VERY LOW CARBON BUILDING IMPROVEMENTS FOR LEEDS VICTORIAN TERRACE HOMES

A GUIDANCE MANUAL








This Manual was commissioned by Leeds Action to Create Homes (LATCH) and is a collaboration with SURE Solid Wall Insulation and Leeds Environmental Design Associates (LEDA).

SPRING **2012**

This manual aims to provide guidance on how to substantially improve the thermal performance of the fabric of the existing housing stock with particular reference to a typical Victorian terrace house type found in Leeds but also in many other parts of the UK.

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INTRODUCTION

In early 2012 Leeds Action To Create Homes (LATCH) commissioned SURE Solid Wall Insulation CIC (SURE), Leeds Environmental Design Associates Ltd (LEDA) and AECOM Ltd to create a Guidance Manual and associated training courses describing the installation of high specification insulation and ventilation in hard-to-treat homes.

This Guidance Manual and associated training will be used to add new skills to the workforce at LATCH resulting in a significantly improved renovation standard in the area of thermal performance. This will have many benefits including improved health of tenants, reduction of fuel poverty and reduction in fuel bills and carbon emissions.

This Manual is intended for use by moderately skilled tradespeople. The techniques described use readily available building materials and well known construction methods.

The innovative and distinctive aspects of the manual and training are:

- its precise application to a specific building type in Leeds
- best application of measures with a limited budget without precluding future improvement works
- the documentation of innovative methods and techniques developed by SURE for use on the building type
- deep understanding of the underlying principles required to approach 'PassivHaus' standards
- presentation of guidance material that is not available from other sources
- material developed with integrated team of specialist architects, consulting engineers, builders and social housing providers

An ultimate aim is to provide a system which delivers very high thermal performance standards that typically have been achieved only at much higher cost.

Limitations

It is essential that advice be sought from persons already experienced and knowledgeable of the legal and technical aspects of the processes involved in maintaining and refurbishing existing housing stock before embarking on a renovation project.

The authors of this Manual have made every effort to ensure the accuracy of the information presented. This Manual should be used as guidance material and not as a replacement for current regulations or existing standards.

Acknowledgements

This Guidance Manual is the combined work of a number of people.
Thanks are due to each of these people for their efforts to create this document.

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OVERVIEW

There are **5 main sections** in this manual.

Section A describes **the principles** behind improved thermal performance, the standards and assessments that can be used to provide data on the energy use of houses.

Section B outlines **the process of making decisions** to achieve the greatest benefit given the particular circumstances of budget, potential disruption, and the available resource and skills. This section is based on the construction of a typical Victorian house type and itemises a range of possible measures that can be applied to improve the thermal performance of the building.

Section C reviews the **health and safety** implications of the type of work.

Section D contains detailed descriptions of **how to prepare for and tackle each of the major aspects of whole of house refurbishment**. It is organised in sub-sections dedicated to the various measures and gives installation instructions with photos and diagrams.

Section E contains **appendices** and **related information**.

There are already some excellent guides that provide a broader picture of how to improve the thermal performance of the existing housing stock including other examples of how this may be achieved. We have listed some of these in an Appendix.

CONTENTS

PAGE REFERENCING SYSTEM USED WITHIN THIS MANUAL

Each page in this manual has a unique reference code. This code contains the section letter and three digits, for example D201. These reference codes appear in ascending order. There are gaps left to allow future development of the content of this Manual.

The page reference is also part of a QR code shown on most pages, like the one shown on the left. The full QR code contains a web link to further material related to the topic on each page. Each code may be scanned by suitably equipped mobile devices to allow on-site access to expanded explanation, further diagrams and in some cases video tutorials. Each web link takes the form of this example: www.SUREinsulation.co.uk/leaf/A001.htm

SECTION A

PERFORMANCE STANDARDS AND ASSESSMENTS

A001

Performance Standards and Assessment Methods

CURRENT MATERIAL

There is a rapidly growing quantity of documents and web based material concerning the upgrading of our current housing stock to high standards of thermal performance. A certain amount of this material that is known to the authors and considered relevant has informed the preparation of this document. A list of reference information can be found at the end of this manual.

STANDARDS AND MEASUREMENT

The approach taken in this document is to simplify the process of upgrading the building fabric to high levels of thermal efficiency and make it more affordable. The proposed upgrades may be undertaken incrementally or as a whole house refurbishment dependent on the project circumstances.

Benchmarks:
The benchmark for this document is a SAP/ EPC rating based on a real example of an untreated Victorian terrace property. The SAP calculation method is then used to compare a range of measures that are described in the manual and identified in the Comparison Matrix of Improvement Measures in Section B. The Comparison Matrix is used to inform the decision making process of selecting the most appropriate and beneficial improvement measures.

Targets:
The target for a whole house treatment with a comprehensive set of low cost measures implemented is at least 42% reduction in energy demand. This would involve the following specification:

Insulation:
- Floor 275mm mineral wool
- External walls 100mm PIR board
- Loft 275mm mineral wool

Heating and Lighting:
- New condensing combi boiler (90% efficient)
- New programmer, thermostat and TRVs
- Low energy bulbs throughout
- Double glazing with low E coating and argon fill

A 'high specification' set of measures to achieve an 83% reduction in energy demand is also shown in Section B to show the best that would be possible if circumstances allowed. The selection of individual isolated improvement measures then can be made dependent on the choice of final intended performance in the future when all measures are in place.

A002

Principles Adopted to Guide the Selection of Improvement Measures

Section B of this document refers to the selection of measures that may be considered as opportunities arise for maintenance or improvement work to be undertaken. In order to prioritise these measures, the following considerations are used:

1. Initial cost
2. Time taken for the measure to be carried out
3. Effectiveness as measured in reduction of CO_2 emissions and kWh of energy used to provide comfort conditions
4. Savings in energy running costs
5. Disturbance to the occupants
6. Level of awareness and knowledge required by the occupant
7. Level of comfort increase for occupants
8. Potential for higher standard of indoor air quality
9. Reduced maintenance

The first four considerations are readily quantifiable and therefore allow more easy comparison. The fifth and following considerations are more difficult to measure and have variables that may be specific to the context of the property, owner and occupant. This guide has been developed in partnership with LATCH who are providers of supported housing services. Issues of maintenance, level of awareness required by the occupant, disturbance to the occupants and the potential to deal with indoor air quality problems such as mould growth within the house have particular importance when selecting the improvement measures to be carried out.

The evaluation of the measures to be taken that are not readily quantifiable is subjective and context specific. These measures are desirable for all houses though the considerations will vary when applied to a property that may, for instance, be owner occupied rather than privately rented etc.

Section D of this document details the specific measures to improve the thermal performance and internal environment of a Victorian house typical of a significant proportion of the existing housing stock in the UK (21% of the housing stock was built before 1919). The particular methods shown have been tried and tested on a range of other properties. The measures and methods illustrated have the following underlying assumptions:

VENTILATION AND AIRTIGHTNESS

The specification of higher levels of insulation requires very careful consideration of the installation of the materials to achieve a fully effective thermal envelope. The airtightness of the external construction layer is paramount and we have aimed to show in detail how this can be relatively simply achieved. The airtightness layer is positioned to the inside face of the insulated layer (in the position of the vapour barrier). It is essential that this layer achieves a seal between all the elements of the external envelope as illustrated by the red line in Fig. 1. The idea of the 'red line' is taken from the Passivhaus approach to achieving very high levels of thermal efficiency in the external building fabric.

Controlling the rate at which warm air leaks out of the house and cold air leaks in is an extremely important aspect of energy efficiency, comfort and health. Many elements of this manual deal with making the house more airtight either directly or indirectly though the application of insulation. The aim is to achieve a state of controlled ventilation where correct amounts of ventilation (not too much or too little) are provided and the minimum of energy is wasted.

Adequate ventilation is required to: remove pollutants and water vapour; provide fresh air for the occupants to breathe; and to provide a means of cooling in summer.
Both issues of air leakage and adequate ventilation need to be tackled at the same time. This can be summed up succinctly by 'BUILD TIGHT, VENTILATE RIGHT'.

A measurement of permeability is used to define how airtight a building is. It is measured by pressurising the building with a fan and calculating the rate of air flow. The result is given in units of cubic metres of air per hour, per square metre of external envelope at a pressure of 50 pascals or XY $m^3/h.m^2$ @50pa as it is usually written. For existing houses values of >25 $m^3/h.m^2$ are not uncommon, but the best new build or refurbishments will achieve $<0.5 m^3/h.m^2$. As a result

of implementing the basic measures in this manual achieving a value of below 10 would be a good achievement. A value of below 3 would be very good, and easily justify whole house heat recovery ventilation. For the example house before any works we would expect an airtightness level of between 15-25 m^3 /h.m^2 @ 50pa.

The strategy for airtightness is to refer to the red line diagram (see Fig. 1) and consider each and every element as you go around the inside face of the building, sealing up and creating the 'red line' of a continuous air tight layer. It is also important to ensure that the external face of the building is well sealed to minimise air paths and ensure that thermal bypass does not occur.

The key issues in ventilation are to provide controlled air inlet paths with means of drawing the stale air out whilst securely ventilating the house on still days and maintaining cool conditions during warm weather. Effective extractor fans and heat recovery units have been proposed as a means of achieving correct levels of ventilation.

FABRIC IMPROVEMENTS TO THE EXTERNAL ENVELOPE

The building fabric should be insulated to the highest possible level (given existing wall type and construction, internal space available and budget constraints). The slogan to be adopted is “NO GAPS”. A completely continuous layer of insulation is required with as few interruptions as possible (some will be unavoidable due to the configuration of the existing building elements of wall, floor joist, etc.). Small gaps of 1 or 2 mm can dramatically reduce the effectiveness of the insulation. Retrofitting should be seen as a building’s once in a lifetime opportunity to provide affordable comfort for as long into the future as possible.

HEATING AND CONTROLS

The use of ‘A’ rated gas combi boilers in radiator systems to provide heating and hot water is the preferred option with 7 day programmable thermostat and zoning controls. This guide recognises the importance of the occupants’ understanding of the implications of controlling the heating in conjunction with the impact of leaving windows and doors open. We recommend simple and short guides to help the occupant understand the implications of raising thermostats by increments of a single degree, and the importance of closing windows and doors in winter as soon as the requirement for ventilation or access has been satisfied. The influence of the behaviour of the occupants in relation to building use is a vital part of achieving real efficiencies (as opposed to those that have been calculated). This important issue is outside the scope of this guide. References are provided at the end of this manual for further guidance from other sources.

LIGHTING AND APPLIANCES

The installation of low energy lighting – fluorescent tube, compact fluorescent and LED – is necessary to complement the energy reduction ensuing from the thermal performance upgrade of the fabric. The issues raised above regarding the influence of people’s behaviour during occupancy equally apply to the management of energy consumption from lighting and appliances.

RENEWABLE ENERGY

The guide is focussed on minimising demand through treating the existing building fabric. The use of renewable energy in the form of solar thermal and PV is not covered in the guide. It is seen as a measure to be considered once the fabric, heating and lighting systems have been renewed to provide the maximum level of energy saving. Other renewable energy options such as heat pumps and biomass should be considered only if mains gas is not available. These technologies require specific circumstances to ensure they function with maximum efficiency and these need to be satisfied before they are selected e.g. availability of biomass fuel. They also require specialist design of the heating system.

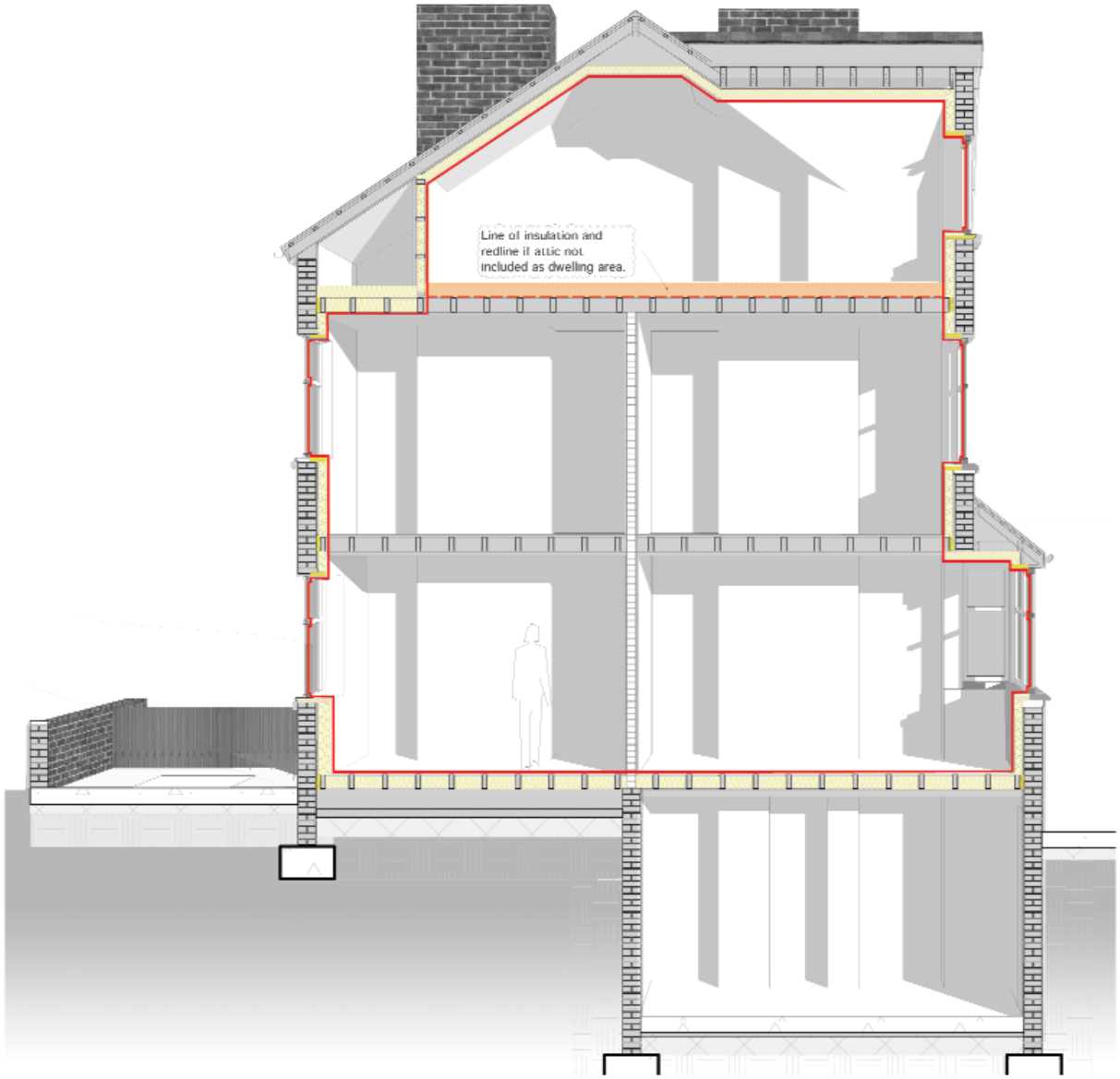


Fig.1 Position of Red line around external envelope

SECTION B

DECISIONS AND CHOICES IN SELECTING LOW CARBON IMPROVEMENTS

Background

EXISTING BUILDING CONSTRUCTION

There are a number of excellent documents that describe the different construction methods commonly found in the UK housing stock and their condition (see English Housing Survey Housing Stock Report 2008 – DCLG). The focus of this document is a Victorian Terrace house with a typical construction of:

Nine inch solid external wall, single brick load bearing internal walls, timber stud partitions, timber suspended floors, pitched slate covered roof and timber sliding sash windows.

Before considering the upgrading of the thermal performance it is important to ensure that the existing building structure is in a condition to allow the improvement measures to be installed. The external elements of the building need to be fully weatherproof, free from damp and performing the weather shielding function that they were originally designed to do. The assessment of the condition of the existing construction needs to be carried out by appropriate qualified persons. The particular circumstances of the property should be taken into account such as the exposure level of the location to wind driven rain, the condition of adjoining properties and other site-specific criteria.

APPLYING RETROFITTED INSULATION

As stated in Section A, it is most important to maintain the continuity of the insulation to minimise gaps. This document illustrates how to upgrade the walls using internal wall insulation. This presents a particular set of problems to solve in order to maintain the continuity of the insulation, particularly at intermediate floor junctions. The application of external wall insulation is not covered in this manual, but can enable a simpler and more effective covering of the existing fabric. External wall insulation presents many of its own difficulties however, for example: termination of insulation at junctions with adjacent terraced properties and at the junction of the wall at roof level. The advantage of internal wall insulation is that it can be installed in stages. It offers more flexibility to exploit the opportunities afforded when other works are being carried out, such as the renewal of a kitchen.

Insulating the roof and the underfloor areas of a house offer easier ways to upgrade the fabric and are generally less intrusive.

A further important factor to highlight is the impact of the installation of insulation on the performance and condition of the existing construction. An example of this is referred to in Section D where the first floor joists are bearing onto the external wall. Potential increased moisture levels in walls may occur due to the separation of the existing brick wall from the house interior through applying insulation. There is much current debate about how the increased moisture levels may affect the timber joist ends and the brickwork in the longer term. Additionally, it is essential to achieve a complete vapour tight seal to the whole of the internal face of the applied insulation to ensure no further moisture is able to enter the wall from inside the house. These details should be confirmed after assessing the particular conditions that occur in the house where internal wall insulation is to be installed.

PROPERTY WORK PLAN

The preferred method of approaching improvement work is to tackle the whole building at once and apply all measures. This is not always possible and more often maintenance works are undertaken on particular parts of the house. This allows opportunities for carrying out other improvement works dependent on time, budget available and possible disturbance to occupants amongst other factors. These ‘trigger points’ are already the subject of guidance from other bodies such as the Energy Saving Trust.

The formulation of a working plan for carrying out the improvements to the house over a period of time allows the works to have the best cumulative benefit. Deciding which improvements to carry out can be a complex process. A working plan for an individual house will help overcome the barriers and constraints that otherwise result in opportunities for improvement being missed. The rest of this section gives information and guidance for the selection and scheduling of the possible low carbon improvement works. The improvement works considered are described in detail in Section D.

STATUTORY APPROVALS

Some of the works considered require statutory approvals to comply with the current building regulations and planning legislation. Professional advice and direct contact with the local authority departments concerned will be necessary to ensure the statutory requirements are met.

B002

Guide to Decision Making

INTRODUCTION

The purpose of this section is to provide a methodology for making decisions that provide the greatest impact on energy use and reduced running costs for the budgets allowed.

It is broken down into three elements:

1. A presentation of the trigger points and opportunities that may arise, giving indicators for what measures should be considered at these points. Various influencing factors are referred to in order to help the more detailed selection of measures. (B003)

2. An analysis and comparison of the cost effectiveness of individual improvement measures to help select those that best suit the particular context and circumstances. (B004)

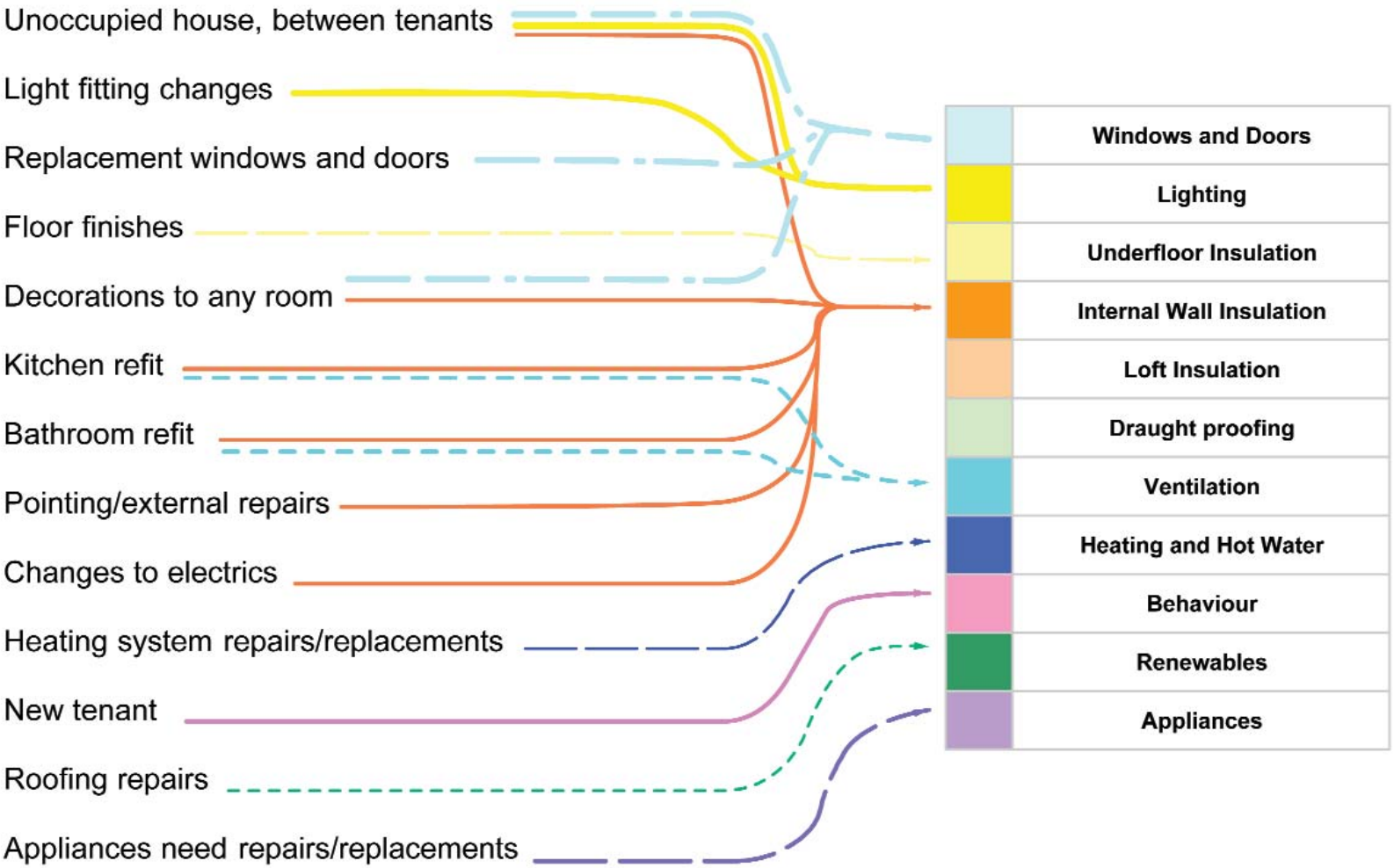
3. An information table that gives more specific details of the measures and energy saving impacts. This may help further develop the final selection of measures once the first two elements above have been considered. (B005-7)

B003

Trigger Points Decision Tool

At any point where there is time and money to spend, all measures should be considered. Some of the measures are low disruption, and so always possible, and are not specifically triggered by other events. If renovation works are to be carried out, they often provide a unique opportunity to carry out disruptive energy saving works. These opportunities only arise occasionally. This tool identifies these trigger points.

Triggers



B004

Cost Effectiveness Measures

INTRODUCTION

Each measure has been calculated as an isolated improvement. Making multiple improvements will cause an interaction between the various energy efficiency measures and so will have an impact on how effective these measures are. The cost effectiveness ranking shown in this table is useful for comparison; actual figures will vary due to numerous factors

KEY

	Windows and Doors
	Lighting
	Underfloor Insulation
	Internal Wall Insulation
	Loft Insulation
	Draught proofing
	Ventilation
	Heating and Hot Water
	Behaviour
	Renewables
	Appliances

	MANUAL REF	Total Cost	£ fuel bill saved each year /£ spent initially
Train occupants on low energy living		£10	£21.523
Gas monitor to display in the kitchen (assumes occupants respond with 10% reduction in consumption)		£95	£1.850
Hot water - Insulate water tank with 160mm jacket if present	D092	£39	£1.194
Electricity monitor to display in the kitchen (assumes occupants respond with 10% reduction in consumption)		£40	£0.987
Loft Insulation - 250mm mineral wool	D050 series	£295	£0.621
Solid wall insulation on cellar wall	D020 series	£230	£0.398
Loft insulation - 400mm mineral wool	D050 series	£525	£0.350
Lighting - fit simple pendants and high efficiency CFL lamps	D090	£121	£0.340
Water monitor to display in the kitchen (assumes occupants respond with 10% reduction in consumption)		£95	£0.283
Heating & hot water - Use existing radiators, insulate existing pipework, fit new efficient combi boiler.	D094	£1,950	£0.266
Draught proofing - Whole house; bathroom waste pipes, ground floor radiator pipes, skirting board perimeters (from underneath).	D070 series	£180	£0.236
Underfloor insulation - 200mm mineral wool between the joists	D001 series	£1,200	£0.177
Windows - draught proof and seal up around the frames.	D070 series	£180	£0.160
Draught proofing - Seal up and insulate air bricks from outside to heated spaces and introduce vent.	D022	£180	£0.160
Doors - draught proof.	D070 series	£28	£0.147
Doors - draught proof and seal up around the frames.	D070 series	£58	£0.143
Heating & hot water - Install water saving taps, toilets, baths, showers		£800	£0.084
Heating & hot water - insulate existing pipework.	D094	£605	£0.080
Assess the suitability of solar PV. Figures relate to a 2.5kw Peak system facing west or east.		£7,000	£0.066
Appliances - A rated washing machine	D096	£320	£0.066
Draught proofing - Seal up the house using a range of measures.	D070	£1,800	£0.065
Appliances - A++ rated freezer no larger than required	D096	£350	£0.063
Appliances - A+ rated fridge no larger than required	D096	£250	£0.058
Appliances - B rated washing machine	D096	£270	£0.058
Solid wall insulation on Bedroom external walls	D020 series	£1,540	£0.058
Appliances - Functioning Washing Machine C rated	D096	£230	£0.046
Appliances - A++ rated fridge no larger than required	D096	£350	£0.038
Appliances - A+ rated fridge no larger than required	D096	£250	£0.035
Insulate roof above bay window	D040 series	£230	£0.029
Solid wall insulation on Bathroom external walls	D020 series	£670	£0.028
Appliances - Functioning Freezer A rated	D096	£200	£0.024
Solid wall insulation on Lounge external walls	D020 series	£1,810	£0.020
Solid wall insulation on Kitchen external walls	D020 series	£2,160	£0.018
Doors - Replace cellar door with insulated airtight door.	D060 series	£380	£0.017
Solid wall insulation on Stairs external walls	D020 series	£920	£0.016
Appliances - Functioning Fridge A rated	D093	£200	£0.015
Windows down to 0.8W/m²K in all areas	D060 series	£5,880	£0.014
Doors - Replace front and back doors with GRP doors (U = 1.5 or lower)	D060 series	£1,860	£0.014
Windows - PVC Double glazed argon filled low E (U = 1.6 or lower)	D060 series	£3,980	£0.013
Windows down to 0.8W/m²K in Living room and kitchen	D060 series	£4,880	£0.013
Solid wall insulation on Lounge internal walls including chimney breasts	D020 series	£760	£0.012
Doors - Front and back doors down to 1.0W/m²K	D060 series	£2,760	£0.012
Ventilation - Whole house heat recovery ventilation	D081	£3,436	£0.009
Solid wall insulation on Bathroom internal walls	D020 series	£230	£0.008
Solar Thermal. Figures relate to a 6m2 system facing west or east. Renewable Heat Incentive not yet known		£5,000	£0.007
Solid wall insulation on Kitchen internal walls including chimney breasts	D020 series	£460	£0.005
Solid wall insulation on Bedroom internal walls including chimney breasts	D020 series	£920	£0.004

Most Cost Effective

Least Cost Effective

B005

Comparison Matrix of Improvement Measures 1

Energy Performance and potential savings is based on a specific mid-terrace property - Existing Condition SAP Assessed:

Annual CO2 emissions:	9429	Kg/year (F rated)
Annual Gas Bill:	£1,758	
Annual Electricity Bill:	£395	

Assumptions:

Labour rates £130 /day

	£/kwh	Kg CO2/kwh
electricity	0.13	0.527
gas	0.04	0.185

	BASIC & ESSENTIAL WORKS (F rated)				GOOD SPECIFICATION (C rated)				HIGH SPECIFICATION (B rated)			
Building Fabric	Completing these measures gives a 13% saving on the annual fuel bills	MANUAL REF	Total Cost	£ fuel bill saved each year /£ spent initially	Completing these additional measures gives a 64% saving on the annual fuel bills	MANUAL REF	Total Cost	£ fuel bill saved each year /£ spent initially	Completing these additional measures gives a 83% saving on the annual fuel bills	MANUAL REF	Total Cost	£ fuel bill saved each year /£ spent initially
Windows	Check the integrity of the existing windows, draught proof and seal up around the frames.	D070 series	£180	£0.160	PVC Double glazed argon filled low E (U = 1.6 or lower)	D060 series	£3,980	£0.013	Windows down to 0.8W/m²K in Living room and kitchen	D060 series	£4,880	£0.013
									Windows down to 0.8W/m²K in all areas	D060 series	£5,880	£0.014
Doors	Check the integrity of the existing doors, draught proof and seal up around the frames.	D070 series	£58	£0.143	Replace front and back doors with GRP doors (U = 1.5 or lower)	D060 series	£1,860	£0.014	Front and back doors down to 1.0W/m²K	D060 series	£2,760	£0.012
Cellar Door	Check the integrity of the cellar door, and draught proof.	D070 series	£28	£0.147	Replace cellar door with airtight door, 50mm PIR + 6mm structural board on reverse surface (U = 0.6)	D060 series	£380	£0.017	As for GOOD SPECIFICATION			
	Improve the air tightness from 20 to 15 (i.e. Probably do all of the above)	D070 series				D070 series			As for GOOD SPECIFICATION			
Loft insulation	250mm mineral wool across the entire floor surface of the attic room and including into the stairwell (U = 0.16)	D050 series	£295	£0.621	400mm mineral wool across the entire floor surface of the attic room and including into the stairwell (U = 0.1)	D050 series	£525	£0.350	As for GOOD SPECIFICATION			
Roof above bay window					150mm PIR (Kingspan) + plasterboard and skim (U = 0.15)	D040 series	£230	£0.029	As for GOOD SPECIFICATION			Roof
Underfloor insulation					Under the ground floor - assumes underlay and carpets 200mm mineral wool between the joists (U = 0.20)	D001 series	£1,200	£0.177	As for GOOD SPECIFICATION			windows
Draught Proofing	draught proofing strips around doors and windows. Fill in any gaps from warm spaces to cold spaces around the house that you can find, eg kitchen and bathroom waste pipes, ground floor radiator pipes, skirting board perimeters (from underneath).	D070 series	£180	£0.236	Seal up and insulate air bricks from outside to heated spaces and introduce vent (see vent section). Leave all air bricks to unheated spaces. In addition complete work detailed under Basic specification.	D022	£180	£0.160	Seal up the house using a range of measures. Measures such as solid wall insulation or just unbroken wet plaster, sealing around all services using tapes, sealing up the floor and roof areas with tyvec or structural board. Air tightness target 6 (m^3/m^2.h at 50Pa).	D070	£1,800	£0.065
					Internal solid wall insulation on external walls:				**Internal solid wall insulation on internal walls and chimney breast:**			
Lounge					150mm PIR (Kingspan) + plasterboard and skim(U = 0.15)	D020 series	£1,810	£0.020	100mm PIR + plasterboard and skim on bay window sides (U = 0.25) 50mm PIR + plasterboard and skim on party walls on north side of house (including chimney breasts) (U = 0.40) In addition complete work detailed under GOOD SPECIFICATION.	D020 series	£760	£0.012

B006

Comparison Matrix of Improvement Measures 2

	BASIC & ESSENTIAL WORKS (F rated)				GOOD SPECIFICATION (C rated)				HIGH SPECIFICATION (B rated)			
	Completing these measures gives a 13% saving on the annual fuel bills	MANUAL REF	Total Cost	£ fuel bill saved each year /£ spent initially	Completing these additional measures gives a 64% saving on the annual fuel bills	MANUAL REF	Total Cost	£ fuel bill saved each year /£ spent initially	Completing these additional measures gives a 83% saving on the annual fuel bills	MANUAL REF	Total Cost	£ fuel bill saved each year /£ spent initially
Kitchen	If replacing the kitchen, consider solid wall insulation	D020 series			150mm PIR (Kingspan) + 18mm structural board and skim (U = 0.14)	D020 series	£2,160	£0.018	50mm PIR + plasterboard and skim on party walls on north side of house (including chimney breasts) (U = 0.40). In addition complete work detailed under GOOD SPECIFICATION.	D020 series	£460	£0.005
Bathroom	If replacing the bathroom, consider solid wall insulation	D020 series			120mm PIR (Kingspan) + structural board and skim (U = 0.18)	D020 series	£670	£0.028	50mm PIR + structural board and skim on party walls in bathroom (U = 0.40). In addition complete work detailed under GOOD SPECIFICATION.	D020 series	£230	£0.008
Bedrooms					150mm PIR (Kingspan) + plasterboard and skim(U = 0.15)	D020 series	£1,540	£0.058	50mm PIR + plasterboard and skim on party walls on north side of house (including chimney breasts) (U = 0.40). In addition complete work detailed under GOOD SPECIFICATION.	D020 series	£920	£0.004
Corridors					150mm PIR (Kingspan) + plasterboard and skim(U = 0.15)	D020 series	£920	£0.016	As for GOOD SPECIFICATION			
Cellar					100mm PIR + 6mm structural board on wood walls at top of cellar stairs (U = 0.25)	D020 series	£230	£0.398	As for GOOD SPECIFICATION			
Ventilation												
Kitchen	Kitchen extract fan (for carbon savings see draught proofing)	D080 series	£138		As for BASIC AND ESSENTIAL specification				Whole house heat recovery ventilation - Supply to the lounge and bedrooms, extract from the kitchen, bathroom and drying area - this only saves energy when combined with a good level of air tightness. Care should be taken to select the correct controls strategy, an efficient and quiet fan, and properly insulate the intake and exhaust ductwork. Filters should be cleaned/replaced following the manufacturer's instructions.	D081		
Bathroom	Bathroom extract fan (for carbon savings see draught proofing)	D080 series	£138		As for BASIC AND ESSENTIAL specification					D081	£3,436	£0.009
Drying area - back door lobby	Drying area extract fan (for carbon savings see draught proofing)	D080 series	£138		As for BASIC AND ESSENTIAL specification					D081		
Heating & hot water	Heating required. Use existing radiators, re-fit existing boiler, insulate existing pipe work.	D094	£605	£0.080	Use existing radiators, insulate existing pipework, fit new efficient combi boiler.	D094	£1,950	£0.266	Solar Thermal. Assess the suitability of solar thermal. Refer to solar thermal sheet. These figures relate to a 6m2 system facing west or east. Renewable Heat Incentive will improve this figure in the future. In addition complete work detailed under GOOD SPECIFICATION.		£5,000	£0.007
					Install water saving taps, toilets, baths, showers		£800	£0.084	As for GOOD SPECIFICATION			
					Insulate water tank with 160mm jacket if present	D092	£39	£1.194	As for GOOD SPECIFICATION			
Lighting												
Internal Lighting	Lighting required, fit simple pendants and high efficiency CFL lamps for client's own shades	D090	£121	£0.340	As for BASIC AND ESSENTIAL specification				As for BASIC AND ESSENTIAL specification			

B007

Comparison Matrix of Improvement Measures 3

	BASIC & ESSENTIAL WORKS (F rated)				GOOD SPECIFICATION (C rated)				HIGH SPECIFICATION (B rated)			
	Completing these measures gives a 13% saving on the annual fuel bills	MANUAL REF	Total Cost	£ fuel bill saved each year /£ spent initially	Completing these additional measures gives a 64% saving on the annual fuel bills	MANUAL REF	Total Cost	£ fuel bill saved each year /£ spent initially	Completing these additional measures gives a 83% saving on the annual fuel bills	MANUAL REF	Total Cost	£ fuel bill saved each year /£ spent initially
External Lighting					If external lighting is required use low power metal halide, CFL or LED lamps to light only the area which is needed. Remove any existing halogen external lighting. Control using local PIR/Photocell or Timeclock/Photocell.	D090	£173		As for GOOD SPECIFICATION			
Appliances												
Fridge	Functioning Fridge A rated	D093	£200	£0.015	A+ rated fridge no larger than required	D096	£250	£0.035	A++ rated no larger than required	D096	£350	£0.038
Freezer	Functioning Freezer A rated	D096	£200	£0.024	A+ rated fridge no larger than required	D096	£250	£0.058	A++ rated no larger than required	D096	£350	£0.063
Washing Machine	Functioning Washing Machine C rated	D096	£230	£0.046	B rated	D096	£270	£0.058	A rated	D096	£320	£0.066
Metering												
Gas	Basic utility meter				Fit meter to display in the kitchen (assumes occupants respond with 10% reduction in consumption)		£95	£1.850	As for GOOD SPECIFICATION			
Water	Basic utility meter				Fit meter to display in the kitchen (assumes occupants respond with 10% reduction in consumption)		£95	£0.283	As for GOOD SPECIFICATION			
Electricity	Basic utility meter				Fit Energy Monitor to display in the kitchen (assumes occupants respond with 10% reduction in consumption)		£40	£0.987	As for GOOD SPECIFICATION			
Solar PV									Fit meter display in the kitchen		£80	
Solar Thermal									Fit meter display in the kitchen		£80	
Behaviour					Train occupants on low energy living		£10	£21.52	As for GOOD SPECIFICATION			
PV									Assess the suitability of solar PV. Refer to solar PV sheet. These figures relate to a 2.5kw Peak system facing west or east.		£7,000	£0.066

Notes:

The energy saving figures for the above measures have been calculated using SAP for a specific Victorian mid-terrace - very typical in Leeds. In general these were calculated directly, although some were extrapolated and some were calculated by other means.

Where it was possible to calculate measures in SAP, they were introduced in isolation to the SAP calculation, and the whole house energy compared with the baseline current condition figures. Making multiple improvements will cause an interaction between the various energy efficiency measures and so will have an impact on how effective these measures are.

Separate calculations were completed for each group of measures in SAP, providing the 13%, 64% and 83% figures against the baseline current condition figures.

Prices were taken from various sources including LATCH budgets and quotations from previous jobs, LEDA quotations from previous jobs, the Energy Saving Trust 'Sheffield EcoTerrace' study and SURE Insulation pricing information.

The 10% occupant response to information and training is based on LEDA experience, this is the figure used in Carbon Trust reports. Occupant behaviour is not predictable. This saving is included in the good and high specification total savings, but not in the basic and essential savings

Notionally appliances values given are compared with:
Fridge - B rated
Freezer - B rated
Washing Machine - E rated

SECTION C

HEALTH AND SAFETY

C001

Health and Safety

The guidance manual has been written with health and safety as a core consideration. Section D covers the main installation methods for the improvement works with brief health and safety paragraphs outlining the risks and hazards to be aware of. Simple procedures and precautions are highlighted where appropriate. All works should be approached in accordance with the current CDM (Construction Design and Management) Regulations, the Health and Safety at Work regulations and The Health and Safety at Work Act.

The health and safety information in this document is provided for guidance purposes. Full health and safety procedures should be drawn up by suitably trained persons for each project undertaken.

WHAT NEEDS TO BE DONE

Working practices need to be set up to ensure that health and safety is fully managed when carrying out work. This involves carrying out risk assessments for the work, method statements of how to proceed and management of the workplace to ensure it is a safe area and that everyone is aware of the required safe systems of work. People carrying out the work should have the correct protective equipment (PPE). The workplace should be managed so as to minimise the hazards arising from the site constraints – e.g. available space to store materials and provide safe working areas; separation of areas for storing waste; provision of proper welfare facilities. Examples of protective clothing required for carrying out the suggested improvement works are given in the relevant paragraphs of Section D.

If the project is notifiable under the CDM regulations then the roles of CDM co-ordinator to advise the client and Principal Contractor need to be fulfilled.

RISK ASSESSMENTS AND HAZARDS

Existing houses can present a number of risks and hazards arising from unknowns, particularly during the uncovering of existing structure and through working in sub floor voids and roof void areas. The following are some of the likely risks and hazards that may be present and potential ways of dealing with them:

- Asbestos boarding and insulation to pipes and flues – carry out survey prior to commencing work and organise removal by licensed contractors
- Electrical wiring in poor condition – examine the installation carefully prior to executing work
- Working in restricted height areas – provide adequate lighting and protective clothing
- Working in the presence of potentially hazardous pollutants such as mineral fibres and faecal matter from vermin – inspect roof and cellar areas
- Areas with restricted ventilation and the presence of fumes produced by using materials such as glues and expanding foam – provide adequate ventilation by opening up work area or by using powered respirators; carry out work in short timed periods to prevent build up of fumes
- Areas where light levels are poor and there are trip hazards – provide adequate lighting and clear out areas of debris prior to commencing work

It is important that all available information regarding the existing building condition and the positions of incoming services is provided to contractors carrying out the work to ensure any potential hazards and risks are identified at the earliest possible stage.

SECTION D

SOLUTIONS, SPECIFICATIONS, DESIGNS AND INSTALLATION

D001

UNDERFLOOR INSULATION

Preparation

OVERVIEW

It is important to create a safe working environment and prepare the work area for efficient working.

HEALTH AND SAFETY ISSUES

Provide appropriate personal protective equipment (PPE). This will include some of: a good mask - at least FFP2 rated; goggles; work gloves; helmet or bump cap; woolly hat / balaclava; kneepads; elbow pads; work boots; boiler suit; neck gaiter; head torch.

Ensure safe access to the area. Set up an adequate amount of lighting - both for the general area including stair wells and also for each person working on a task.

Ensure adequate ventilation in the workspace. Some materials give off fumes.

Ensure good communication between the people working underfloor. Consider using walkie-talkies.

METHOD

Ensure outside air vents are free of debris and blockages (inside and outside).

Low or sharp edges should be highlighted at least and protected if possible.

If the floor is full of obstacles e.g. old building debris or discarded items, move them out of the workspace or to one side. This will speed up the work and make it safer.

Trailing cables are a hazard and should be fastened out of the way. (See 'Dealing with electrics' below).

Old ceilings: typically these will need to be taken down, bagged and removed from site.

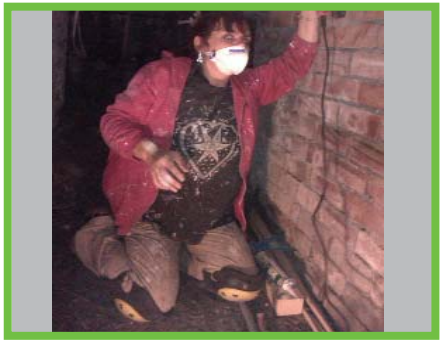
Old pipe lagging should be removed. (See 'Pipe Insulation' below).

If a radiator is to be moved on the floor above this is a good time to do this work. A radiator might be moved away from a location on an outside wall under a window. This would simplify wall insulation work and the fitting of full length curtains.

TYPICAL USAGE AND TASK DURATION

Depending on the size of the cellar and ease of access this preparation can take several hours.

A full set of protection



Disposable mask and kneepads

Waterproof walkie-talkies

Disposable FFP2 dust mask

Powered respirator with bump cap

LED work lights

D002

UNDERFLOOR INSULATION

Sealing around the outside edges of a ground floor room

OVERVIEW

Gaps always occur at the edge of floors where they meet the wall. Sealing the gaps makes the house more airtight, easier to heat and more comfortable. This gap sealing and to gaps around pipes and wires, is important preparatory work before installing insulation.

HEALTH AND SAFETY ISSUES

The expanding foam will give off fumes. Make sure the workspace is well ventilated. Wear gloves and goggles.

MATERIALS AND TOOLS

Low expansion foam. A can of low expansion foam will seal about 5 metres of edging. Sanitary silicon sealant. A tube of silicon will seal about 2 metres. Plastic mesh.

METHOD

For thin gaps around edges and between floorboards (0-10mm) use sanitary silicon sealant. A powered sealant gun is helpful. Low expansion foam is ideal for the smaller edge gaps (10-30mm).

Where access is difficult it may be necessary to extend the length of the nozzle tube using a length of wider tube slotted over the one provided and taped on.

With wider gaps (30-75mm) insert a length of stiff plastic mesh first and squirt regular expanding foam through the mesh to provide a complete fill up to the level of the floor boards. The foam fill in these wider gaps provides both airtightness and insulation.

Make sure the cans of foam are well shaken and at about 20ºC to get the best performance. Draw a small bead with the nozzle in or close to the edge of the floorboard. To be able to use all of the can's contents ensure the can of foam is held upside down as directed. Make sure the section above each joist is also sealed.

TYPICAL USAGE AND TASK DURATION

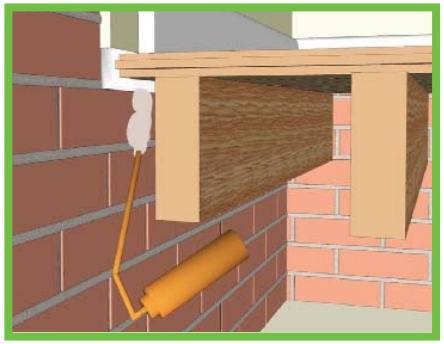
With good access each metre of edge sealing will take around 5 to 10 minutes.

Large gaps between floorboards and wall

Daylight visible from below

A bead of low expansion foam

A bead of silicone sealant in gaps



Keep the can upside down

For wide gaps use mesh

D003

UNDERFLOOR INSULATION

Sealing other gaps including around pipes and wires

OVERVIEW

In many houses the tongue and groove floorboards have been damaged during building work to install pipes and wires. This almost always results in holes and gaps through which cold air can blow into the living space. It is important to seal these gaps before the installation is fitted.

HEALTH AND SAFETY ISSUES

An FFP2 dust mask is recommended. Gloves are useful when working with sealants and glues.

MATERIALS AND TOOLS

Sanitary silicone sealant. Construction grade adhesive. Expanding foam. Wood strips and boards may be needed.

METHOD

The sealant chosen will depend on the size of the hole. Smaller gaps round wires and pipes can be filled with sanitary silicon sealant. Note: clear sealant will be less noticeable if it's visible from above. Use expanding foam for larger gaps.

Inspect the whole of the under surface of the floor being insulated. It can be useful to have a strong light present in the room above because the light shining through cracks can more easily be seen.

For small gaps run a bead of silicon sealant to completely fill the opening. For larger gaps use a suitably sized piece of wood and glue it into place.

To obtain high levels of airtightness with tongue and groove floorboards each joint must be sealed. This can be done with either a frame sealant from above or sanitary silicon sealant from below. If the floorboards had been lifted or if new boards are being fitted then the tongue and grooves can be glued together.

TYPICAL USAGE AND TASK DURATION

This is dependent on the number of holes and gaps found and the ease of access. Allow 1 to 2 hours.

Large gap in floorboards under kitchen unit

Gap around central heating pipe entering a living space

Old hole for pipe sealed with wood strip glued in place

Silicone sealant around pipe

Large hole cut for pipe and wire

Large hole closed with wood panel and sealed

D004

UNDERFLOOR INSULATION

Dealing with electrics

OVERVIEW

Cellars and underfloor voids are very commonly used for wiring runs. It is important to avoid having electricity mains wires tightly surrounded by insulation. In normal operation mains wires may become warm and need to be able to shed their heat. These wires must either be moved away from where the insulation is to be fitted or sheathed with a suitable conduit.

The fitting of conduit is not necessary for television aerial, telephone wire, network cable, audio speaker wire or bell wire.

HEALTH AND SAFETY ISSUES

Relocating wires and repositioning junction boxes, sockets and switches should be done by a competent person. Good practice is essential when dealing with electrics to maintain safe working. Ensure all live wiring is isolated before any work involving disconnection begins. Good communication between workers during this task is important.

MATERIALS AND TOOLS

Lengths of flexible conduit – 25mm diameter for individual cables, 100mm diameter where groups of cables cannot be separated. Sharp knife. Pincers. Hammer. Cable clips. Metal strapping.

METHOD

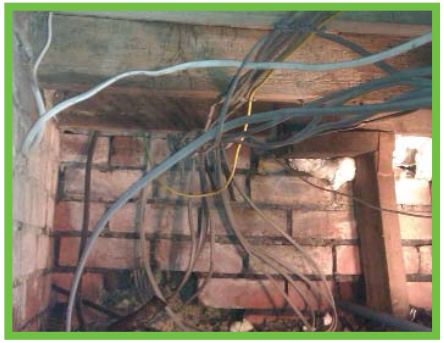
Identify the cable runs which are in places where insulation is to be fitted. Cables which are run along the side of joists should be unclipped and relocated to the lower face of the joists. Individual cables that cannot be moved should be fitted with narrow conduit. Use wider conduit where necessary.

Similarly, switches, sockets and junction boxes must be moved away from places to be insulated.

Where wire passes up through the floorboards a length of conduit greater than the depth of the joists must be fitted and secured in place. By making a slit down the length of the conduit this can be fitted without disconnecting the wires.

TYPICAL USAGE AND TASK DURATION

The duration of this task depends on the number of wires and electrical fittings to be moved. Typically allow 1–2 hours per room.



Typical tangle of wires

Trailing wires clipped up

Thin conduit on a ring main cable

Wide conduit fitted to a group of cables passing through floor joists

Mains sockets to be moved

Wire run and junction box moved to bottom of joist

D005

UNDERFLOOR INSULATION

Insulating pipework

OVERVIEW

The cellar / void under the ground floor is typically cold and often close to outside air temperature. Uninsulated hot water and central heating pipes lose a lot of heat and so waste a lot of energy.

HEALTH AND SAFETY ISSUES

Always wear an FFP2 dust mask for this job. Note: some types of old lagging may contain asbestos. If in any doubt seek professional advice. Goggles advised.

MATERIALS AND TOOLS

Pipe insulation with 25mm wall thickness – for 15mm and 22mm pipe diameters. Sharp knife – ideally with around a 125mm blade. Coloured tape – red, blue and green/yellow (eg electrical insulation tape). Radiator foil – ideally the flexible type with foil on both sides. Scissors. Screwdriver. Metal strapping. Clout nails. Hammer. Duct tape. Head torch.

METHOD

Remove all old lagging. Bag it for removal.

Determine what each pipe is carrying and then mark each one with coloured tape to make the next stage easier.

- Domestic hot water and central heating pipes - red tape. At least 25mm thick insulation.
- Cold water pipes - blue tape. At least 13mm thick insulation.
- Gas pipes - green and yellow tape. These pipes do not need insulating.

It is important to make sure that no bare copper pipe is visible (other than gas pipes). Carefully cut each corner to ensure continuous insulation. When fitting long runs of pipe insulation slightly compress each piece against the next to allow for shrinkage over time. Seal all joints securely with duct tape.

If required, unclip hot water pipes from their mounts on joists and walls to allow the pipe insulation to be fitted. Use strap hangers to support the insulated pipe runs.

In tight corners and where pipes are located very close to joists or walls use radiator foil layers in place of the thick wall foam insulation. Expanding foam can also be used in tight spaces.

Fit new or re-used 13 mm thick insulation (or thicker) to cold water pipes for frost protection.

TYPICAL USAGE AND TASK DURATION

Depending on access and complexity, around 10 – 15 metres of pipe per hour can be insulated. A typical house has around 50 metres of pipework in a cellar / underfloor void.

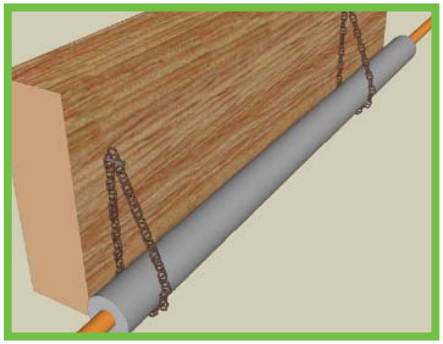
Poorly insulated pipe

Partially insulated central heating pipes

Typical array of uninsulated pipes

Central heating and domestic hot water pipes now insulated with 25mm wall pipe insulation, cold water with 13mm and gas pipe remains uninsulated.

Use of radiator foil for difficult sections



Metal strap hanger

D006

UNDERFLOOR INSULATION

Maintaining underfloor ventilation

OVERVIEW

Good air flow should be maintained to the void under the ground floor to comply with current Building Regulations (Approved Document C). Care needs to be taken to avoid blocking vents when fitting insulation.

HEALTH AND SAFETY ISSUES

The underfloor area of a house is often dusty. The wearing of an FFP2 dust mask is recommended.

MATERIALS AND TOOLS

Wood panels or PIR board pieces. Construction grade glue or silicone sealant.

METHOD

Find the positions of all of the air vents. Ensure that they are free of debris and that the airflow is clear. It is particularly important to check that they are not blocked on the outside surface.

Case one: Air vent position level with joist running parallel to outside wall. Fit pieces of floor grade insulation board between the wall and joist on either side of the vent. Ensure tight fit to the floor boards above. Alternatively, use plastic mesh with expanding foam fill in place of cut insulation board.

Case two: The air vent is located between the ends of floor joists running into the outside wall. It is necessary to create a duct space to channel the ventilation air downwards into the underfloor void. Use a treated wood panel or a piece of PIR board insulation angled downwards at 45 degrees from the top of the air vent. Use glue or silicon to fix in place.

TYPICAL USAGE AND TASK DURATION

Depending on access this task takes around 30 minutes per air vent.

Duct formed with floor grade insulation on either side of an air vent.

Duct formed with sloping piece of PIR board.

Plastic barrier fitted in error over an outside air vent by previous home owner. Note condensation.

Plastic barrier removed to allow free air flow.

Duct made from board

D007

UNDERFLOOR INSULATION

Fitting the insulation

OVERVIEW

The floor insulation needs to be fitted with no gaps to avoid thermal bridges that can cause cold spots and substantially reduce the effectiveness of the insulation as a whole. Just 5% gaps reduce the effectiveness of the insulation by 50%.

HEALTH AND SAFETY ISSUES

A good FFP2 dust mask must be worn for this task. Gloves and goggles will be found useful. Suitable protective clothing is also recommended.

MATERIALS AND TOOLS

Mineral wool. The amount required can be calculated directly from the underfloor area to be insulated. Plywood straps (or similar material) approximately 480 mm x 40 mm x 4 mm, around 10 per square metre will be required. Ideally a powered nail gun.

METHOD

Fill space between joists with mineral wool to the full depth of the joist (typically 200 mm). Use roll widths to suit joist spacing.

A plastic sheet or tarpaulin can be laid on the floor to reduce the amount of dust picked up whilst unrolling the mineral wool.

Measure each run of floor joists and cut a length of mineral wool from a roll. Insert the mineral wool between the joists making sure that it touches the floorboards but is not compressed too much. At the ends of each run the mineral wool can be "bunched up" horizontally to ensure a complete fill with no gaps. Typically the friction on the sides of the joists will hold the mineral wool in place temporarily.

Fix the wood straps across the joists at intervals of around 300 mm. Additional straps may be needed at the end of a run.

Ensure that the mineral wool fills the entire space between the joists and is not squashed upwards towards the floor boards.

Where a joist runs close to a wall short lengths of mineral wool (e.g. offcuts) can be used to fill this space.

TYPICAL USAGE AND TASK DURATION

With good access and a ready supply of materials it is possible to fit between 5m² and 10m² of insulation per hour. Where access is poor this task can be very time consuming.

Typical underfloor before insulation

Mineral wool in place prior to fitting of wood straps. Note conduit around cable through joists

Insulation in place with straps fitted
Note uninsulated gas pipe

Showing insulation, expanding foam behind outer joist and insulated pipe

A complete underfloor insulated

D020
WALL INSULATION

Preparation

OVERVIEW

The walls in a Victorian Terrace house are without doubt the most difficult to deal with. However, they are perhaps the most important element of our hard to treat homes that need to be refurbished. They present a challenge because of the complexity of the work involved and the critical importance of high quality workmanship.

There is substantial disruption with this type of refurbishment and not a little mess. Ideally the work on a wall is done with the room already empty.

The benefit of super-insulated walls is very considerable.

HEALTH AND SAFETY ISSUES

Furniture and materials can be heavy, use correct lifting techniques.
The route from the workspace to the outside should be made safe for the workforce. This will include removing hazards and ensuring good lighting. Keeping the workspace tidy will improve both productivity and safety.

MATERIALS AND TOOLS

Self adhesive, protective floor covering is very useful. Lengths of pipe insulation can be used to protect corners on stairways. Gloves and dust masks can make the job more comfortable.

METHOD

Set up good access to waste disposal and storage areas for reusable/recyclable materials.

If the work is being done in a house that is still being lived in then efforts must be made to contain the dust within the work area to prevent it moving into other parts of the house. Connecting doors can be taped up and dust barriers can be hung across open corridors. Fit appropriate protective material to floor surfaces and vulnerable corners.

Although it is possible to insulate a room still containing furniture it is time well spent to clear the room completely and to lift the carpet.

Organising the storage area with the materials stacked in the order in which they will be used will save time and effort during the job. Note: PIR board is bulky. Plan where the materials can be stored flat without getting in the way of the refurbishment work.

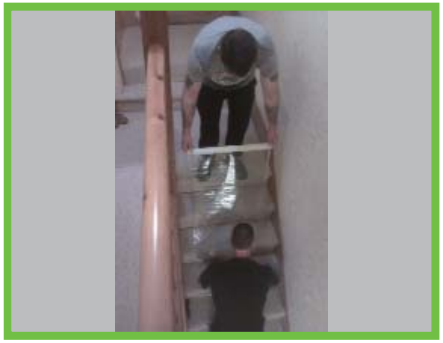
When setting up the workspace consider the size of the materials to be handled.

If radiators are to be moved away from walls to be insulated than this should be done right at the start.

TYPICAL USAGE AND TASK DURATION

The clearing of the room and the setting up of a workspace can take several hours.

Set up waste and reusable materials locations



Fitting the self-adhesive carpet protector

Materials can be bulky and heavy

Note order of stacked materials. Flooring chipboard on top, then PIR board, then plasterboard.

Set up a workspace with plenty of room

Keeping the workplace tidy improves safety

D021

WALL INSULATION

Stripping out the existing woodwork and coving

OVERVIEW

After setting up the workspace the first job is the ‘strip out phase’. In this part of the work the area to be insulated is made accessible by removing woodwork, coving and any linings to windows and doors. This is an important part of the job since the actual structure of the wall, including any previous alterations, will be revealed. A revision to the design of the insulation works may be necessary depending on what is uncovered.

HEALTH AND SAFETY ISSUES

Normal precautions are required for working on a building site. This phase of the work typically creates a lot of dust. Gloves, dust mask, goggles and ear defenders can make the work more comfortable. Ensure good lighting.

Note: Bay window ceilings pose a special hazard because there may be the presence of animal droppings. Dust mask and goggles are required.

MATERIALS AND TOOLS

In addition to normal construction tools an oscillating "multi-cutter" power tool will be found useful.

METHOD

Skirting board, dado rails, picture rails: where a wall to be insulated meets a wall that will be left untouched a section of skirting board etc. on the uninsulated wall must be removed. The length of this piece is typically the depth of the PIR board to be used added to the depth of the plasterboard plus around 12.5 mm. This extra amount allows for the thickness of the adhesive layers. So for 100 mm PIR with 12.5 mm plasterboard the length of skirting to be removed is 125 mm. A "multi-cutter” is ideal for this job although hand tools can also be used. The remainder of the skirting board etc can be removed with normal construction tools. It may be possible to reuse the sections that are removed although typically the wood is damaged since the fixings are stronger than the material itself.

Coving: similarly a length of coving on each uninsulated wall must also be removed. It can be useful to run a sharp knife along the top and bottom edges of the coving to avoid disturbing the existing wall and ceiling. The coving on the wall to be insulated can be removed with a hammer and masonry chisel.

Window linings, window head, window ledge: unless the window frame is to be replaced it is useful to run a sharp knife round the edge of the frame to avoid damage to paint work.

Bay window ceilings: if this ceiling is to be insulated later then this is the time to do the strip-out. See section on Ceilings and Roofs below.

TYPICAL USAGE AND TASK DURATION

Depending on the size of the room being tackled this task can take several hours.

Remove the skirting board

Remove architrave and other woodwork

Cut out a section of coving to make space for the insulation and plasterboard

Large hole found behind a skirting board

Large gap into the external wall found behind window reveal

Large gap above window head into the external wall

D022

WALL INSULATION

Filling major holes and patching brickwork

OVERVIEW

Before starting the installation of the insulation fill any gaps and holes in the wall surface to prevent air movement behind the insulation. This is especially true for gaps into a wall cavity which typically has cold outside air continually blowing through it.
Some patching of the brickwork may be necessary if it has deteriorated.
Air leakage paths around pipes and at the edge of floorboards should also be sealed if not already done.

HEALTH AND SAFETY ISSUES

It is recommended to wear gloves and goggles when using expanding foam. Ensure the work area is well ventilated and well lit.

MATERIALS AND TOOLS

Regular building materials. Expanding foam. Plastic mesh. Possibly acoustic sealant.

METHOD

Identify the parts of the wall which need to be repaired. Use appropriate construction materials to do this.
For gaps into the external wall, especially behind window reveals and window heads, fit lengths of plastic mesh in the shape of a 'U' or a tube to form a supporting framework to hold the expanding foam in place as it cures.
For deep cracks at wall junctions an acoustic sealant can be used.

TYPICAL USAGE AND TASK DURATION

Depends on the amount of remedial work required. This is an important part of ensuring the integrity of the wall and the time required can only be assessed after the strip out phase.

Holes in the external wall found under a window ledge

Repairing a wall section near a window

Deep crack between a party wall and an outside wall

Filling the crack with acoustic sealant

Hole found near external vent

Demonstration of amount of air blowing out of a wall cavity

D025

WALL INSULATION

Dealing with wall sections near windows & external doors

OVERVIEW

These parts of the walls are often particularly badly insulated. Consider doing this work even if the main external walls are planned for a future refurbishment phase. Very much recommended if the windows are to be changed.

HEALTH AND SAFETY ISSUES

Recommend using an FFP2 rated dust mask when cutting PIR board. Latex gloves when using expanding foam or adhesive are advised.

MATERIALS AND TOOLS

Expanding foam. Plastic mesh. PIR board. Thermal-break foam sheet. Long blade knife for trimming cured foam. Aluminium tape.

METHOD

Once the window linings have been removed ensure that all the holes and gaps are filled.
For gaps into the external wall, especially behind window reveals and window heads, fit lengths of plastic mesh in the shape of a 'U' or a tube to form a supporting framework to hold the expanding foam in place as it cures.

Extension tubes can make this easier. Slide a larger tube over the tube that comes with the expanding foam and tape it in place.

The use of dilute PVA on exposed brickwork may be necessary to stabilise the surface.

Choose an appropriate width of insulation board so that some of the window frame is still visible. Where there is very little space in this location thin foam sheets may be used to act as a thermal break. The vapour barrier must be maintained between the window reveals and the internal surface of the external wall.

Plasterboard can be used to create the final surface or alternatively a moisture resistant structural board.

TYPICAL USAGE AND TASK DURATION

Allow several hours per window or door.

Stripping the linings can reveal holes and gaps

Wire mesh fitted above window head ready for foam. Gap at side into external wall already filled

Injecting foam into the window head. Note the use of an extended nozzle on the can of foam.

The cured foam before being trimmed.

Using PVA to seal the brickwork before gluing

PIR board on the reveal and extra foam near the window ledge. Note Alu tape will be used to create vapour barrier across cut edge of PIR board

D026

WALL INSULATION

Insulating walls with PIR board Part 1

OVERVIEW

Improving the thermal performance of the external wall is a keystone of the whole super-insulation process. It is crucial to use high specification insulation of sufficient depth to achieve a worthwhile improvement. The system described here will create not only a very good thermal layer but will also provide an airtight vapour control barrier.

HEALTH AND SAFETY ISSUES

Recommend using an FFP2 rated dust mask when cutting PIR board. Ear defenders when drilling are useful. Latex gloves when using expanding foam or adhesive are advised.

MATERIALS AND TOOLS

PIR board. Good work table. 'Celotex' saw. Aluminium tape (at least 75mm wide). PU foam adhesive. Foam adhesive applicator. Silicone sealant. Long straight edge. Spirit level. Rawlplug type fixings eg KI140 (for 50mm PIR) / KI180 (for 100mm PIR) / KI220N. (for 150mm PIR). Long blade knife for trimming cured foam.

METHOD

To insulate the external walls it is easier to start with the large areas. Using a specialist 'Celotex' saw will create less dust than a wood saw. Care is needed to keep the saw cuts square when using PIR board above 50 mm.

An airtight seal must be formed where the PIR board meets a wall, the floor or the ceiling. When the piece of PIR board has been measured and cut to shape place it on the work table front face upwards. Attach a length of aluminium tape to the corner of the board edge that will touch a wall or the floor. This tape should be part on the front face and be folded over the corner to attach to the board edge. (Fig 1).

Now turn the PIR board over and apply a bead of foam adhesive on the rear foil face around the edge of the board. Apply additional lines of foam adhesive across the centre of the board (Fig 2).

Allow the foam adhesive to cure for between 5 and 10 minutes depending on the room temperature (the cooler the room the longer the cure time).

A generous bead of silicone sealant can then be applied to the wall and floor where the PIR board will touch those surfaces. This will form the airtight seal. If there is a gap between the floor and the wall then a line of foam adhesive can be applied here also (Fig 3).

When the foam adhesive on the PIR board has cured a little, offer the PIR board up to the wall and ensure it is vertical. Some pressure will need to be applied for a few minutes until the bond is firm (Fig 4).

A spirit level (Fig 5) and a long straight edge (>2m) will help in creating a flat surface across multiple boards (Fig 6).

It is important to ensure that all butt joints between adjacent PIR boards are tight to avoid an air gap and thermal bridging. Applying a bead of foam adhesive to the edge of the previous board will provide a very good attachment and seal. As the foam adhesive is setting it may be necessary to wedge some boards in place.

Fig 1: Fix aluminium foil on edges to be fixed against walls, floor and ceiling

Fig 2: Apply foam adhesive around the complete edge of the board and in the middle

Fig 3: Apply additional foam adhesive along gaps at the floor edge

Fig 4: Hold the board in place until the bond is firm

Fig 5: Ensure the joints are tight and the boards vertical

Fig 6: Use a long straight edge to ensure a flat surface

D027

WALL INSULATION

Insulating walls with PIR board Part 2

METHOD CONTINUED

Continue around the room until the entire surface is covered (Fig 7). The window and door reveals can have pieces of PIR board cut so that they overlap the insulation on the main wall (Fig 8).

Where the wall is particularly uneven extra foam adhesive can be applied to the board or to the wall to provide support and attachment.

To create a strong mechanical attachment fit 4 to 6 Rawlplug-type insulation fixings to each full board (Fig 9). These fixings must be 60-75 mm longer than the insulation is deep. This is to ensure that the fixings will reach back through any plaster layer to the solid brick / stone in the wall.

When the foam adhesive has fully set – typically 30-45 minutes after the board has been fixed on the wall - use a masonry drill with a bit long enough to pass through the insulation and 80 or 90 mm into the wall surface.

For a 150mm thick PIR board this will typically require a 300mm drill.

Drill the required holes 100-150mm in from the edge of the PIR board. Tap in the body of the fixing ensuring that the head is flush with the surface of the board. Then hammer home the supplied pin into the middle off the fixing.

Any gaps that remain between PIR boards, and between board and the wall / floor, can be deep filled with low expansion foam or foam adhesive (Fig 10). When the foam has cured these can be trimmed flat.

All joints between boards, tears in the foil surface and heads of Rawlplug-type fixings must be sealed with lengths of adhesive aluminium tape. This is crucial to create the airtight vapour barrier (Fig 11, 12).

TYPICAL USAGE AND TASK DURATION

The time will be dependent on the condition of the existing wall surface and the complexity of the shape of the room. Allow about 1 –2 hours per full PIR board.

Fig 7: Fix smaller pieces at the top of the wall

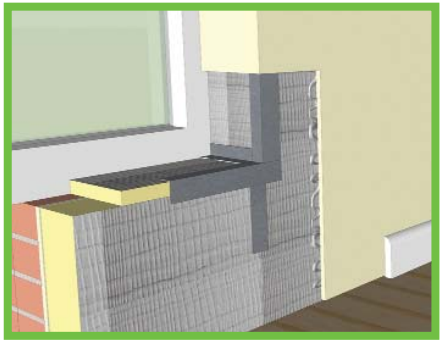


Fig 8: PIR board on window reveals can overlap board on the main wall surface

Fig 9: Fit Rawlplug-type insulation anchors, then put aluminium tape over the head

Fig 10: Deep fill any remaining gaps with foam

Fig 11: Use aluminium tape to seal all joints

Fig 12: Ensure the entire surface is airtight

D028

WALL INSULATION

Fixing the structural inserts & plasterboard to the wall

OVERVIEW

The continuous insulation layer and vapour barrier has now been installed. A final layer is now required to protect the PIR board and provide a surface which can be decorated.

Where it is required to attach heavy objects to the wall then a structural board can be attached in place of plasterboard. These solid inserts are mechanically attached to the wall for extra strength.

HEALTH AND SAFETY ISSUES

Normal construction safety considerations. Latex gloves can be useful when dealing with adhesive.

MATERIALS AND TOOLS

Plasterboard. Structural board eg. “FermaCell”. Construction grade adhesive Eg “EverBuild Solvent Free PinkGrip”. Plasterboard cutting tools. A "Blade Runner" cutting tool could be useful. A “Surform” type sanding tool can be useful for shaping the edges. Plasterboard metal edging. Plasterboard screws. Plasterboard gap filler. Mechanical fixings for the structural board, e.g. "Hammer Plugs". A bonding agent may be required. E.g. "FebBond BlueGrit”.

METHOD

The structural board can usefully be fitted as a 150 mm tall strip at the base of the wall to allow easy fixing of the skirting board. Similarly a piece above each window will make it easy to attach curtain rails. Such a piece could be 150 mm tall and extended beyond the sides of the window reveals by 150 to 200 mm. If a radiator is to be fitted to the wall being treated then vertical pieces of structural board can be attached to make this easier as well. This structural board can be mechanically attached with suitably sized "Hammer Plugs" through the insulation into the wall.

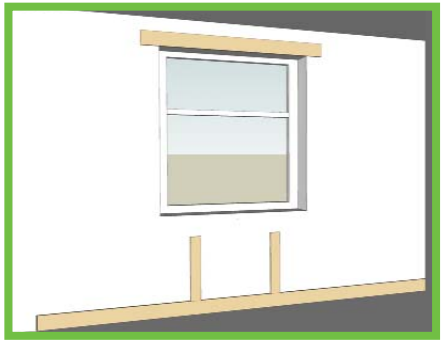
The surface of the structural board may require treating with a bonding agent prior to the plaster skim.

The remainder of the wall surface can be covered with regular plasterboard. This board can be stuck on to the wall with “PinkGrip-type” adhesive. Certain rooms, eg kitchens and bathrooms, could have the structural board fitted in place of plasterboard across the entire wall surface.

Gaps between the attached plasterboard of more than a couple of millimetres should be filled with appropriate filler. All joints are then to be bridged with a scrim tape. The edge and top of boards adjacent to walls and ceilings which are not to be skimmed should also have scrim tape applied. External corners should have metal stop edging attached. It is useful to apply a continuous bead of “PinkGrip-type” adhesive behind where this metal edging will be fixed to provide extra support. The wall is then ready for the plaster skim.

TYPICAL USAGE AND TASK DURATION

The complexity of the room shape will determine the length of time for this task. Individual uncut plasterboards can be fixed in minutes. Complicated shapes can take at least an hour.



Typical locations of structural board inserts

Structural board fixed behind radiator brackets

Applying “PinkGrip-type” adhesive to the back of the plasterboard

Scrim tape across all joints and tops of boards.

Applying the plaster skim. Note the metal edging on the external corner.

The finished, skimmed wall.

D029

WALL INSULATION

Reinstating the woodwork and coving

OVERVIEW

This is the final stage of rebuilding the wall surface before decorating. The level of finish will depend on the budget available and the desired result.

HEALTH AND SAFETY ISSUES

Normal safety procedures should be followed for the workplace.

MATERIALS AND TOOLS

Skirting board and coving to match the existing in the room. An appropriate material from which to make the wider window ledges e.g. MDF. A router may be needed. A "multi-cutter" power tool may be useful. “PinkGrip-type” construction grade adhesive.

METHOD

The skirting board lengths should be cut to size and attached to the wall with “PinkGrip-type” adhesive. Additional screw fixings into the structural board facing are recommended particularly if the skirting board is tall or is made of wood rather than MDF.

The depth of the window reveals will be larger than before. Typically it will be necessary to make new window ledges to suit the increase depth. Commonly these will need to be made from sheet material, for example 18 mm MDF, and a router may be used to form a suitable curved front edge. The design of these window ledges can be chosen to suit the room.

Architrave around windows and doors can be attached with “PinkGrip-type” adhesive and screws similar to the skirting board.

If coving is to be fitted and replacement pieces can be easily obtained to match the existing coving then this should be fitted in the normal way. The use of a template to create the angled joint in the existing coving can be useful. If the coving is of a complex design then either it can be omitted from the finished wall or replacement pieces can be commissioned from specialist suppliers.

TYPICAL USAGE AND TASK DURATION

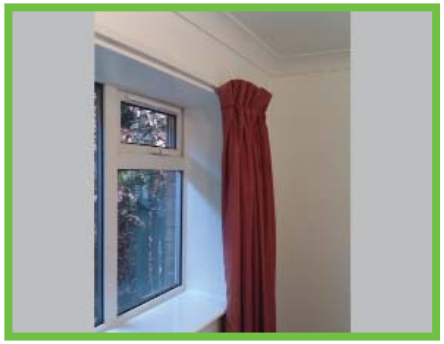
The time for this task depends on the level of complexity of the room and the extent of the woodwork and coving to be reinstated.

Complex pine skirting board installation

MDF skirting board along a flat wall

Creating a bull nose on an MDF window ledge

An extra wide window ledge fitted in place



Two insulated walls with new coving fitted, extended window ledge and curtain rail in place

D030

WALL INSULATION

Party walls, internal stairways & cellar stairways

OVERVIEW

In addition to the main external walls of the building heat can also escape through the other walls. The section of the party wall which is closest to the external wall will be particularly cool because of its thermal connection to the outside wall. The first metre of wall is most affected.

In addition to thermal bridging with external walls there can also be a marked temperature difference in an adjacent property. This is particularly true for unoccupied attics.

Where a house has a cellar the dividing wall between the living space and the cellar stairway is often thermally leaky. In many Victorian terrace houses this wall is made only of vertically fixed floorboard material.

To create a highly energy-efficient house it is necessary to insulate the party walls.

HEALTH AND SAFETY ISSUES

Recommend using an FFP2 rated dust mask when cutting PIR board.
Ear defenders when drilling are useful. Latex gloves when using expanding foam or adhesive are advised.

MATERIALS AND TOOLS

PIR board. Good work table. 'Celotex' saw. Aluminium tape (at least 75mm wide). PU foam adhesive. Foam adhesive applicator. Silicone sealant. Long straight edge. Spirit level. Rawlplug type fixings (Eg KI140 (for 50mm PIR) / KI180 (for 100mm PIR) / KI220N. (for 150mm PIR). Long blade knife for trimming cured foam.

METHOD

Several of the methods described here are identical to the section above on the installation of PIR board.

The dividing wall to a cellar stairway is an important place to insulate. If there are significant gaps between the vertical boards then these should first be filled with silicone sealant. Electric cables must be moved or fitted with conduit. The depth of PIR board that can be applied will depend on the available space in the stairway. As before the edges must be sealed to create an airtight join. The facing material chosen can be suitable for the application e.g. painted structural board rather than plasterboard.

The underside of internal stairs can be filled with mineral wool and then over boarded with structural board.

For a party wall alongside an internal stairway the available space for insulation may be limited. Choose a width of insulation that will fit on the top edge of the stair string. Fix this insulation board to the wall as described above. The surface facing can be plasterboard as normal or could be a thinner structural board to save space. This can be fixed onto the face of the stair string.

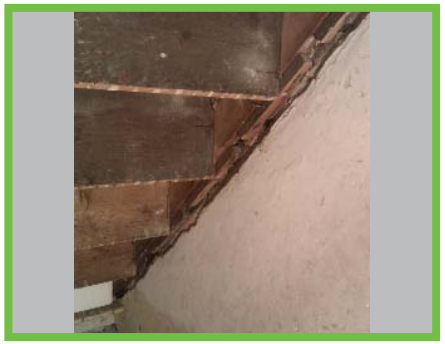
Where the party wall is split by a chimney breast it may be decided to only insulate the back of the alcove nearest to the external wall.

TYPICAL USAGE AND TASK DURATION

The duration of this task is highly dependent on the complexity of the surfaces to be treated.

Typical cellar stairway with wooden side wall

Cellar stairway with first PIR board in place



Beneath an internal stairway

Mineral wool held in place with tape until board fitted

PIR board fitted on top edge of stair string

Surface layer fitted onto surface of stair string

D031

WALL INSULATION

Dealing with inter-floor spaces

OVERVIEW

This part of the external wall lies above the ground floor ceiling and below the floor of the room above. It is an important part of the whole-house insulation system. To achieve high performance thermal insulation and airtightness this area must be refurbished at the same time as the walls of the main rooms.

This manual only deals with the case where the outside joist runs parallel to the external wall. This is a common arrangement in many Victorian terrace houses.

The case where the floor joists are bearing on the external wall is less usual and will require significantly more work to treat. Solutions in this case would range from cutting back joist ends and the installation of a steel beam to support the joists on the internal side of the insulation to just cutting insulation and vapour barrier / airtightness membrane around the joists and ensuring a positive airtight seal to the joists.

The situation of joists bearing onto party walls can be treated in the same way. However, the factors involved in deciding the appropriate solution are specific to each house context. Decisions as to the extent of measures should be made to ensure that the joist ends will not suffer from increased moisture levels. This case is likely to be the subject of a future extension to this manual.

HEALTH AND SAFETY ISSUES

All previously stated safety recommendations about working with PIR board and adhesives apply.

MATERIALS AND TOOLS

PIR board. Good work table. 'Celotex' saw. "Visqueen-type" polythene membrane. Silicone sealant. Aluminium tape (at least 75mm wide). PU foam adhesive. Foam adhesive applicator. Long blade knife for trimming cured foam.

METHOD

This method only deals with the case where the outside joist runs parallel to the external wall.

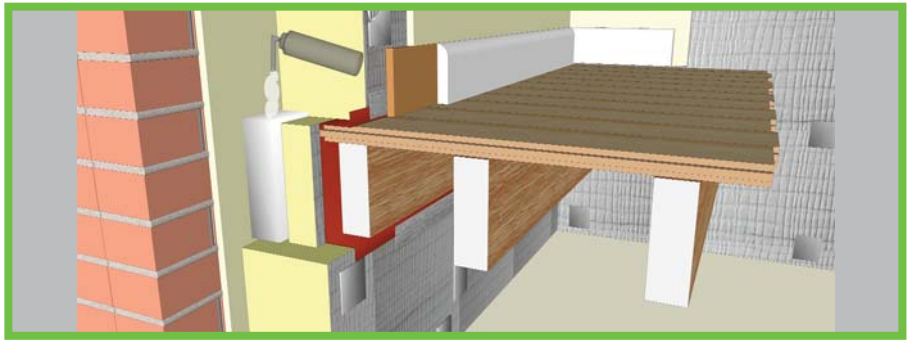
This procedure assumes that the gap between the outside joist face and the inside face of the external wall is less than the thickness of the PIR board to be fitted to the walls.

In the upper room use a hand saw or power tool to trim the floorboard ends level with the outside face of the joist nearest to the external wall. Use a small diameter drill or other sharp tool to make 'marker holes' through the ceiling of the lower room along the lower edge of the joist. In the lower room use these marker holes to draw a line across the ceiling. Use a hand saw or power tool to trim the ceiling back to this line.

In the upper room cut a sheet of "Visqueen-type" membrane the length of the room and around 800mm wide. Lower the membrane into the slot by the external wall until there is around 300mm showing above the line of the floorboards. Fold the membrane flat to the floor and use duct tape or similar to temporarily fasten the membrane to the floorboards. In the lower room use white paper tape or similar to temporarily fasten the membrane to the ceiling.

The PIR in the lower room can then be fitted. When this is installed remove the lower edge of the membrane from the ceiling and fasten it to the foil face of the PIR board with aluminium tape to create an air-tight seal. Inject silicone sealant between the membrane and the ceiling. Pay particular attention to sealing the edge of the membrane where it meets the wall at each end.

In the upper room cut pieces of PIR board to fill the gap between the membrane covering the joist and the external wall. The height of these pieces will be the distance from the top edge of the PIR board fitted in the lower room and the top of the floorboards in the upper room (See diagram opposite).



Wall build up showing insulation and vapour control barrier (shown in red)

Remove a section of floorboard near the external wall.

Use expanding foam to deep fill any gaps between the PIR pieces and the external wall. The 'Low Expansion' variety cures relatively quickly and can be trimmed flat within a few hours (depending on the room temperature).

The PIR board for the upper room can then be fitted and sealed onto the foam in the inter-floor space and also to the Visqueen. The top flap of Visqueen can then be folded up and fixed with aluminium tape onto the foil face of the PIR to create an air-tight seal. Inject silicone sealant between the membrane and the floorboards. Pay particular attention to sealing each end of the membrane where it meets the wall.

TYPICAL USAGE AND TASK DURATION

Highly dependent on the actual construction of the house being refurbished. Allow half a day per inter-floor space

D040

ATTICS, DORMERS AND BAY WINDOWS

Insulating attics, dormers & bay window ceilings Part 1

OVERVIEW

This work is a variation on the "Wall Insulation" section above. Please refer to that section for a description of the common techniques.

In certain rooms and all attic rooms there is part of the ceiling which is at an angle. This creates a different challenge than installing insulation on a vertical wall. This section describes how to form a good mechanical attachment for the applied material whilst maintaining a very high level of performance.

Dormer windows in to an attic room present the added difficulty of very limited space in which to fit the insulation. The sides of the dormer cheeks are often level with the window frame. The design of the insulation system will involve pragmatic choices.

Bay window ceilings are a special case of dormer ceilings, typically with more space available for insulation.

HEALTH AND SAFETY ISSUES

The voids above dormer ceilings and bay window ceilings may have been inhabited by vermin. Protection against droppings and other contaminants is important.

MATERIALS AND TOOLS

PIR board. Good work table. 'Celotex' saw. Aluminium tape (at least 75mm wide). PU foam adhesive. Foam adhesive applicator. Silicone sealant. Long straight edge. Spirit level. Plasterboard. Rawlplug type fixings (Eg KI120 (for 50mm PIR) / KI140 / KI160 (for 100mm PIR) / KI200 / KI220N. (for 150mm PIR) Nb these may be shorter than those used for attachment to brick / stone walls. Auger wood bit. Long blade knife for trimming cured foam.

METHOD

SLOPING CEILINGS

A key difference with attaching the PIR board to a sloping ceiling is that this will typically be into timber roof rafters rather than stone or brick. A shorter length of Rawlplug-type fixing may be used because of the better attachment that is typically possible.

For rooms where there is limited headroom it may be decided to remove the existing ceiling to expose the rafters. The space between the rafters can then be filled with PIR board ensuring that there is at least a 50 mm air gap on the roof side of the fitted insulation. These PIR board sections must be fitted with no gaps at their edges. A straightforward and quick way to do this is to cut the board slightly narrower and then use expanding foam adhesive or low expansion foam to seal the sides. It will be necessary to hold the boards in place temporarily with battens as the foam cures. Trim excess foam when cured with a sharp knife.

The final layer of PIR board is held in place with the Rawlplug type fixings. If the ceiling is left in place then the position of the rafters must be found with test drilling using a small diameter drill or by using a bradawl. Only a few fixings will be needed since further fixings are used when the plasterboard is attached. Use an auger wood bit to drill the fixing holes (Fig 1).

Some sections of the sloping ceiling will have angled edges. It may be necessary to shape the PIR board pieces to fit (Fig 2,3). To achieve a very high level of thermal performance then the timber perlins can be covered with insulation as well.

Fill any remaining gaps with foam and then seal all of the joints with aluminium tape (Fig 4).

Fig 1: drilling the fixing holes in the sloping ceiling

Fig 2: a shaped piece of PIR board

Fig 3: attaching PIR board to the sloping ceiling

Fig 4: remaining gaps filled with foam and the joints taped

Fig 5: plasterboard and scrim tape in place

Insulating attics, dormers & bay window ceilings Part 2

METHOD CONTINUED

Cut and fit the plasterboard and in addition to using “PinkGrip-type” adhesive fix this board to the rafters using Rawlplug-type fixings. With care, the heads of the fixings can be slightly indented into the plasterboard surface. This may allow the plaster skim to be applied more easily. The application of a small amount of bonding plaster to the heads of the fixings may also be required. After fitting scrim tape to the plasterboard joints and metal edging to the external corners the surface is then ready for the plaster skim (Fig 5).

DORMER WINDOWS

If the dormer window frame is to be replaced then this should be done first. Strip out the linings and ceiling of the dormer (Fig 6). Identify spaces where insulation can be fitted (Fig 7). Cut and fit PIR board at a depth which still leaves an air gap between the outside face of the PIR board and the inside surface of the dormer wall. Use expanding adhesive foam or low expansion foam to seal the edges round this PIR board (Fig 8). The depth of the surface layer can be chosen to match the available space (Fig 9).

Use the attachment techniques as described for attic ceiling insulation in the section above.
Fit scrim tape and metal edging prior to the plaster skim (Fig 10).

BAY WINDOW CEILINGS

Score a straight line in the bay window ceiling in line with the inside surface of the external walls of the room. Use an oscillating "multi-cutter" power tool or hand tool to cut through the ceiling along this line. Remove the remainder of the ceiling with normal construction tools. Clear any debris from the void.

Before the insulation is fitted pieces of structural board should be installed above the ceiling timbers. This protective facing for the PIR board is to minimise damage caused by vermin. Cut lengths of PIR board to fit between the ceiling timbers. Use foam adhesive to attach them to the structural board and to fill the gaps along the sides. Strips of PIR board fixed on top of the ceiling timbers may be required if additional insulation depth is specified (Fig 11).

Secure plasterboard of a thickness to match the existing ceiling and secure with plasterboard screws into the ceiling timbers of the bay window. Apply a plaster skim.

TYPICAL USAGE AND TASK DURATION

Insulating a sloping ceiling can be a time-consuming operation because of the complexity of the angles in the room. Allow 2 to 3 hours per full PIR board.

Each dormer can take a number of hours because of the complexity of their shape and access limitations in the smaller spaces.

Additional time should also be allowed for moving the materials into an attic room.

A bay window ceiling may contain additional debris in the void but typically will otherwise be straightforward.

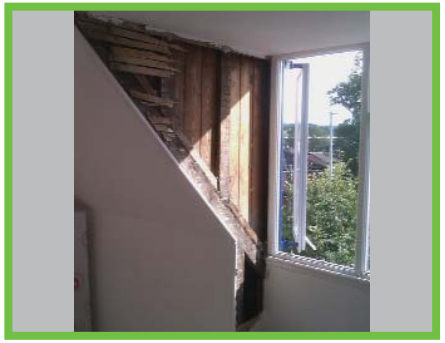


Fig 6: Stripping out the dormer sides

Fig 7: space for insulation within the frame of the dormer

Fig 8: PIR board fitted tight between the roof timbers

Fig 9: PIR board fitted to dormer cheek, sloping attic ceiling and Perlin.

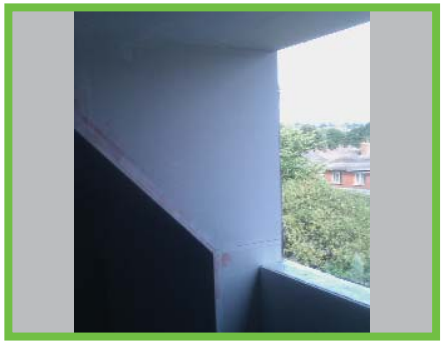


Fig 10: plasterboard in place ready for skim

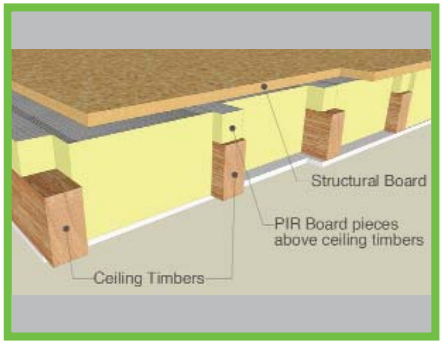


Fig 11: PIR board pieces above bay window ceiling timbers

D042

ATTICS, DORMERS AND BAY WINDOWS

Dealing with stud walls, eaves voids & access doors

OVERVIEW

A high proportion of attic rooms have small vertical walls part way down the sloping ceiling. These partition walls, also called stud walls, create a void space between the remainder of the sloping roof and the ceiling of the room below. Typically this eaves void is open to the outside air and so can be very cold. This stud wall and the horizontal part of the void represent the boundary between heated living space and the outside. It is important to insulate this boundary and make it airtight. This includes any access doors into the void.

HEALTH AND SAFETY ISSUES

Working in confined spaces necessitates both risk assessment and good working practice. Follow normal procedures. The spaces may have been inhabited by vermin. Protection against droppings and other contaminants is important.

MATERIALS AND TOOLS

Good lighting arrangements. FFP2 dust masks essential. Knee pads useful. Head torches. Crawler boards. Cable conduit. Cable clips. Silicone sealant. Wood strips. “PinkGrip-type” adhesive. Mineral wool. Long nails. PIR board pieces. High-spec draught strip. Extending pole can be useful.

METHOD

Prepare the area by setting up good lights and clearing the void of unwanted items. The use of crawler boards can make moving around easier. Electric cables must be either clipped out of the way of the insulation or sheathed with conduit.

A stud wall can either be insulated on the room side or the eaves void side. On the room side PIR board can be attached using the methods described above. On the void side mineral wool can be hung in a curtain across the entire surface. The mineral wool can be held in place using long nails hammered into the frame of the stud wall, eg use 220mm nails for fixing 200mm mineral wool (Fig 1). Before attaching the mineral wool seal gaps and holes in the stud wall using silicone sealant and if necessary wood strips and “PinkGrip-type” adhesive.

On the horizontal part of the void, effectively a loft area above the room below, mineral wool can be fitted in a deep layer (Fig 2). Care must be taken to ensure that an air gap remains between the rafters right from the edge of the eaves void / roof soffit. An extending pole can be useful for positioning lengths of mineral wool into hard to reach corners.

Access doors must be insulated and made draught proof and ideally air-tight. A 100mm PIR board can be glued to the void-side face of the door (Fig 4) and draught strip fixed to a lip running round all four sides of the door frame (Fig 5, 6). The door can be semi-permanently closed with screws or a positive closure catch fitted.

TYPICAL USAGE AND TASK DURATION

Working in confined spaces can extend the time to complete a task by 2 to 5 times.

Fig 1: Stud wall with mineral wool hung vertically.

Fig 2: Eaves void with first layer of mineral wool, cables clipped on stud wall which is insulated on the other side with PIR board (Fig 3)

Fig 3: Access hole through stud wall insulated with PIR board.

Fig 4: hinged access door showing PIR board

Fig 5: Insulated draught proof door to electrical fuse cupboard

Fig 6: Insulated hatch to underfloor void showing PIR board and draught strip

D050

LOFT INSULATION AND LOFT HATCHES

Insulating lofts and loft hatches Part 1

OVERVIEW

Around 25% of the heat lost from a house is through the loft and roof. Adding a high-performance thermal barrier in this part of the building is crucial. Airtightness is also very important and so leakage paths round light fittings, pipes, cables and loft hatches must be minimised.

HEALTH AND SAFETY ISSUES

Loft spaces may have been inhabited by vermin. Personal protection against droppings and other contaminants is important.

MATERIALS AND TOOLS

Good lighting arrangements. FFP2 dust masks essential. Knee pads useful. Head torches. Crawler boards. Cable conduit. Cable clips. Pipe insulation with 25mm wall thickness. Radiator foil – ideally the flexible type with foil on both sides. Scissors. “PinkGrip-type” adhesive. Mineral wool. PIR board pieces. High-spec draught strip. Extending pole can be useful.

METHOD

Prepare the area by setting up good lights and clearing the loft space of unwanted items (Fig 1). The use of crawler boards can make moving around easier.

Gaps around pipes and cables entering the loft space should be sealed with silicone sealant.

Electric cables must be either clipped out of the way of the insulation or sheathed with conduit. Groups of cables can be run in large diameter (100mm) conduit (Fig 2, 5). Junction boxes should ideally be relocated above the level of the insulation. Alternatively use the large diameter conduit to create an air gap around them. See section above “Underfloor – Dealing With Electrics” for more detail.

Light fittings which are fitted into an upstairs room ceiling may be a route for cold air to enter the living space (Fig 3). Such light fittings also often use very inefficient halogen bulbs. These bulbs give off a great deal of waste heat and so insulation cannot be fitted directly above them. It is strongly recommended that these light fittings are replaced with showerproof fittings capable of using high brightness LED bulbs. No draughts enter through these fittings and insulation can be fitted above the LED bulbs. Alternatively use silicone to seal around the rim of the light fitting as it meets the ceiling – nb this is only a partial solution. Some space around the light fitting is still needed and this can be created with a board laid across the joists above the lower layer of insulation (Fig 4).

A loft space should be considered as being open to the outside. All pipes must be highly insulated to avoid heat loss or even freezing in cold weather. Remove old lagging (Fig 6) and replace with high specification pipe insulation. When fitting long runs of pipe insulation slightly compress each piece against the next to allow for shrinkage over time. In limited access areas multiple layers of radiator-type foil can be used. Seal all joints securely with duct tape. See section above “Underfloor – Insulating Pipework” for more detail.

If a water tank is present then there must be no insulation underneath it (Fig 7). This is to minimise the risk of freezing in cold weather.

A storage area can be created by fixing additional timbers or I-Beams at right angles to the existing ceiling joists and attaching flooring grade chipboard panels on top (Fig 8, 9).

Fig 1: Loft showing LED light string in place, double insulation layer now in place at far end. Patchy insulation in foreground

Fig 2: Typical disarray of wires and poorly insulated loft area

Fig 3: Downlighters fitted into ceiling of room below.

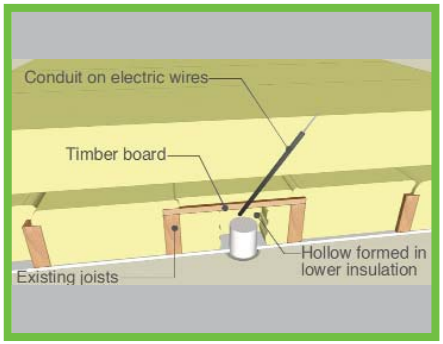


Fig 4: Hollow in lower insulation layer formed around low energy bulb fitting

Fig 5: Sections of large conduit ready for fitting

Fig 6: Pipes with poor insulation

Insulating lofts and loft hatches Part 2

METHOD CONTINUED

Mineral wool can be fitted in a deep layer – ideally at least two layers of 200mm. Ensure that the insulation is continuous and that each roll is laid to avoid the joints lining up. Ensure that air can still flow from the junction between the roof and the wall (ie the eaves / roof soffit) up between the rafters. An extending pole can be useful for positioning lengths of mineral wool into hard to reach corners (Fig 10).

The loft hatch must be insulated and made draught proof and ideally air-tight. High specification draught proof strip can be run around the lip of the access hatch way. It can be useful to fix an additional piece of heavy board to the top of the access panel to ensure it sits down firmly onto the draught strip. A 100mm PIR board can be glued to the loft-side face of the hatch with "Pinkgrip-type" adhesive (Fig 11).

A loft ladder access door can be treated in a similar way (Fig 12). The draught strip is run around the lower edge of the access hatch way and PIR board fitted to the surface of the hatch. It may be necessary to extend the ladder mounts to create sufficient space for the PIR board.

TYPICAL USAGE AND TASK DURATION

The time-consuming part of this task is the preparation. Dealing with the pipes, wires and light fittings can take several hours. The laying of the insulation is relatively straightforward and simply moving the material into position is what takes the time.

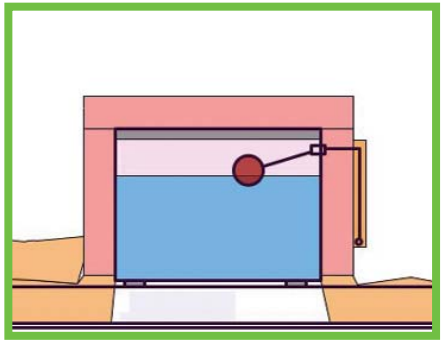


Fig 7: Water tank with PIR insulation around top and sides, but no insulation beneath it

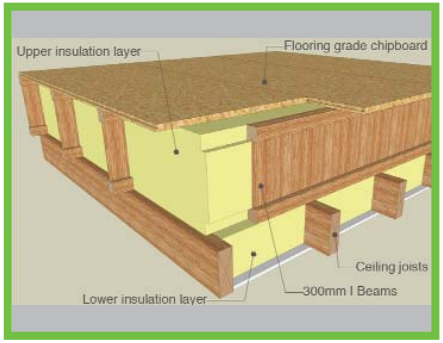


Fig 8: Storage platform raised on timbers to create more space for insulation underneath

Fig 9: Additional timbers fixed to top of existing ceiling joists

Fig 10: Two complete layers of insulation

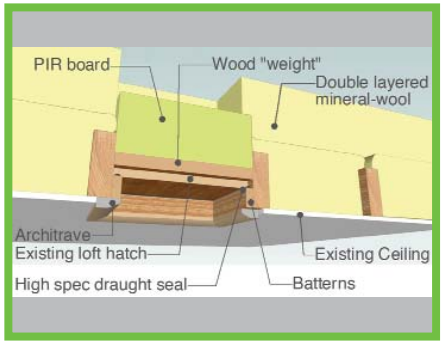


Fig 11: Weighted loft access hatch with PIR board glued to top surface.

Fig 12: Loft ladder before insulation fixed to access hatch panel.

D060

WINDOWS AND DOORS

Windows and doors

OVERVIEW

The upgrading of windows and doors on a property can have a dramatic effect on comfort and in reducing heat loss. The improvement in comfort is more pronounced because of the reduction in air leakage associated with the windows through gaps in frames as well as around the edges at the wall junctions. The cool radiant effect (i.e how cold a body feels when sat close to a window) of single glazing on comfort is dramatically reduced by modern double or triple glazed windows. Replacing external doors provides important draught sealing and reduction in heat loss.

TYPES OF WINDOW AND GLAZING

To comply with current building regulations requires replacement windows with very effective draught seals and double glazing that incorporates coatings on the glass with argon gas filling. The whole window must achieve a 'C' Energy rating which requires a whole window 'U' value of 1.6 W/m²/°C. Higher performance with 'U' values as low as 0.7 W/m²/°C is possible with more expensive triple glazed windows with insulated frames. These are strongly recommended when a high specification refurbishment is being carried out on a property. Please refer to Section B for further information on comparative cost savings.

Timber frames offer economy, robustness and long-term maintenance benefits. Aluminium clad and framed windows are more costly but offer very long life and low maintenance. UPVC offers economy and performance with higher environmental impacts associated with disposal and manufacturing. The maintenance costs over the lifetime are slightly higher.

Secondary glazing and refurbishment of existing windows offers some economy in initial cost (approximately 50-60% the cost of new windows). They will offer only about 60% of the performance, higher maintenance and less convenience in terms of opening.

REPLACEMENT OF DOUBLE GLAZED UNITS

Double and triple glazing units have a lifetime of 12-15 years. Existing failed units can be replaced with much higher performing units of the same depth that will fit into the existing window rebates. It may be possible to fit in slightly deeper units that have better performance. Vacuum glazing units and very slim double glazing units are available for replacing single glazing in historic buildings though secondary glazing is generally more effective.

INSTALLATION

Take care to ensure seals at the junctions with the walls are sealed with tape for airtightness. The reveals should be prepared and treated with insulation as shown in Section D ref. D025. Ensure the external brickwork pointing is fully filled and sound prior to sealing the joint between the wall and window frame. Use damp proof course membrane to protect the frame and take care that the membrane does not interfere with the seals internally and externally.

TYPES OF DOORS

Replacement doors are required to provide a 'U' Value of 1.8 W/m²/°C to comply with the current Part L of the building regs. This requires insulated cores and high performance double glazing if glazed as for windows above. Doors are available with 'U' values down to 0.7 W/m²/°C.

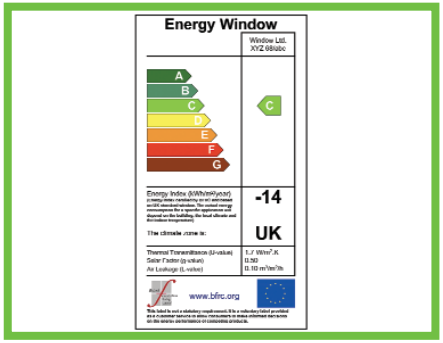
INSTALLATION

As for windows and take care to ensure the threshold seal provides an effective seal to the door as well as the floor.

BEHAVIOUR

The use of opening windows and doors can dramatically influence the effect of improvement measures. Reminders about the benefit of only opening windows in winter for short periods to allow occasional rapid fresh air ventilation are always worth making. Winter solar gain effects, as well as insulation benefits, can be vastly reduced by forgetting to close windows.

Typical high performance double glazed window



Window energy rating label

SECURITY

Door security is an important consideration and homeowners will gain from the assurance of a door certified to PAS 23 / PAS 24.

D070

DRAUGHT PROOFING AND AIR LEAKAGE

Draught proofing and air leakage

OVERVIEW

Where other works are not providing an improvement to the airtight seal, the following procedures should be carried out in those locations to improve air tightness.

MATERIALS AND TOOLS

Frame sealant and building mastic, draught proofing strips.

METHOD

Building draught proofing to do list.

WINDOWS AND DOORS

- Seal gaps around windows and doors to prevent air leakage via the reveals and thresholds. Make sure letterboxes to doors seal shut properly. (http://www.ecoflap.co.uk/)
- Apply an external mastic seal to all window and door frames.
- Seal any internal gaps where the wall reveals/window boards abut window units or external doors with a bead of mastic.
- Repair any damage to window frames and ensure the casements, sashes and top-lights close firmly. It may be necessary to replace closing mechanisms.
- Apply draught-stripping to gaps around window casements, sashes and top-lights.

WALLS

- Air leakage and air movement behind dry-lining can be reduced by injecting continuous ribbons of expanding polyurethane foam or adhesive between the insulation sheets and the inner face of external wall.
- Seal air bricks into rooms. Fill with mineral fibre and board or plaster over internal face. Do not block any airbricks that are supplying air for combustion to stoves or open fires. Consider benefit of removing these fires
- Make good damage to mortar joints and fill holes in external walls especially around waste pipes and clothes drier vents. Ensure gaps are filled around extract fan ducts.

FLOOR

- Improve timber floors by laying hardboard sheeting over the top. Ensure boards are pre-shrunk and are laid with very tight joints, seal joints and all way round edge with mastic.
- Seal around the edges of the room and make good gaps around service pipes. Ensure seal either by removing skirting or seal to top and bottom edges of the skirting board with mastic.

ROOF

- Ensure the loft hatch fits snugly into its aperture and apply draught-stripping between the hatch and the frame.

SERVICES

- Seal gaps around any service pipes and cables passing through external walls, ceilings and ground floors.

CHIMNEY

- Ventilate the top of the chimney: either a) a gas cowl on each stack or b) cap off top and ventilate each stack with air bricks.
- In each room clear debris from fire place if possible and then seal fire place.
  Leave basement alone - i.e. leave vent open if present, or do not make one if not present.

Air leakage pathways

1. *Through air bricks which are required to ventilate sub-floor voids to prevent wet and dry rot (need to be retained)*
2. *Gaps between floor boards, at the floor edge and around radiator pipes.*
3. *Leaking windows and doors.*
4. *Pathways into floor voids and then through the poorly pointed joints in the brickwork behind and around the joist ends.*
5. *Gaps between window and door frames and external walls.*
6. *Gaps at the edges of ceilings below a roof void.*
7. *Open chimneys, chimney vents and gas fires.*
8. *Gaps around loft hatches.*
9. *Service penetrations (light fitting and water pipes etc.) through ceiling into floor or roof void.*
10. *Permanently open bathroom and kitchen extract vents.*
11. *Gaps around kitchen and bathroom waste pipes.*

D080
VENTILATION

Ventilation Strategy Level 1

OVERVIEW

An expected airtightness target is approximately 10 $m^3/h.m^2$ @ 50pa – this involves a thorough check and sealing of all air leakage paths. It is not, however, expected that the rate is measured and some residual leakage is presumed. If the whole building is to be thoroughly sealed refer to Ventilation Strategy Level 2.

MATERIALS AND TOOLS

Extract fan, wall kit, core drill and drill bit (size to suit fan), access equipment for inside and outside, mastic/sealant/foam, electrical works – fan isolator and any junction boxes etc required.

Ref.	*Code*	*Description*	*Kits/accessories*
Fan 1	EFHT2S-230V	EnviroVent Filterless Extract Fan	Wall Kit – 1RD EFWAK 100 TC
Fan 2	SIL100HT	EnviroVent Silent 100	Wall Kit – 1RD EFWAK 100 TC

METHOD

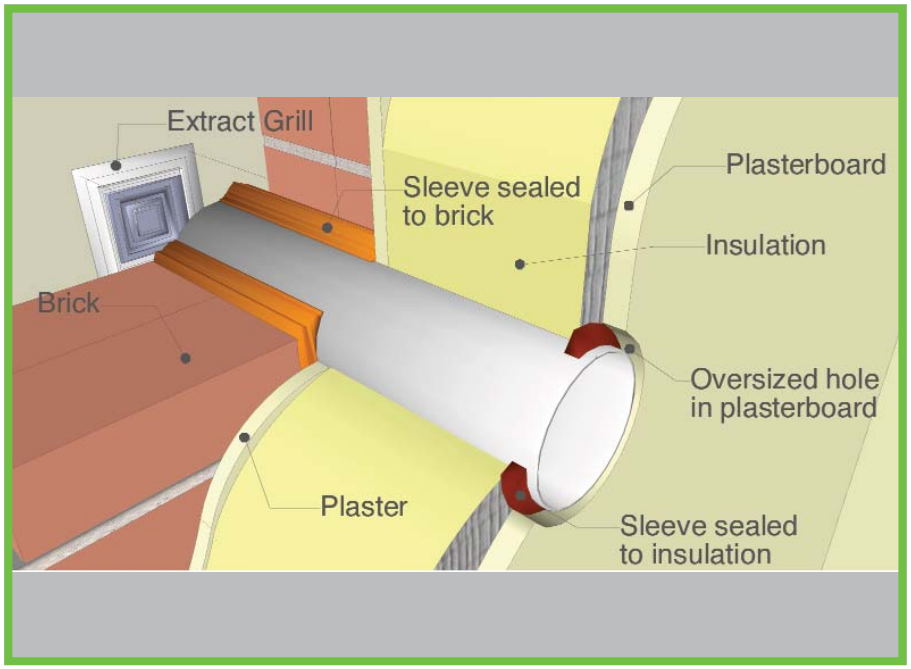
Provide good draughtproofing to all doors and windows and seal up all air leakage pathways using methods described in other measures.

Ensure windows have controllable trickle vents or secure method of being opened just a crack and each room has a good opening window for summer ventilation.

Provide extract fans to bathrooms, shower rooms, kitchens, utility and clothes drying areas. Use the following:
Kitchens and Bathrooms use Fan 1
Utility and clothes drying areas use Fan 2
Cooker hoods are only needed to control excessive odours, and can be installed as an additional option. Install either a recirculation type with carbon filters or an extracting type, remembering to include a back-draught shutter.

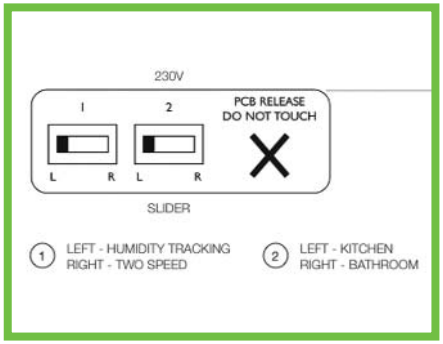
INSTALLATION
Install as manufacturer's recommendations. Power from permanent live from lighting circuit or spur off ring main. Locate fan isolator in accessible location for maintenance, but out of reach to prevent the fan being switched off by mistake. Important points:

- Make sure that fan 1 is installed in a position where the pull cord is accessible or extend the cord using eyelets to guide the cord if necessary.
- Ensure an airtight seal around the wall sleeve as it passes through both the internal airtightness line and the external face of the wall. Use frame sealant or building mastic to provide this seal. See diagram.
- Fill any voids between the sleeve and wall with expanding foam to minimise air circulation and compromise of insulation. See diagram.
- Ensure airtight seals on any electrical cables that run to the fan through the internal air tightness line. Use proper sized grommets and/or small amounts of mastic to achieve this seal.
- For fan type 1 only, set fan dip switches to appropriate room and set to run on humidity tracking. DP 1 to left; and DP 2 to left for kitchen, right for bathroom. See diagram.
- Fan 1 is designed to run continuously and will provide a controlled level of back-ground ventilation which is required once a reasonable level of airtightness is achieved. The fans should not be turned off.
- For Fan 2, wire with dedicated switch (wall or pull cord), set the humidity switch to 65% RH and timed run on to 30mins. This fan is not on unless it is switched on, but the timer and humidity sensor allows the user to not have to remember to switch it off.
- Give users clear guidance on use and importance of continuous running and low energy consumption.



Sealing the sleeve into the wall

Install fan onto wall and wire as per manufacturer's instructions. (from envirovent website)



Setting the dip switches

D081

VENTILATION

Ventilation Strategy Level 2

OVERVIEW

It is expected that the whole house has been sealed through the other measures and new high performance or very well sealed windows and doors are fitted. Ideally the house has been pressure tested and any air leaks found sealed up.

MATERIALS AND TOOLS

Either obtain a supply only or a supply and fit quotation, which includes design and parts list for the specific house. For supply only where you are installing the unit many different tools will be required and an assessment should be made before starting the work.

METHOD

Ensure the whole house is thoroughly sealed using methods described in other measures and perform airtightness testing and carry out any remedial works.

Ensure windows in each room have a good opening window for summer ventilation, with secure opening position for day and night time use. No trickle ventilators are required in windows and if present remove, fill in hole with foam and blank over holes inside and out with 3mm ply/plastic cut to size and paint if necessary.

It would be too extensive to include complete installation of HRV systems in the manual, however the key points are covered below and should be made clear to the installer.

In a small kitchen where gas appliances are installed there may be a need for a permanent opening or air brick, refer to building regulations Part J for guidance. This opening will compromise the airtightness, and to remove this issue electric ovens and good quality induction hobs can be used instead of gas.

Important installation points

- Electrical supply should come direct from fuse board, otherwise use permanent live from lighting circuit or fused spur off ring main.
- Locate fan isolator/fused connection unit in accessible location for maintenance in attic space, but out of reach to prevent the fan being switched off by mistake.
- Fit boost switches in kitchen and bathroom.
- Ensure air tight seal around between duct and grilles, and between grilles and ceilings at first floor level where the grille sits in the airtightness line. Use frame sealant or building mastic to provide this seal.
- Box in ducts running to the ground floor as they pass through the first floor rooms (including as they pass into floor) and compress acoustic grade mineral fibre into void around the duct to prevent sound transfer between rooms. The ducts could be recessed into the insulation where installed to party walls.
- Ensure airtight seals on any grilles, ducts and electrical cables that pass through the airtightness line. Do not rely on the boxing to provide this seal.
- Ensure the unit is correctly commissioned with the calculation rate measured and recorded at background and boost settings. If this is not done the unit can use excessive electrical energy and produce waste heat, or not perform and allow damp to cause mould growth.
- The unit is designed to run continuously and automatically to provide a controlled level of background ventilation. In certain circumstances the unit can be switched off in summer however it is not necessary or recommended.
- Give users clear guidance on use and importance of continuous running and low energy consumption.
- Provide annual check on operation of unit and clean filters. Supplier can provide this service for a cost.

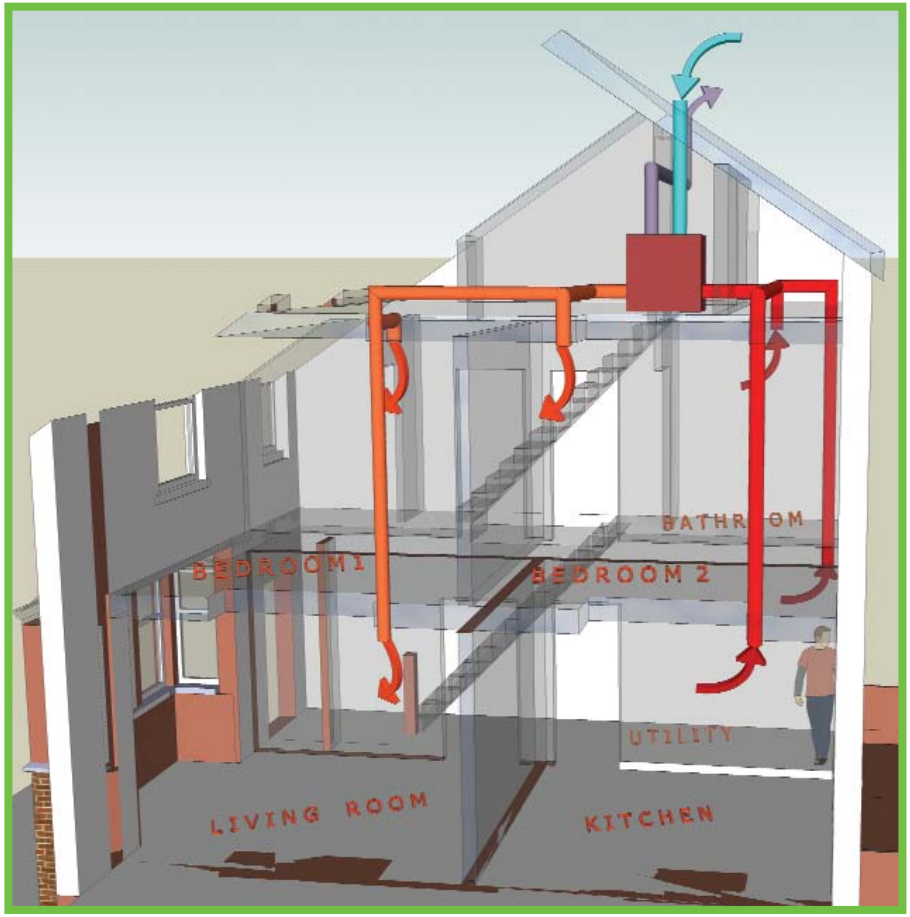


Diagram showing typical whole house HRV installation

Suggested quote specification:

HRV Unit:	*EnergiVent FLOW as manufactured by EnviroVent Ltd. Ensure correct controls variants.*
Controls:	*Inbuilt with boost switches.*
Ducts:	*110x54 flat ducting for supply and extract to the kitchen and living room. Ø125 & Ø150 flexible ducting for connecting unit. Use insulated in unheated spaces like attic.*
Accessories:	*All connectors, grilles, roof terminals, fire dampers.*
Builders work:	*Plasterboard and timber framing for boxing, Rockwool Acoustic Slab 47 or 75mm compressed wall batt for surrounding ducts in rooms and floors.*

D090

RELATED TOPICS

Lighting Part 1

OVERVIEW

Lighting can consume about a quarter of the electricity used in a home and simple changes can provide effective reductions. Beyond the simple measures there is scope to make further worthwhile savings. The most energy efficient bulbs and lighting, the appropriate light levels and how to achieve these are detailed below.

METHOD

Energy efficient replacement bulbs can be fitted into standard fittings. As there are a range of types available, this can usually be done without the need to replace the fitting or bulb holder.

BEHAVIOUR CHANGE

The simplest and best method of energy saving is to reduce the length of time lights are on. A good real time energy monitor will help to reinforce this. Encourage the use of task lighting for reading by having sockets in the right places and providing floor standing reading bulbs and bedside bulbs. Ensure that light switches are logically positioned. For example each switch in a double bank should ideally be nearest the bulb it controls. During house rewiring consider relocating lights to be in the correct position in rooms and near stairs. Consider light sensitive PIR controlled lights in communal spaces such as hallways and toilets – set to switch on only when light levels drop below 20lx with a reasonable run on such as five minutes. Provide a switch to allow the occupants to override the lighting if they would like to. Dual output light sensitive PIRs can be used to ensure that if fans are switched by lights then fans run but lights stay off in good light levels.

RECOMMENDED BULBS AND LIGHTING

Where possible simply install the most energy efficient replacement bulbs possible. LED bulbs use less energy than compact fluorescent bulbs and a fraction of the energy of incandescent or halogen bulbs. Their use is highly recommended. Even in rooms with dimmer switches, dimmable compact fluorescent bulbs or dimmable LED bulbs are available. See table opposite for examples.

THE RIGHT LIGHT LEVELS

Higher than necessary light levels use more energy so care can be taken when selecting new bulbs or lighting to not provide too much light. Lumens outputs (lm) are usually now given on the bulb packaging and give a true reading of light output to enable comparisons between efficiency of bulbs, were the Lumens per Watt (lm/W) shows the efficiency of the bulb. A good value is greater than 55 lm/W and a poor value is less than 30 lm/W.

Covering the bulb by a shade can drastically reduce light output and this should be factored into the choice of shade and the necessary bulb output. The Light Output Ratio of a shade or light fitting is illustrated opposite.

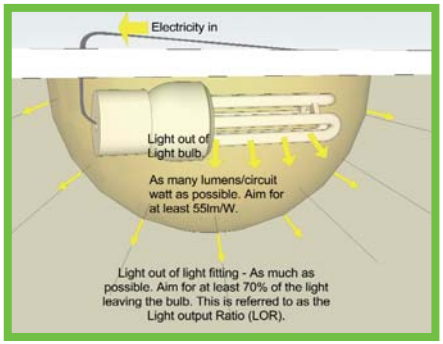
SAFETY

Where lighting is used in a fire rated ceiling or wall, the light fitting must achieve at least the same fire rating. The 17th Edition wiring regulations has special provisions for lighting in bathrooms or wet rooms that need to be observed to prevent possible electrical shock.

	Bayonet or Edison screw replacements	Halogen Spot lights	
Existing	***Replacement***	***Mains voltage replacements***	***12 V replacement options:***
Standard bulbs	Megaman 11W (600lm) Tubular – Liliput 20W (1151 lm) Tubular Compact	GU10 Philips Master LEDspot MV 7W (270 lm)	MR16 is Toshiba 6.7W (300 lm)
Dimmable	Megaman CFL 11W (600lm) Dimmerable tube	Toshiba E-Core 8.5W GU10 LED Dimmable (275 lm)	MR16 Bell 5W (220 lm) LED (additional driver required)
Candle type	Megaman CFL 7W (286 lm) or 9W (405 lm) Frosted Candle		Crompton or Deltech 3W MR16

Types of replacement bulbs with output data

Packaging showing bulb light output. This example shows 630 lm for 11W = 57 lumens per watt. This is more than 55, which is good.



Lighting Efficiency

BULBS TO USE:							
Bulb Type	**Efficiency (Lumens/ watt)**	**Typical Bulb Life**	**Dimmable ^**	**Warm up Time**	**Colour Temperatures (K)**	**Colour Rendering (Ra)**	**Comments**
LED 	20 - 100	50,000**	Yes	0s	2700 - 6000 (warm to cold)	90 - 98 (excellent)	These need to be carefully selected as colour, quality, efficiency and bulb life vary hugely from manufacturer to manufacturer. Ask for the lumens/watt (look for over 55), the bulb life (should be close to 50,000 hours) and colour temperature (select 3000K)
Fluorescent 	70 - 98	24,000*	Yes to 10%	0 to 2s	2700- 6500 (warm to cold)	50 - 90 (fair to good)	T5 fluorescents are efficient, have a good bulb life, and are good value. The types of fittings these are used in mean that they are really only suitable for kitchens and stores in a home. Good quality high frequency (HF) or dimmable ballasts are essential. In a home, select a bulb with a colour temperature around 3000K.
Compact Fluorescent 	50 - 75	10,000*	Yes to 10%	Up to 3 mins	2700- 6500 (warm to cold)	50 - 90 (fair to good)	These are efficient and available in different shapes and sizes so are suitable for a variety of different fittings from floodlights to spotlights to chandeliers. Also available in dimmable varieties, these are very flexible and have a sensible bulb life for accessible locations.

* to 50% failures
** to 70% brightness
^ With the correct bulbs, gear and wiring arrangement
NB LED bulbs are non-standard, always check the efficiency, colour temperature and lamp life with the manufacturer. The technology is advancing very quickly. LEDs have had bad press for being too blue, not consistent colours, not being re-lampable and having poor colour rendering, but these problems have been overcome in the good quality LEDs. The theoretical limit for LED is 300 lumens/watt.

Careful selection of replacement bulbs can greatly increase the efficiency of the lighting. Choose replacement bulbs with an efficiency of over 55 lumens per watt, more if possible. This is achievable in any domestic application, and is 3 times more efficient than halogen or incandescent lighting, and will last at least 3 times as long on average.

BULBS TO REPLACE WHERE EXISTING:			
Bulb Type	**Efficiency (Lumens/ watt)**	**Typical Bulb Life**	**Comments**
Incandescent 	12 - 18	2,000	These are inefficient with a short bulb life and should be replaced with efficient alternatives. Compact fluorescent and LED replacements are available, see D091.
Halogen 	12 - 19	3,000	These are inefficient with a short bulb life and should be replaced with efficient alternatives. Compact fluorescent and LED replacements are available, see D091.

* to 50% failures
** to 70% brightness
^ With the correct bulbs, gear and wiring arrangement

D092

RELATED TOPICS

Hot and cold water

OVERVIEW

After heating hot water can be the next highest energy use. This is especially so if the house is well insulated. Any opportunity to reduce hot water use has the dual effect of reducing energy use and mains water use. Total mains water use can be reduced through a correct installation and careful use. Some plumbing works require specific skills and should only be undertaken by competent persons.

MATERIALS AND TOOLS

Any necessary pipe and cylinder insulation, controls and wiring. Any plumbing tools required. To fit insulation a sharp knife and glue and/or foil tape. Other items named below.

METHOD

Key considerations in reducing energy use for hot water are the efficiency of the boiler and cylinder (if present), the effective control of the heating and hot water to minimise wastage, and minimising hot and cold water usage through correct selection of taps and provision of user information.

PIPES

Insulate all water pipes in uninsulated spaces. Where possible, insulate hot water pipework running to taps with the same insulation regardless of location. Ensure that hot pipes are separated from cold water pipework and arrange with cold pipes below and hot pipes above. Ensure that pipework penetrations through the airtightness red line are sealed to the building to prevent air movement.

HOT WATER CYLINDERS

Ensure that any existing hot water cylinder is insulated with the best jacket, try two 60mm or 80mm jackets on top of each other. Even rigid foam insulated tanks can be fitted with additional insulation. Use appropriate controls like the Honeywell Sundial plan with a 7 day programmer to provide hot water at suitable times. Set hot water cylinder thermostat to 55ºC, this is sufficient if hot taps and shower are close enough to the cylinder. Where water tanks and cylinders are present legionella management systems may be in place and should be referred to.

PLUMBING AND WATER

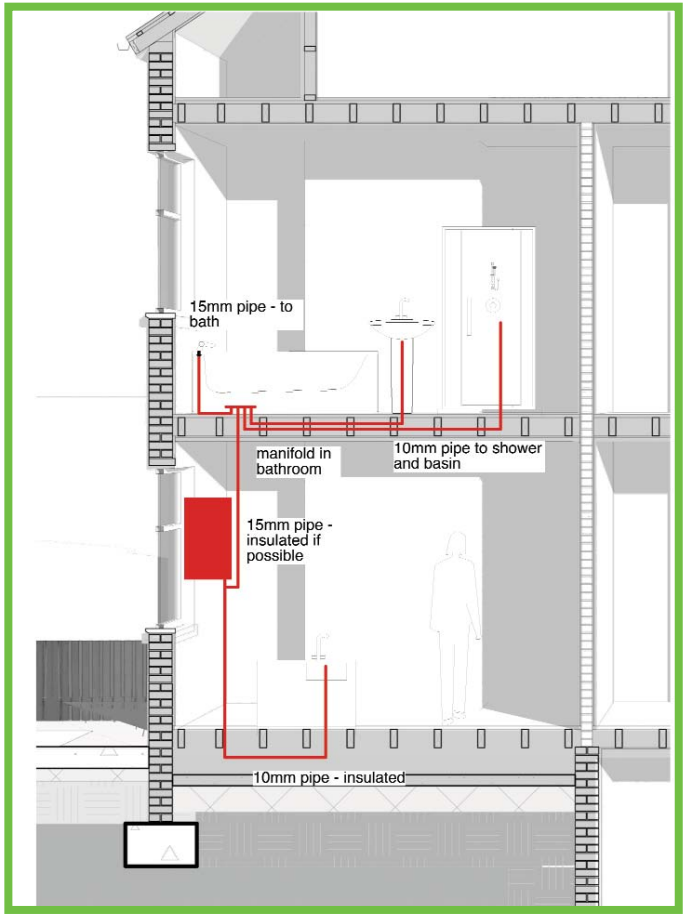
For health reasons instigate a lead service pipe replacement and new connection to the mains. This is a free service if not already completed, however you will need to lay the new 25mm MDPE pipe from inside the house though the garden to the boundary with the street. Call Yorkshire Water helpline on 0845 124 2424 for more information.

Ensure mains supply to a combi-boiler is fed from a dedicated 15mm pipe and use 22mm where it is a shared pipe. Mains pressure hot water cylinders require 22mm.

For hot water pipes from boiler and cold water to bathroom use a manifold system with 10mm plastic pipe to shower and basin taps, and 15mm to bath unless the mains pressure is very low (static less than 1bar) in which case use 15mm to all. Smaller pipes take less time to deliver hot water and therefore less water is wasted running taps.

RAINWATER

For a rainwater collection system use a Wisy rainwater harvesting downpipe filter-collector and draw water into the water storage tank in the basement. Use a Multigo pressure pump to extract stored rainwater to the washing machine and the toilet. A maintenance free mains water top-up unit provides automatic mains water back-up supply with a type AA air-gap preventing direct connection between mains water and untreated rainwater.



Water piping with manifold

LOW WATER USE

A++ rated washing machines and dishwashers tend to also use less water. Check the label for water use figures and compare.

Use new low flow taps, or add in-line inserts or low flow heads. These should be rated at 2.5 litres per minute to the wash hand basins, 4 litres per minute to the kitchen tap and 8 litres per minute to the shower head, but remember a low flow shower spray head is also required. Robert Pearson & Co. do a range of heads and inserts.

Ideal Standard toilets have a 2.5 / 4 litre dual flush that minimises water use.

Use a bath mixer with a hand held shower-head to allow hair washing.

Used bathwater can be diverted to an outside water butt with a 'Watertwo' diverting valve for watering the garden. Keep stored water in the shade.

D094

RELATED TOPICS

Heating systems

OVERVIEW

Where there is any opportunity to make additions or alterations to the heating system the measures detailed should be incorporated. Key considerations are the efficiency of the boiler and effective control of the boiler to minimise wastage.

MATERIALS AND TOOLS

Any necessary plumbing and electrical tools and parts. Pipe insulation, heating controls, wiring. To fit insulation a sharp knife and glue and/or foil tape. Plumbing and electrical works are a skilled trade and should only be undertaken by competent persons.

Recommended equipment list for new items:

Boiler	Vaillant ecoTEC plus 831 + any necessary flue kit + weather compensation controls (if funds allow)
Programmable room thermostat	Honeywell CM927 (wireless) or CM907 (wired) or Sundial Pack 5 for houses with 4 bedrooms or more providing 2 zones.
Radiators	Stelrad Compact P+ or K2
Thermostatic radiator valves	Oventrop 15mm Uniset Pro TRV c/w head 118 85 84 and 15mm Combi 3 lockshield valve Code 109 83 62
Pipe insulation *Minimum specifications*	Armaflex Armacell 19mm thick or Armaflex Tubolit 20mm thick Kingspan Kooltherm 15mm thick sections. *9mm 'tubolit' type is completely inadequate, and plastic pipework needs as much insulation as copper pipe.*

METHOD

BOILER

Where boiler replacement is considered use 'A rated' combi boiler as listed above or preferred model. Ideally the boiler should have options for weather compensation, control via remote room thermostat and modulating burner. Locate the boiler as close as practical to most frequently used hot taps i.e. kitchen sink and bathroom basin to keep the pipe runs short, ideally less than 4m.

PIPES

Insulate all pipes in uninsulated spaces. Where possible insulate heating and hot water pipework running to radiators and taps.

Ensure that hot pipes are separated from cold water pipework and arrange horizontal runs with cold pipes running below and hot pipes above.

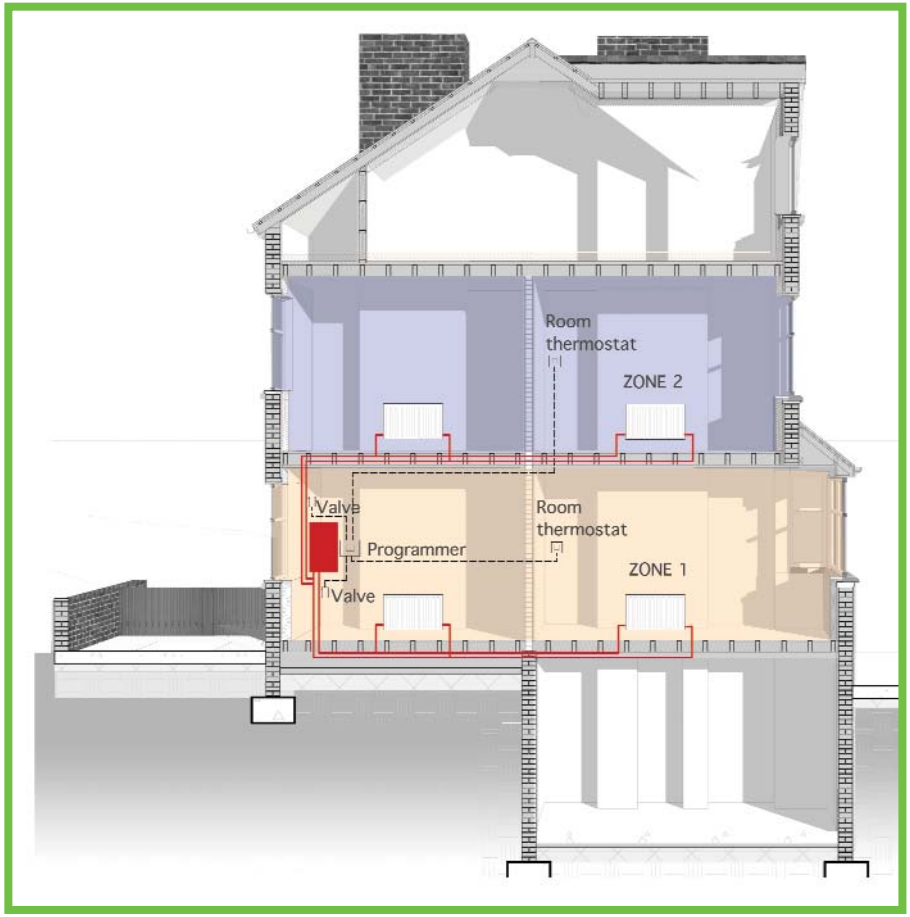
Ensure that pipework penetrations through airtightness red line are sealed to the building to prevent air movement.

ZONING

Heating zones are different parts of the house that are heated independently. This is useful as normally the downstairs and upstairs of a house are used at different times of the day and can then be heated to different times and temperatures.

RADIATORS

Over sized radiators can provide higher boiler efficiencies. Where replacing a radiator use a heat loss



Heating system using zones

calculation to provide sizing, and select radiator on 60ºC flow and 45ºC return temperatures to improve boiler condensing efficiency. This means multiplying the heat output required by 1.4 before selecting the radiator.
Use thermostatic radiator valves on all radiators except those in rooms with a thermostat.

CONTROLS
Ideally locate the room thermostat in the most used room in the house. For example, if the hall is cold and draughty then locate the thermostat in the living room. If the house is airtight then locate the thermostat in the hall.
Correctly set up boiler controls by turning off 'comfort function' and 'legionella control' default settings if present. These functions are not normally relevant for domestic properties unless there is specific reason to enable these.
Set any weather compensation to 60ºC flow at 0ºC outside and 30ºC flow at 20ºC. If weather compensation is not included then use 55ºC or 60 ºC max flow to match correctly sized radiators (or existing radiators if thermal improvements have been made to house). Aim to set the boiler temperature as low as possible to improve condensing in the boiler.
Set the programmable room thermostat to correct settings and instruct the occupants as to how to set the controls. Always leave a user guide and an electronic copy for reprinting.
Explain that temperature setting is room target temperature, not heat output – and setting it higher will not warm the rooms up more quickly, but will result in more energy used and higher gas bills.
Set combi boiler hot water flow temperature to 47ºC, this is sufficient if hot taps and shower are close enough to the boiler, but ensures maximum boiler efficiency.

Rigid pipe insulation

D096

RELATED TOPICS

Appliances

OVERVIEW

The energy consumption of the appliances often provided by a landlord (washing machine, fridge, freezer and oven) account for 50% of a typical households electrical consumption. Landlords can make a difference to the energy bills of their clients by careful selection of these products, and advice on how to use them efficiently.

WASHING MACHINES

An E rated washing machine is only half as efficient as an A rated washing machine, so it is worthwhile selecting the most efficient washing machine for the available budget. Providing the washing machine complete with a sticker advising the selection of a 30ºC or 40ºC temperature wash, a faster spin speed to reduce the necessary drying, and reducing the number of washes, by always washing with a full load could also improve occupant behaviour.

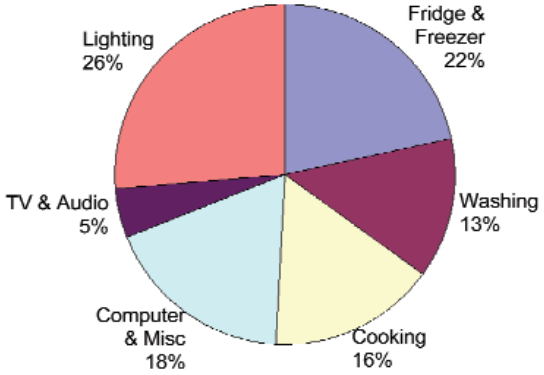
FRIDGES AND FREEZERS

The energy rating of fridges and freezers are a good indication of the efficiency of the appliance, however, the best way to compare them is to use the kWh/year rating, as this gives a pure indication of how much energy the appliance uses without reference to its size or how it defrosts. As these appliances run all the time all year round, significant savings can be made by improving the energy rating.

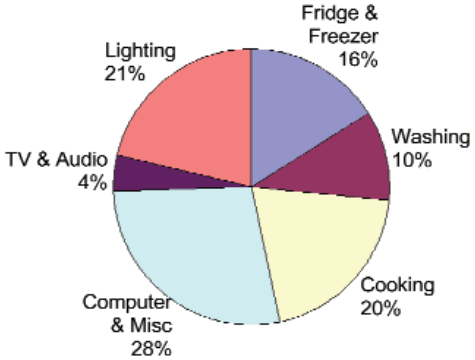
OVENS AND HOBS

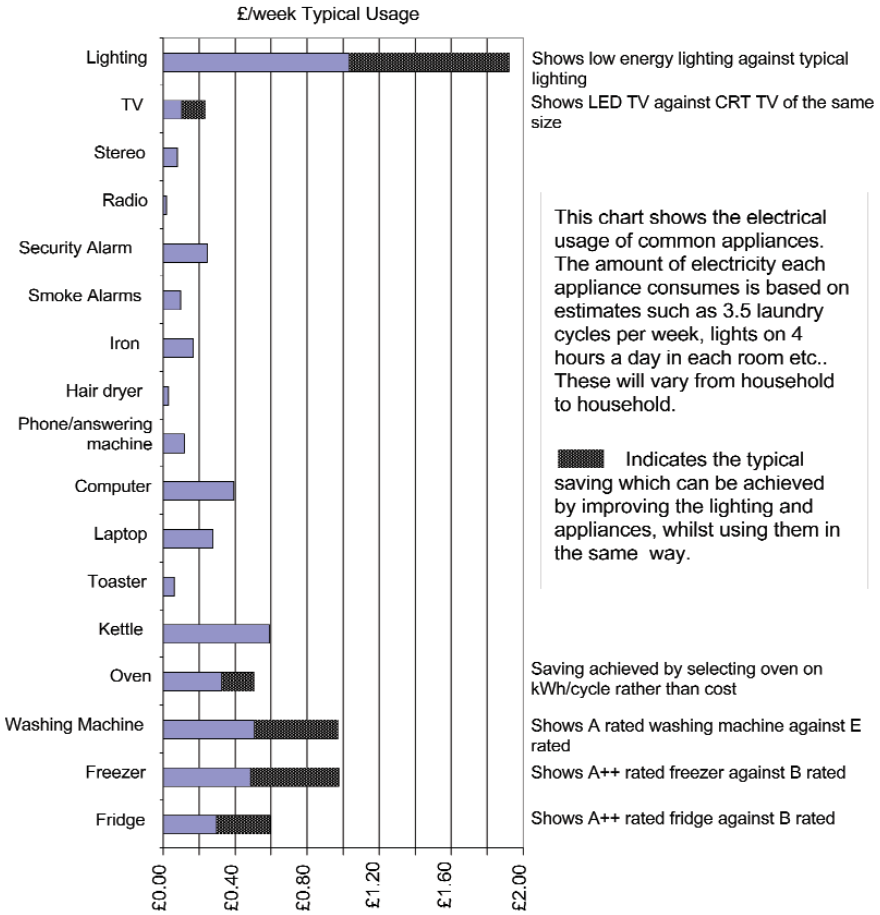
Select the oven based on the comparing the kWh/cycle figure against the best on the market. At the time of writing a good oven would use 0.74 kWh/cycle, whilst a poor one would use 1.19 kWh/cycle. Of the electric hobs, induction hobs are the most energy efficient at 90%. Gas is cheaper and less carbon intensive, but requires adequate ventilation and produces water vapour as it burns.

Typical Electricity Use £7.27 a week



Improved Electricity Use £4.79 a week





	EFFICIENCY	ESTIMATED COST TO BOIL 2 LITRES WATER
Induction Hob	90%	£0.027
Halogen Hob	60%	£0.040
Electric Coil	55%	£0.044
Gas Hob	50%	£0.015

D200

WALL ELECTRICS

Extending the electrical connections Part 1

OVERVIEW

Electrical connections on a wall to be insulated must have their wires extended so that they can still be used after the insulation is fitted. These connections can include mains sockets, light switches, fused connection units and wall lights. In some cases it is possible to pull additional wire out of the wall and no new wire will therefore be needed.

To extend the wiring involves making a connection that conforms with BS7271 (17th Edition Wiring Regulations). The connectors used must either be certified as zero-maintenance so that they can be sealed into the wall or an access way must be left to be able to get to the connections.

There is an opportunity to change the position of the electrical sockets and add new sockets.
The use of conduit to contain long cable runs is required to avoid surrounding the cable with insulation.

As this is an electrical alteration Part P of the building regulations applies and works should be carried out by a competent person.

These instructions do not cover cookers, showers or other high amperage devices.

HEALTH AND SAFETY ISSUES

Any work on electrical systems must be done by a competent person. It is also important to turn off the power before any work is done. Good communication between the workers on site is important so that everyone knows which circuits have been turned off.

MATERIALS AND TOOLS

Phase1: Screwless connectors. Earth wire sleeving. Mains cable. Silicone sealant. Insulation tape.
Phase2: A set of templates to make the cut outs in the insulation and the plasterboard (see appendix).
A bradawl. Spirit level. Adhesive aluminium tape. An oscillating "multi-cutter" power tool will be found useful.
Dry lined wall back boxes (typically 35mm deep). Socket and switch fronts. Conduit. Long blade knife.

METHOD

PHASE 1 – PREPARING THE EXISTING SOCKET
Make the electrical circuit that is being worked on safe. Remove the faceplate and disconnect the wires. Without damaging the wire attempt to pull out some extra wire (Fig 1).

Suitably rated mains cable should always be used. These wire extensions should be around 400 to 500 mm in length. This length is required to make it easy to pass the cable extensions through the insulation as it is fitted.

Use the screwless connectors to remake the ring main and also connect in the extension wire (Fig 2).
With a plastic strap fasten the extension cable securely to one of the incoming cables in the back box (Fig 3).

Apply some silicone sealant to the connectors to make them watertight. Carefully settle the wiring and connectors back into the existing recess (Fig 4). Measure the location of the centre of the socket relative to the floor and the nearest wall (Fig 5). Record this information for later.

Make the wire extensions safe and then reconnect the power to the mains circuit.

Fig 1: Remove the socket front and prepare the wires for the screwless connectors

Fig 2: Remake the ring and connect in the extension wire using the screwless connectors

Fig 3: Secure the extension wire to the existing wires with a cable tie

Fig 4: Carefully tuck the wires into the old back box

Fig 5: Measure and record the location of the centre of the old back box

Fig 6: Drill a hole in the PIR board for the wire

Extending the electrical connections Part 2

METHOD CONTINUED

PHASE 2 – FITTING THE PIR BOARD

This task is done as the PIR board is being fitted ie when a PIR board is about to cover an electric point. Measure the position on the PIR board where the electrical cable is to appear. Make a hole through the insulation layer in the required wire location - just large enough to pass the conduit through (Fig 6). A long 25mm wood bit and power drill will make this easy and neat.

Bring the PIR board back onto the cutting table face up. Use the larger of the templates to mark the position of the recess for the back box (Fig 7). Then swap the first template for the smaller template ensuring that the registration holes line up (Fig 8). Now mark the position of the removable PIR section 5mm in from the aperture in the smaller template (Fig 9). Use the long knife to cut this piece out (Fig 10) and then remove 30mm from the front face (Fig 11). Cut a length of conduit the same depth as this smaller piece and insert it into the cable hole.

This removable piece allows access to the connections in the old back box should this ever be necessary.

Now use a knife / "multi cutter" tool to cut the rest of the recess in the main PIR board to a depth of 30mm using the larger cut line drawn using the first template (Fig 12).

Without re-inserting the removable piece the large PIR board can now be attached to the wall (this is described in a section D026). Slide the removable piece of PIR board over the cable and locate it in its original place in the main PIR board (Fig 13).

Use aluminium foil tape to remake the vapour control barrier. Do this by sticking lengths of tape around the sides and back and overlapping onto the original surface (Fig 14). Deep fill the hole around the wire with silicone sealant (Fig 15).

Record the position of the template registration hole – i.e. the distance from the nearest wall and the height from the floor.

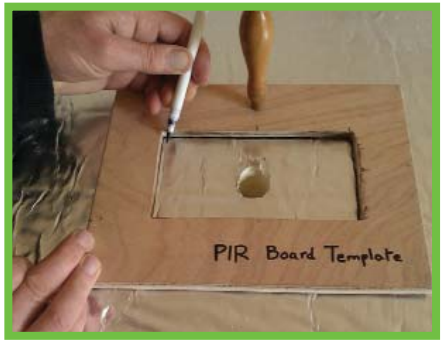


Fig 7 : Mark the cut out for the recess in the PIR board

Fig 8: Swap the template and use the same registration hole

Fig 9: Mark the cut line for the removable PIR piece

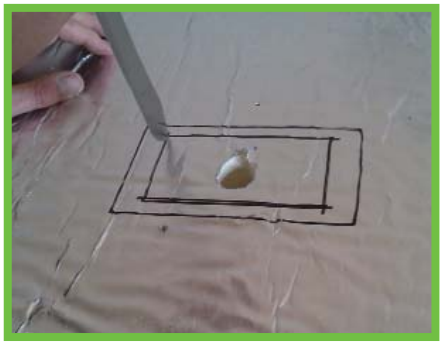


Fig 10: Use a long knife to cut out the removable piece

Fig 11: Cut 30mm from the front of the removable piece

Fig 12: Cut the rest of the recess to a depth of 30mm

Extending the electrical connections Part 3

METHOD CONTINUED

PHASE 3 – FITTING THE PLASTERBOARD

This task is done as the plasterboard is being fitted. Measure where the electrical cable is to appear through the plasterboard. Make a hole through the plasterboard large enough to pass the wire extension through. Pass the wire through the hole and fix the plasterboard to the wall. The wall can now be plaster skimmed or the remainder of this phase can be done straight away.

When the skim has dried sufficiently, make the electrical circuit that is being worked on safe. Mark the position of the template registration hole onto the plasterboard using the location recorded earlier for the first template. Use the smaller of the templates to mark the position of the cut out for the back box (Fig 16). Make the cut out with a "multi cutter" tool or hand tool (Fig 17). This will line up with the recess made in the front of the PIR board in Phase 2 above. Fit the back box and connect the socket front (Fig 18)

The procedure for other types of electrical connections is similar to that described above for sockets. When the new fittings are safe reconnect the power to the main circuit. Test the electrical circuit.

TYPICAL USAGE AND TASK DURATION

Phase1: Three screwless connectors per socket. Time per socket is around 15 minutes.
Phase2: Time per socket is around 20-30 minutes.
Phase3: Time per socket is around 10 minutes.

Fig 13: Fix the PIR board to the wall over the extension wire. Slide on the removable piece containing the conduit. Fit this piece back into the hole.

Fig 14: Use aluminium tape to reform the vapour barrier at the back of the recess

Fig 15: Deep fill the space around the wire with silicone sealant.

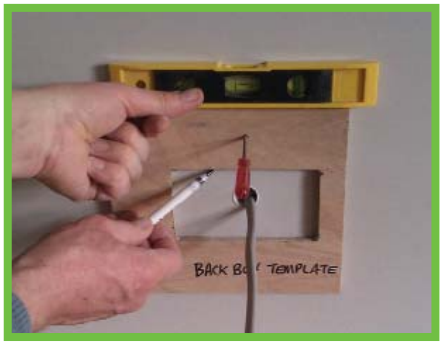


Fig 16: After the plasterboard is fitted mark the registration hole and use the smaller template to mark the position of the new back box.

Fig 17: Cut out the hole in the plasterboard for the new back box

Fig 18: Fit the back box and connect the socket front plate.

SECTION E

APPENDICES

E001

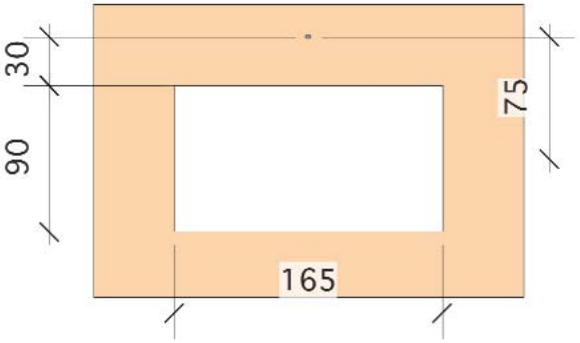
APPENDICES

Tools and Materials and where to obtain them

ITEM	SOURCE	TYPICAL COST (SPRING 2012)
TOOLS		
Face mask (FFP2 disposable)	Toolstation 93297	£1.00
Face mask (FFP2 reusable)	Screwfix 13038	£20.00
Face mask (FFP2, powered respirator, changeable filters)	Toolpost Ref: PCLTUK	£200.00
Insulation saw - "Celotex"	Toolstation 35217	£12.50
LED Lighting string	Screwfix 71341	£70.00
LED work light	Screwfix 26886	£30.00
Plasterboard cutting tool - “Blade Runner”	Toolstation 40440	£40.00
Power tool - Bosch “Multi Cutter”	Screwfix 55824	£110.00
MATERIALS		
Acoustic sealant (900 ml)	Toolstation 29734	£3.95
Acoustic sealant applicator gun	Toolstation 74611	£11.50
Adhesive – EverBuild Solvent Free “Pink Grip”	Toolstation 74548	£2.10
Adhesive foam – Trade applicator gun	Toolstation 75661	£15.15
Adhesive foam (can)	Toolstation 60449	£7.95
Aluminium foil tape (45m x 75mm)	Toolstation 81953	£8.20
Cable conduit – large (25m x 100mm)	Jewson DRLHH069 (land drain)	£40.00
Cable conduit – small (50m x 25mm)	Toolstation 47607	£19.80
Cleaner for foam applicator guns	Toolstation 30658	£3.50
Foam underlay (thermal break) (1m x 10m)	Toolstation 10881	£10.00
Low expansion foam (can)	Toolstation 66044	£5.00
Metal strapping / fixing band (10m x 12mm)	Toolstation 39724	£3.30
Pipe insulation for 15mm pipe (25mm thick wall)	Screwfix 10943	£2.00 / m
Pipe insulation for 22mm pipe (25mm thick wall)	Screwfix 94992	£2.60 / m
Plastic mesh (1m x 5m roll)	Shrubs.co.uk 172516-IS	£29.00
Radiator foil - the flexible type with foil on both sides.	Toolstation 97767 Screwfix 76477	£3.00 £14.00
Rawlplug type insulation fixings	Rawlplug Kl140/Kl180/Kl220N	Approx £0.50 - £1.00 each
Regular expanding foam (can)	Toolstation 27912/57280	£4.50
Sanitary sealant (tube)	Toolstation 50747	£2.05
Screwless connectors Eg https://www.wagobox.com/shop/pushwire/	Wago 4-Port Pushwire Terminal Block	Box of 20 approx £2.00

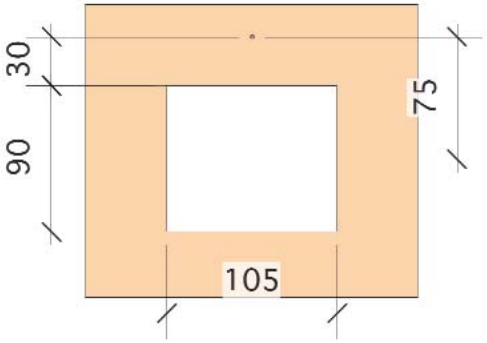
Dimensions of the electrical back box cut outs

DOUBLE SOCKET

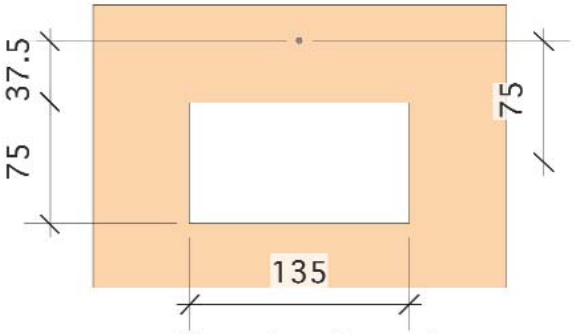


PIR board template

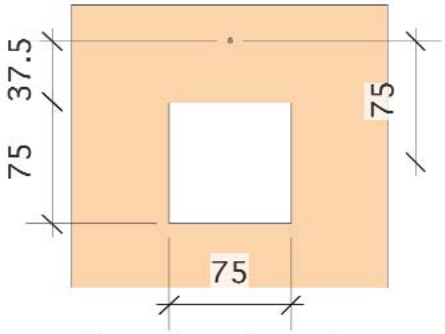
SINGLE SOCKET



PIR board template



Plasterboard template



Plasterboard template

References

The following material is available via download from the Internet:

An introduction to low carbon domestic refurbishment – Construction Products Association
http://www.constructionproducts-sustainability.org.uk/buildings/domestic-refurbishment/a-guide-to-low-carbon-domestic-refurbishment/

A Trainer Resource Manual for Insulation and Building Treatments Manuals TRM 152/1 to 6 – CITB Construction Skills
http://cutcarbon.info/what-can-i-do/green-deal-training-and-qualifications/?&gclid=CLztnYHC164CFQeFDgodVROccw

The following websites have excellent materials and case studies for reference:

http://retrofitforthefuture.org/ - Low energy Building Database including all of the Retrofit for the Future best practice demonstration projects

http://bob.instituteforsustainability.org.uk/knowledgebank/retrofitguides/guide-6/Pages/6.1--Introduction.aspx The Institute for Sustainability have a large information resource including this Section 6 on Improving the Fabric

http://www.energysavingtrust.org.uk/Professional-resources/Housing-professionals/Existing-housing
The Energy Saving Trust has a wealth of resource to offer. The following are some of the most relevant examples:
Sheffield Eco Terrace Study – (CE322)
Sustainable Refurbishment Guide (CE309) with House Comparison Set (CE330)

http://www.energysavingtrust.org.uk/In-your-home/Energy-Saving-Trust-Recommended-products
A selection of recommended products for providing energy saving.

http://www.tzero.org.uk/Homepage.aspx The T Zero website has an interactive tool for selecting and comparing energy efficient options for individual homes

http://timsa.associationhouse.org.uk/default.php?cmd=210&doc_category=98 TIMSA guidance for achieving compliance with Part L of the Building Regulations – includes comparison tables.

Regulatory:

Approved Document B: Fire safety - Volume 1: Dwelling houses
Approved Document F: Ventilation
Approved Document L1B: Conservation of fuel and power (Existing dwellings)
Approved Document J: Heat Producing Appliances
Approved Document P: Electrical Safety

Domestic Heating Compliance Guide

This manual aims to provide guidance on how to substantially improve the thermal performance of the fabric of the existing housing stock with particular reference to a typical Victorian terrace house type found in Leeds but also in many other parts of the UK.








VERY LOW CARBON BUILDING IMPROVEMENTS FOR LEEDS VICTORIAN TERRACE HOMES

A GUIDANCE MANUAL

This Manual was commissioned by Leeds Action to Create Homes (LATCH) and is a collaboration with SURE Solid Wall Insulation and Leeds Environmental Design Associates (LEDA)