gap between panes		
	6mm	**12mm**	**16mm or more**
Single glazing	5.7		
Double glazing (air filled)	3.7	3.4	3.3
Double glazing (low-E, εn = 0.2)	3.3	2.8	2.6
Double glazing (low-E, εn = 0.1)	3.2	2.6	2.5
Double glazing (low-E, εn = 0.05)	3.1	2.5	2.3
Double glazing (argon filled)	3.5	3.3	3.2
Double glazing (low-E, εn = 0.2, argon filled)	3.1	2.6	2.5
Double glazing (low–E, εn = 0.1, argon filled)	2.9	2.4	2.3
Double glazing (low–E, εn =0.05, argon filled)	2.8	2.3	2.1
Triple glazing	2.9	2.6	2.5
Triple glazing (low–E, εn = 0.2)	2.6	2.2	2.0
Triple glazing (low–E, εn =0.1)	2.5	2.0	1.9
Triple glazing (low–E, εn = 0.05)	2.4	1.9	1.8
Triple glazing (argon filled)	2.8	2.5	2.4
Triple glazing (low-E, εn = 0.2, argon filled)	2.4	2.0	1.9
Triple glazing (low-E, εn = 0.1, argon filled)	2.2	1.8	1.7
Triple glazing (low-E, εn = 0.05, argon filled)	2.2	1.8	1.7

Note:

For windows and rooflights with metal frames incorporating a thermal break other than 4mm, the following adjustments should be made to the U values given in Table A.2.

Adjustments to U values for frames with thermal breaks — Table A.3

Thermal break (mm)	Adjustments to U value (W/m²K)	
	Window, or rooflight in building other than a dwelling	**Rooflight in dwellings**
0 (no break)	+0.3	+0.7
4	+0.0	+0.3
8	-0.1	+0.2
12	-0.2	+0.1
16	-0.2	+0.1

Note:

Where applicable adjustments for both thermal and rooflight should be made. For intermediate thicknesses of thermal breaks, linear interpolation may be used.

A1 Corrections to U values of roofs and floors

Annex D of *EN ISO 6946* provides corrections to U values to allow for the effects of:

- air gaps in insulation
- mechanical fasteners penetrating the insulation layer
- precipitation on inverted roofs

The corrected U value (U_c) is obtained by adding a correction term ΔU:

$$U_c = U + \Delta U$$

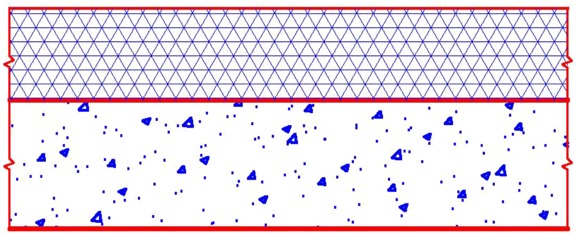
If the total ΔU is less than 3% of U then the corrections need not be applied and ΔU can be taken to be zero. However, where corrections are to be applied, before using the tables the following steps should be carried out:

(i) subtract ΔU from the desired U value.

(ii) use this adjusted U value in the tables when calculating the required thickness of insulation.

This thickness of insulation then meets the original desired U value, having allowed for the ΔU correction(s).

A2 Roofs



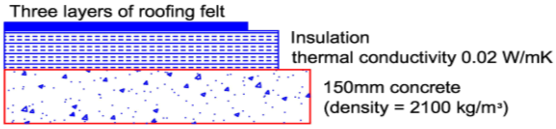
Base thickness for continuous insulation **Table A.4**

	Design U value (W/m²K)	Thermal conductivity of insulant (W/m.k) 0.020	0.025	0.030	0.035	0.040	0.045	0.050
		Base thickness of insulating material (mm)						
	A	B	C	D	E	F	G	H
1	0.15	131	163	196	228	261	294	326
2	0.20	97	122	146	170	194	219	243
3	0.25	77	97	116	135	154	174	193
4	0.30	64	80	96	112	128	144	160
5	0.35	54	68	82	95	109	122	136
6	0.40	47	59	71	83	94	106	118

Allowable reduction in thickness for common roof components — Table A.5

	Concrete slab density (kg/m^3)	Thermal conductivity of insulation (W/m.K) 0.020	0.025	0.030	0.035	0.040	0.045	0.050
		Reduction in base thickness of insulating material for each 100mm of concrete slab						
	A	B	C	D	E	F	G	H
1	600	10	13	15	18	20	23	25
2	800	7	9	11	13	14	16	18
3	1100	5	6	8	9	10	11	13
4	1300	4	5	6	7	8	9	10
5	1700	2	2	3	3	4	4	5
6	2100	1	2	2	2	3	3	3
	Other materials and components	**Reduction in base thickness of insulating material (mm)**						
7	10mm plasterboard	1	2	2	2	3	3	3
8	13mm plasterboard	2	2	2	3	3	4	4
9	13mm sarking board	2	2	3	3	4	4	5
10	12mm Calcium Silicate liner board	1	2	2	2	3	3	4
11	Roof space (pitched)	4	5	6	7	8	9	10
12	Roof space (flat)	3	4	5	6	6	7	8
13	19mm roof tiles	0	1	1	1	1	1	1
14	19mm asphalt (or 3 layers of felt)	1	1	1	1	2	2	2
15	50mm screed	2	3	4	4	5	5	6

Example: Concrete deck roof



Determine the thickness of the insulation layer required to achieve a U-value of 0.25 W/m^2K for the roof construction shown below.

Using Table A.4:

From column D, row 3 of the table, the base thickness of the insulation layer is 116mm.

The base thickness may be reduced by taking account of the other materials as follows:

From Table A.5:

3 layers of felt column D, row 14 = 1mm

150mm concrete deck column D, row 3 adjusted for 150mm thickness (1.5 x 8) = 12mm

Total reduction = 13mm

The minimum thickness of the insulation layer required to achieve a U-value of 0.25W/m^2K is therefore:

Base thickness less total reduction

i.e. 116 – 13 = **103mm**

A3 Building Materials

Thermal conductivity of some common building materials — Table A.6

	Density (kg/m^3)	Conductivity (W/m.K)
Walls		
Lightweight aggregate concrete block	1400	0.57
Autoclaved aerated concrete block	600	0.18
Concrete (medium density inner leaf)	1800	1.13
	2000	1.33
	2200	1.59
Concrete (high density)	2400	1.93
Mortar (protected)	1750	0.88
Mortar (exposed)	1750	0.94
Gypsum	600	0.18
	900	0.30
	1200	0.43
Gypsum plasterboard	900	0.25
Sandstone	2600	2.3
Limestone (soft)	1700	1.1
Limestone (hard)	2400	1.7
Fibreboard	400	0.1
Plasterboard	900	0.25
Tiles (ceramic)	2300	1.3
Timber (softwood), plywood, chipboard	500	0.13
Timber (hardwood)	700	0.18
Wall ties (stainless steel)	7900	17.0
Surface finishes		
External rendering	1300	0.57
Plaster (dense)	1300	0.57
Plaster (lightweight)	600	0.18
Roofs and roof finishes		
Reinforced concrete (1% steel)	2300	2.3
Reinforced concrete (2% steel)	2400	2.5
Aerated concrete slab	500	0.16
Asphalt	2100	0.70
Felt/bitumen layers	1100	0.23
Screed	1200	0.41
Stone chippings *(“hardstone”)*	2000	2.0
Limestone *(“torba”)*	1300	0.8
Tiles (clay)	2000	1.0
Tiles (concrete)	2100	1.5
Wood wool slab	500	0.10
Floors		
Cast concrete	2000	1.35
Metal tray (steel)	7800	50.0
Screed	1200	0.41
Timber (softwood), plywood, chipboard	500	0.13
Timber (hardwood)	700	0.18
Insulation		
Expanded polystyrene (EPS) board	15	0.040
Mineral wood quilt	12	0.042
Mineral wood batt	25	0.038
Phenolic foam board	30	0.025
Polyurethane board	30	0.025

Note:

If available, certified test values should be used in preference to those in the table.

APPENDIX B – Calculating U values

B1 Introduction

When calculating the U value, the effect of thermal bridges should be taken into consideration. Other factors, such as wall ties and air gaps around insulation should also be included where applicable. The calculation method, known as the *"Combined Method"*, is set out in *EN ISO 6946*. The following example illustrates the use of the method for a typical wall.

This example is offered as indicating ways of meeting the requirement but designers also have to ensure that their designs comply with all the other requirements of existing building regulations.

B2 Procedure

The U value is calculated by applying the following steps:

1). Calculate the upper resistance limit (R_{upper}) by combining in parallel the total resistance of all possible heat-flow paths (i.e. sections) through the plane building element.

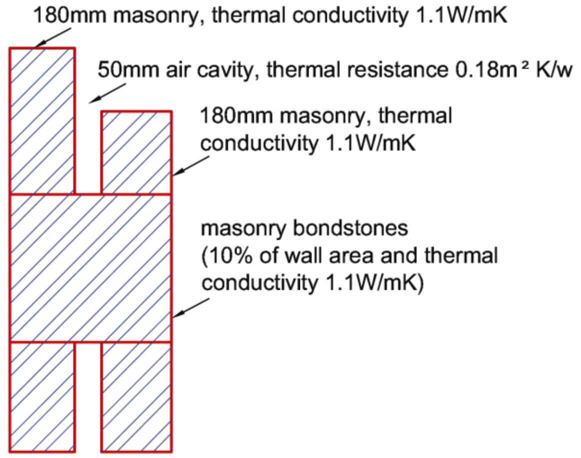
2). Calculate the lower resistance limit (R_{lower}) by combining in parallel the resistance of the heat flow paths of each layer separately and then summing the resistance of all layers of the plane building element.

3). Calculate the U value of the element from $U = \frac{1}{R_T}$

$$\text{where} \quad R_T = \frac{R_{upper} + R_{lower}}{2}$$

4). Adjust the U value as appropriate to take account of metal fasteners, bond stones and air gaps.

B3 Example – U value calculation for a typical double leaf masonry wall



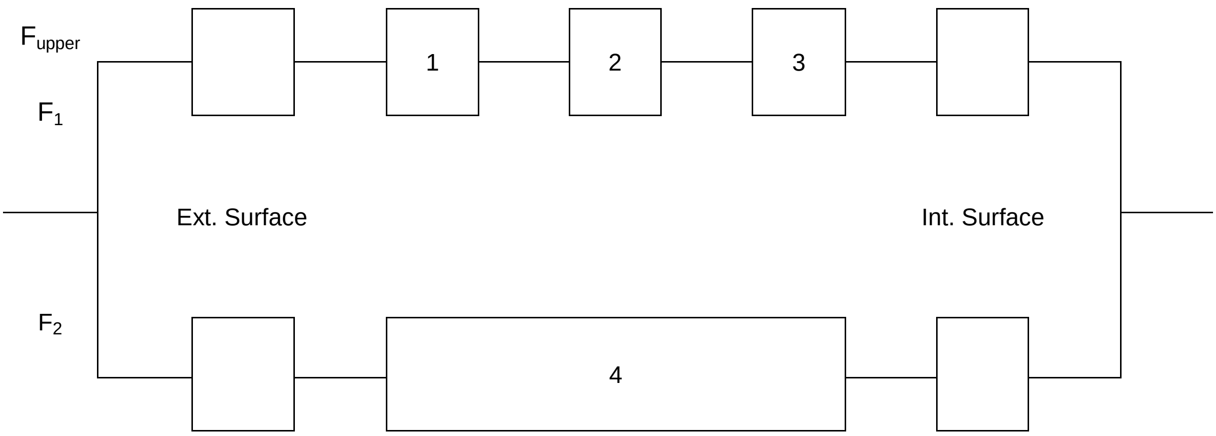
Layer	Material	Thickness *(mm)*	Thermal conductivity *(W/m.k)*	Thermal resistance *(m^2K/W)*
	External surface	----	----	0.060
1	Outer leaf masonry	180	1.1	0.164
2	Air cavity (unvented)	50	----	0.180
3	Internal leaf masonry	180	1.1	0.164
4	Bond stone 10%	410	1.1	0.373
	Internal surface	----	----	0.100

There are two possible paths through which heat can pass. The upper limit of resistance is therefore given by:

$$R_{upper} = \frac{1}{\left(\frac{F_1}{R_1} + \frac{F_2}{R_2}\right)}$$

where F_m is the fractional area of section **m** and R_m is the total thermal resistance of section **m**. A conceptual illustration of the upper limit of resistance is shown in Diagram B.1 below.

Conceptual illustration of the upper limit of resistance — Diagram B.1



Resistance R_1 through section		
External surface resistance	=	0.060
Resistance of 180mm masonry	=	0.164
Resistance of air cavity	=	0.180
Resistance of 180mm masonry	=	0.164
Resistance of internal surface	=	0.100
Total thermal resistance R_1	**=**	**0.667m^2K/W**
Fractional area F_1 = 90%	**=**	**0.9**

Resistance R_2 through section containing bond stone		
External surface resistance	=	0.060
Resistance of 410mm masonry	=	0.373
Resistance of internal surface	=	0.100
Total thermal resistance R_2	**=**	**0.533m^2K/W**
Fractional area F_2 = 10%	**=**	**0.1**

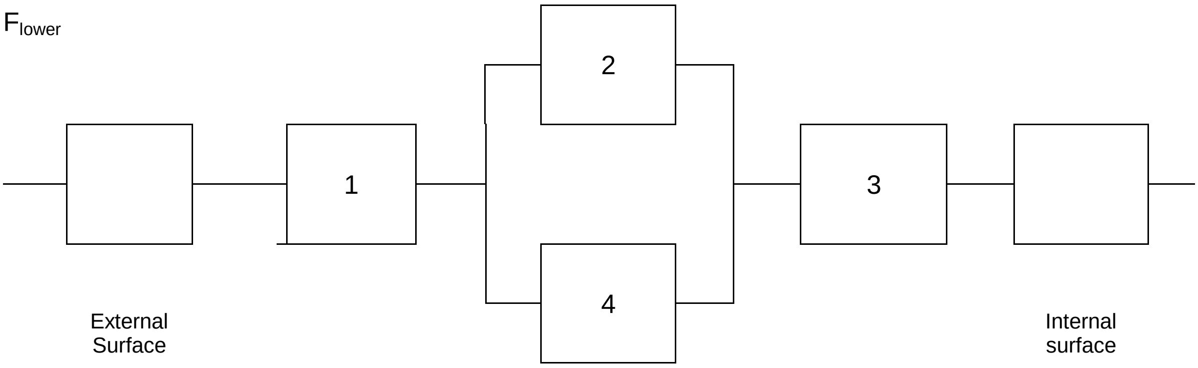
Combining these resistances, we obtain:

$$R_{upper} = \frac{1}{\frac{F_1}{R_1} + \frac{F_2}{R_2}} = \frac{1}{\frac{0.9}{0.667} + \frac{0.1}{0.533}} = \frac{1}{1.5365} = 0.651 m^2 K / W$$

B4 Lower Resistance Limit

A conceptual illustration of the lower limit of resistance is shown in Diagram B.2.

Conceptual illustration of the lower limit of resistance — **Diagram B.2**



The resistance of the layers are added together to give the lower limit of resistance.

The resistance of the bridged layer consisting of the cavity and masonry bond stones is calculated using:

$$R = \frac{1}{\frac{F_{cavity}}{R_{cavity}} + \frac{F_{bondstones}}{R_{bondstones}}}$$

The lower limit of resistance is then obtained by adding together the resistance of the layers:

Resistance R_{lower} through section				
External surface resistance			=	0.060
Resistance of 180mm masonry			=	0.164
Resistance of bridged cavity	=	$\frac{1}{\frac{0.9}{0.18} + \frac{0.1}{0.045}}$	=	0.139
Resistance of 180mm masonry			=	0.164
Internal surface resistance			=	0.100
Total (R_{lower})			**=**	**0.626m²K/W**

B5 Total Resistance R_T of wall

The total resistance of the wall is the average of the upper and lower limits of resistance:

$$R_T = \frac{R_{upper} + R_{lower}}{2} = \frac{0.6508 + 0.6262}{2} = 0.638\, m^2 K / W$$

B6 U value of the wall

$$U = \frac{1}{R_T} = \frac{1}{0.638} = 1.566\text{W/m}^2\text{K}$$

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