Energy Efficiency Best Practice in Housing

Internal wall insulation in existing housing

A guide for specifiers and contractors

- Cost-effective
- External wall appearance maintained
- Easier to install and maintain than external cladding
- Readily available materials

Introduction

The aim of this Guide is to help specifiers and contractors decide when and how to use insulated internal dry lining on the walls of existing houses. Following a brief consideration of the relative merits of internal dry lining, cavity fill and external cladding, the Guide describes and illustrates the four basic types of insulated dry lining. This is followed by detailed information on the factors that will influence the choice of insulation and installation method.

Why insulate?

- increased comfort
- reduced maintenance
- reduce costs for inhabitants
- beneficial for the environment.

Where to use it ?

In general, cavity fill is the most cost-effective way to improve the insulation of brick or masonry cavity walls (for details, see 'Cavity wall insulation in existing housing' GPG 26).

On solid walls, insulation can be improved by installing either internal dry lining or external cladding. In most cases, a dry lining is preferred because it costs less to install and maintain, with no scaffolding or special skills required. It also has advantages that materials are readily available and the building's external appearance is maintained.

Internal wall insulation is especially suitable when it is installed:

- as part of a refurbishment that involves the disruption of internal surfaces and fixtures
- in multi-storey buildings where access for external insulation would be expensive
- in buildings with an attractive external appearance and/or in conservation areas
- in high thermal capacity structures that have problems of condensation and mould growth.

Where not to use it ?

Internal insulation may be inappropriate where:

- ornate plasterwork or wood panelling needs to be retained, and/or the interior appearance is protected under a listed buildings order
- it is difficult to avoid thermal bridging (see Design Considerations pages 7-10)
- walls are unsuitable because of rain penetration or the risk of summer condensation
- room sizes are too small to accommodate the reduction caused by the thicker internal lining
- the disruption of fixtures or services would be excessive
- the cost of disrupting or temporarily housing the occupants is too great.

In the above circumstances, alternative forms of insulation will need to be considered and insulation may need to be increased in other areas.

Regulations

Building regulations for the thermal insulation of walls vary between the nations. Advice should be sought from building control in the local authority. Copies of regulations are available from the Stationery Office, see page 11 for details.

SAP Ratings

The Standard Assessment Procedure (SAP) is an energy rating which estimates the space and water heating costs (based on the size of the property and its heating and hot water system) and converts them into a rating on a scale from 1 to 120. The higher the number, the lower the energy consumption. The SAP rating can be used to compare the relative benefits of different energy efficiency measures.

'The Government's Standard Assessment Procedure for the energy rating of dwellings. 2001 edition' (available from www.bre.co.uk/sap2001 or telephone 0845 120 7799).

Methods

Internal Insulation Methods

The main internal insulation methods are described below. However, the manufacturer's instructions should be referred to for precise details of fixing to backgrounds of different strengths, wetness and material.

Method 1

Plasterboard thermal laminate, incorporating a vapour control layer between the plasterboard and insulation, fixed in a variety of ways:

- secured to the wall with adhesive (figure 1)
- screwed to metal furrings bonded to wall with plaster dabs (figure 1)
- nailed or screwed to timber battens fixed to the wall
- nailed or screwed to timber framed walling (figure 2)
- screwed to smooth dry walls.

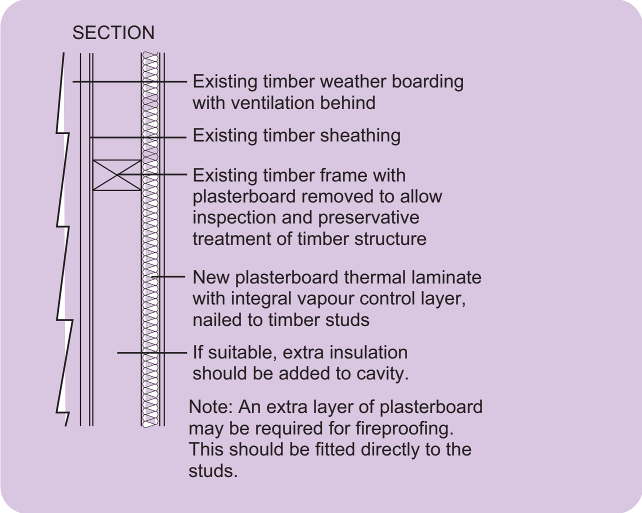

Figure 2: Timber framed external wall with plasterboard laminate

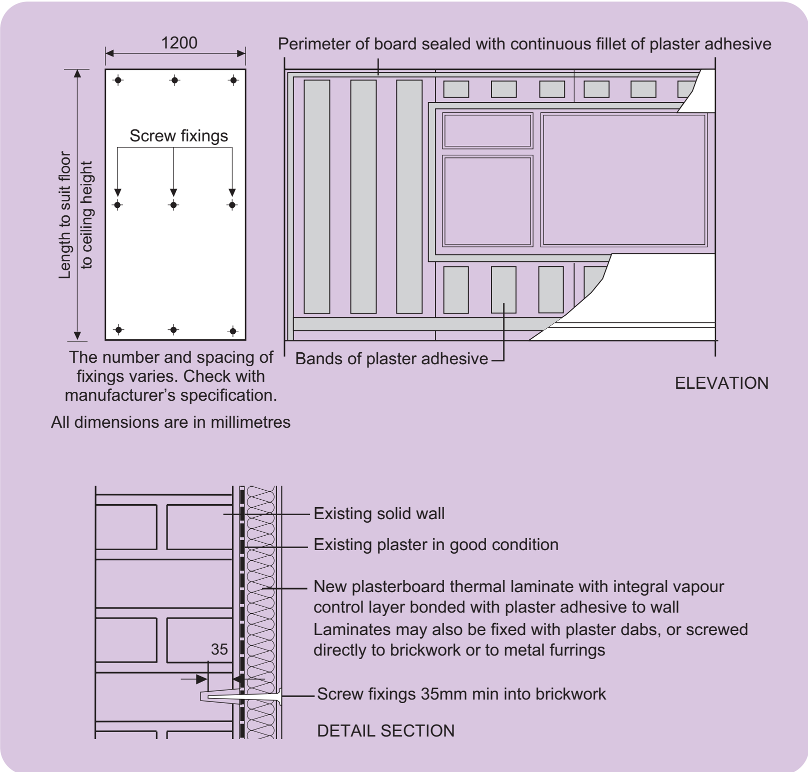

Figure 1: Plasterboard thermal laminate

Method 2

Rigid insulation, friction-fitted between battens, fixed to the wall then covered with a vapour control layer or with flanged paper-faced quilt insulation, incorporating a vapour control layer stapled to battens, then finished with plasterboard (figure 3).

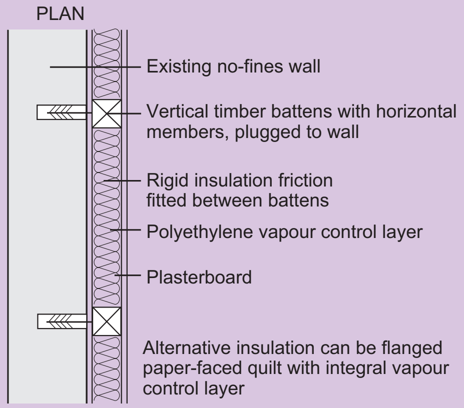

Figure 3: Timber stud frame inside solid no fines wall

Method 3

Timber frame, braced between the floor and ceiling and kept clear of the external wall. Insulation stapled to the frame with a vapour control layer and plasterboard finish (figure 4).

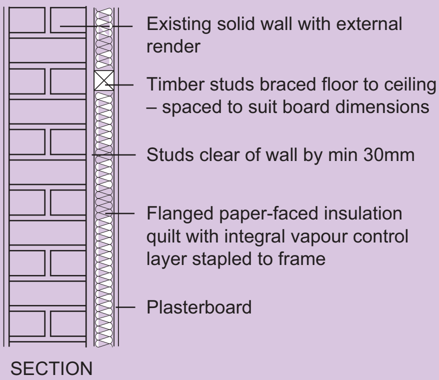

Figure 4: Insulation fitted to battens

Method 4

Aluminium-faced polyethylene air bubble sheet on horizontal battens, fixed to the external wall, with vertical counter-battens, fixed over the insulation to receive the plasterboard finish (figure 5).

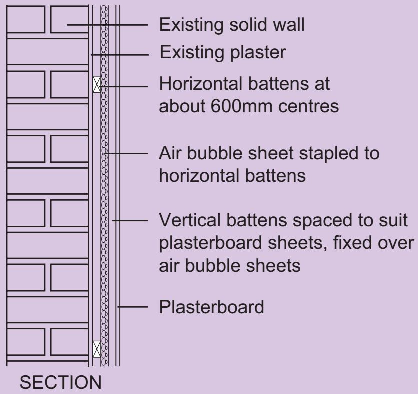

Figure 5: Polyethylene air bubble sheet

Choice of Method

There is a wide range of insulating materials available for dry lining using the four basic methods covered in this guide. Indicative properties of insulating materials are set out in table 1, and table 2 gives U-values of typical construction (page 6).

Adhesive fixing (sub)

Where the wall is dry and has a sound finish of plaster or concrete, laminate boards can be fixed directly to the wall with an adhesive recommended by the board manufacturer. The adhesive is normally applied in 200mm wide bands approximately 50mm from the vertical edges and in the centre of the board. Bands of adhesive are also applied around the periphery of the wall and window to ensure continuous contact at the edges of the boards. To prevent collapse in the event of fire, boards that incorporate insulation made from plastics should be secured with screw fixings and fixed at least 35mm into the solid background. The number of fixings required will be specified by the board manufacturer; some will require nine fixings, and some only two. Positioned as shown in figure 1 on dry, even walls, mechanical fixing may be used without adhesive, subject to manufacturers' recommendations.

Plaster dab fixing

If the wall is uneven, for instance where it has been stripped of plaster, bonding thermal laminate to the wall with plaster based adhesive dabs or strips is a suitable method providing the wall is dry. The perimeter of the wall and the surround of any openings, such as windows, must be sealed with a continuous band of plaster adhesive to restrict air movement into the building. This would otherwise reduce the thermal effectiveness of the insulation.

It is important that sufficient adhesive is used for the perimeter seals to make continuous contact with both the wall and insulation. Mechanical fixings, as for adhesive fixed boards, are also needed.

Fixing to metal furrings or timber battens

Walls that are uneven can also be insulated, by first fixing metal furrings or preservative-treated timber battens to the walls and then screwing, or nailing, thermal laminate onto them. All four edges and the centre of the laminate require support. This method is suitable for walls that are temporarily damp (following treatments for rising damp, after curing rain penetration, or after taking measures to reduce condensation).

Non-traditional buildings, constructed with internal timber or metal frames, can also be insulated by nailing thermal laminate directly onto existing timber (provided it is in good condition) or onto a timber frame supported by the metal frame. Existing vapour control layers, if retained incorrectly within the construction, may cause condensation within the structure and should be removed. For this reason, the components of the existing wall (including any residual insulation) should be determined and a condensation calculation carried out, taking into account all the layers of the final construction.

Insulation between battens

Walls can be insulated between vertical timber battens, commonly 50mm wide and at least the thickness of the insulation, fixed to the wall at centres to suit the width of plasterboard. The boards should be supported by battens at the floor and ceiling, and by intermediate noggings at the middle of the board. All timber should be preservative-treated. Rigid insulation boards can be fitted between the battens or flanged paper-faced quilt insulation can be stapled to the battens. A continuous vapour control layer should be fixed on the warm side of the insulation. This layer may be a separate polyethylene sheet stapled to the battens or incorporated within the flanged paper facing to rolls of insulation (figure 3).

Constructing a separate inner lining

If it is difficult to achieve a secure fixing to the wall, or if the wall is damp, an independent timber or metal inner frame can be constructed leaving a cavity behind the external wall. The frame, supported at floor and ceiling level, is usually 50mm x the thickness of the insulation preservative-treated timber, or metal channel and I-sections dimensioned to take plasterboard laminates. Insulation is fixed (as in 'Insulation between battens') between the timber studs, and covered with a vapour control layer and plasterboard or, for additional thermal performance, a thermal laminate incorporating a vapour control layer (figure 4).

Air bubble sheets

This system is suitable for most walls. The air bubble sheet is fixed to horizontal preservative-treated battens plugged to the external wall. The bubble sheet is then fixed to this framework taking care to lap and welt or tape joints between sheets of the material.

Vertical battens are fixed over the insulation at appropriate centres to support the plasterboard. Plasterboard fixed in contact with the insulation without the secondary battens is less thermally effective and is not recommended (figure 5).

Choice of Method

Table 1: Typical properties of insulation materials

Materials	Density (kg/m^3)	Approximate Thermal Conductivity (W/mK)
Insulants for plasterboard laminates		
Glass and mineral wool	50	0.038
Polystyrene bead board	16	0.038
Polystyrene extruded	35	0.030
Polyurethane	30	0.025
Polyisocyanurate	30	0.025
Phenolic foam	45	0.025
Insulants for battened dry lining		
Glass and mineral wool	15–30	0.040
Multi-layer foil faced bubble, polyethylene	–	N/A

Note: Properties of material from individual manufacturers may vary from those given above.

Table 2: Thermal insulation values of typical internally insulated walls

Material	Insulant Thickness (mm)	U-Value (W/m^2K)
Polystyrene bead board	Nil	2.10
220mm solid brick wall, insulated with polystyrene bead board,	30	0.71
laminated to 9.5mm plasterboard, fixed with plaster dabs.	40	0.60
	60	0.46
	70	0.41
Mineral wool quilt	Nil	2.76
200mm no-fines concrete wall insulated with mineral wool quilt	40	0.82
between timber battens fixed to the wall and covered with	60	0.62
12.5mm plasterboard. (Includes a correction to	80	0.52
allow for thermal bridging through the battens.)	100	0.41
Phenolic foam	Nil	1.22
325mm concrete sandwich panel (incorporating 18mm 20	20	0.56
polystyrene insulation) insulated with phenolic board laminated	30	0.46
to 12.5mm plasterboard and bonded to the wall with adhesive.	40	0.39
	50	0.34
Bubble sheet	Nil	1.44
288mm cavity brickwork insulated with air bubble sheet on	With bubble sheet	0.57
battens covered with counterbattens and plasterboard.		

Design Considerations

Choice of insulation materials

Where possible, use materials that are HCFC and HFC free. Many plastics insulants now satisfy this criterion. It is recommended that checks are made with the manufacturer regarding HCFC, HFC content of their products. If possible use non-ozone depleting (ODP) materials (see Environmental Considerations on page 11).

Before starting any work, a detailed inspection of existing timbers for dry or wet rot and insect attack should be carried out. Decayed timbers should be replaced. Dry rot must be eradicated by appropriate treatment to timbers and walls and all replacement timber should be preservative-treated. Guidance is given in BRE Digest 299 Dry rot: its recognition and control and BRE Digest 345 Wet rot: recognition and control (details are given on the back page), on treatment of timbers and the need for removing sources of moisture and providing adequate ventilation so that further rot does not occur.

Existing internal finishes

Check that the wall is dry and, if it is not, take whatever remedial action is required to make it so. Dampness may have various causes, including leaking pipes or overflows, or faulty damp proof courses and cavity trays. If the dampness, including mould, is caused by condensation, the dwellings may require improved ventilation and heating in addition to insulation.

Solid walls in older housing types may have plaster on timber laths and battens. The batten fixings are likely to have been damp and rotted and usually will not be sound enough to take any further thermal lining. Plaster, lath and battens should therefore be removed and an insulated dry lining system installed. Solid brickwork and stonework may be damp from rain penetration. External pointing or rendering can reduce damp penetration, but if there remains any doubt, the best method of internal insulation is to construct an inner frame of timber or metal at least 30mm clear of the masonry wall and insulate it as described under method 3.

Plaster or fibreboard linings to timber or metal framed walls should also be removed to check the condition of the structure and to allow rot or corrosion treatment of the frames. Insulation can be placed within the frame. An additional insulated lining can also be fixed over the frame.

It is normally suitable to apply thermal laminates directly to plastered cavity walls but ensure that the plaster is not loose and that any broken plasterwork is patched. Thermal linings can also be applied directly to self-finished large panel construction.

Thickness of insulation

Internal insulation reduces the size of rooms by the thickness of the insulation system. Most rooms can accept this reduction, but it can be critical in bathrooms, WCs and small kitchens. Critical room dimensions can influence the choice of insulation. Thermal laminate wall boards bonded by adhesive to the wall take up the least space with the thickness of the laminate added to adhesive of 3mm to 10mm, whereas a timber stud frame kept clear of the wall will intrude at least 90mm.

Exposure of wall to wind driven rain

Dry lining should not be used to isolate dampness. The source of dampness must be cured and the walls allowed to dry. Solid walls should be examined for signs of dampness and assessed to determine what systems would be suitable. When assessing whether the wall is suitable for internal insulation, refer to BS 5628: Part 3 2001 Code of Practice for use of masonary materials and components, design and workmanship (see page 11 for details), for guidance on resistance to weather (with the exception of no-fines concrete). Solid walls subject to very severe driving rain should be externally clad. For conditions assessed as severe, brickwork at least 328mm thick, rendered dense aggregate concrete blockwork 250mm thick, or autoclaved aerated concrete 215mm thick may be suitable for dry lining. A notional cavity is needed behind the dry lining to provide a break in any moisture transmission path.

Design Considerations

Interstitial condensation

All internal insulation methods must incorporate a vapour control layer on the warm side of the insulation to reduce the risk of interstitial condensation. A vapour control layer can be achieved by the use of polyethylene sheet, treated paper facing to mineral wool quilts, or by an integral layer, eg. in thermal laminate boards. In all cases, the weak points are at the joints between the sheets or boards and where pipes or other services penetrate the lining.

Careful attention should be paid to the sealing or lapping of joints and sealing around penetrations. Plasterboard manufacturers supply a plasterboard primer which helps control vapour penetration at the surface of the board but this should be assumed to be an addition to and not an alternative to, polyethylene sheet or an integral vapour control layer. For damp, south-facing masonry walls less than 250mm thick, the cavity between the new frame and wall should be ventilated to the outside to prevent summer condensation (see BR 262 Thermal Insulation: avoiding the risks, see back page for details).

Sealing for air leakage behind dry lining

To ensure that the insulated dry lining will perform thermally as intended, it is important that the wallboard is sealed with adhesive or battens around its perimeter with adjoining walls and partitions, floor and ceiling. It must also be sealed around windows, doors and other openings. If the seal is omitted or incomplete, cold air from the space behind the insulation can leak into the room and reduce the effect of the insulated lining. Any gaps behind the new insulated dry lining (particularly when used for upgrading flats) should be sealed to stop the circulation of cold air, to restrict acoustic transmission, and to prevent the spread of fire and smoke. After ensuring that adequate sound deadening and fire stopping has been provided (check requirements of national building regulations), the flooring and ceiling board should be taken as close to the wall as possible, and the remaining gap filled with a continuous seal of plaster. The plasterboard lining to timber frames should be sealed around the ceiling, wall and skirting perimeter with plaster, and the skirting should be set on a flexible seal (figure 6).

When dry lining plastered or self-finished concrete walls any gaps or major cracks should be filled to avoid air leakage into the dwelling.

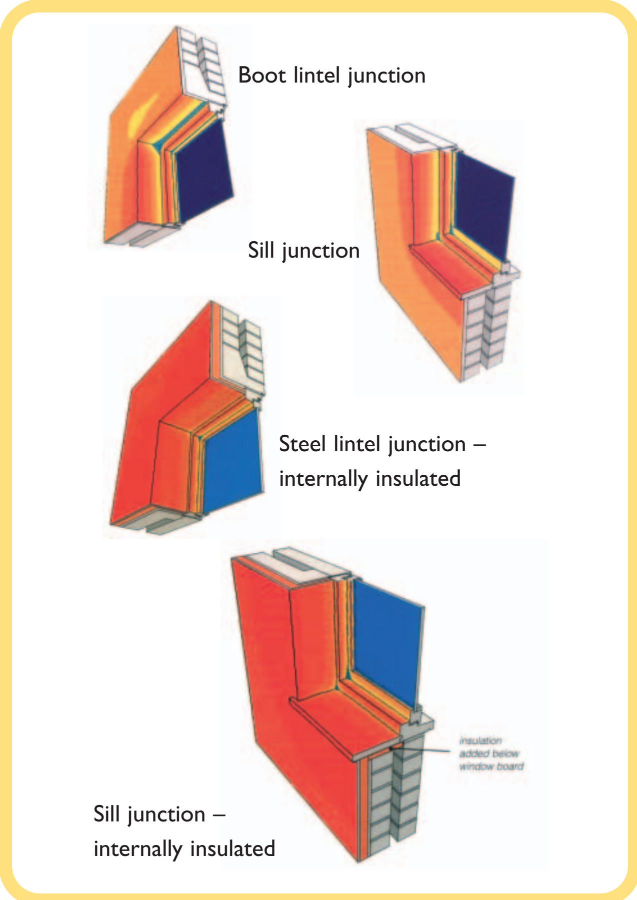

Figure 7

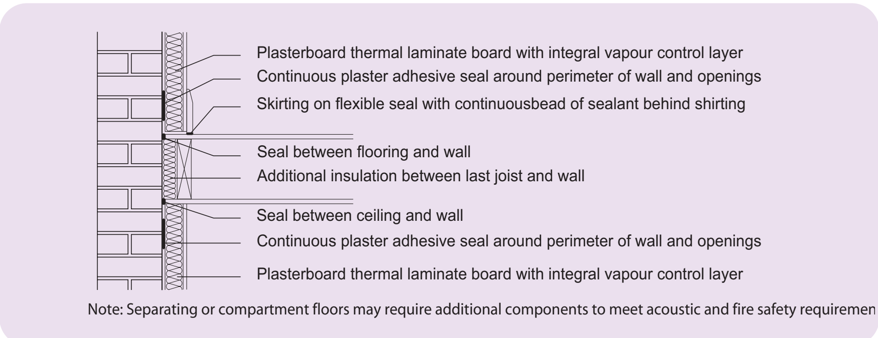

Figure 6: Timber stud frame in existing flats

Dry lining window and door reveals

Window and door reveals can be sources of condensation and mould if not insulated but, if the amount of visible window frame is too small, the full thickness of the insulated dry lining cannot be applied. If this is the case an insulated window lining board, eg. expanded PVC, can be used. Ensure that the lining does not restrict ventilators. It may be necessary to hack off the existing plaster to accommodate an adequate thickness of insulation (figure 7).

If windows are to be replaced the new jamb and soffit details can be designed to accept the insulated lining. The sill board should generally also be insulated and will need to be deep enough to cover the edge of the wall insulation. Architraves and skirtings will need to be removed and refitted. Make sure that doors will open properly after the insulation has been fitted.

Thermal bridging

Thermal bridging will occur whenever there is a break in the continuity of the insulation. This often occurs at the junctions of solid external walls with internal walls (figure 8), where concrete floor edges are exposed on the external face of the building (figure 9), and at projecting balconies, etc.

Thermal bridging results in a loss of heat and a risk of condensation and mould growth. Stepped and staggered terraced housing (common in post-war years) can also present problems of thermal bridging, when the construction is of single leaf no-fines or foamed slag concrete.

The effect of thermal bridging in these conditions can be reduced by returning the dry lining about 1m along the internal wall and continuing it 300mm along the ceiling soffit.

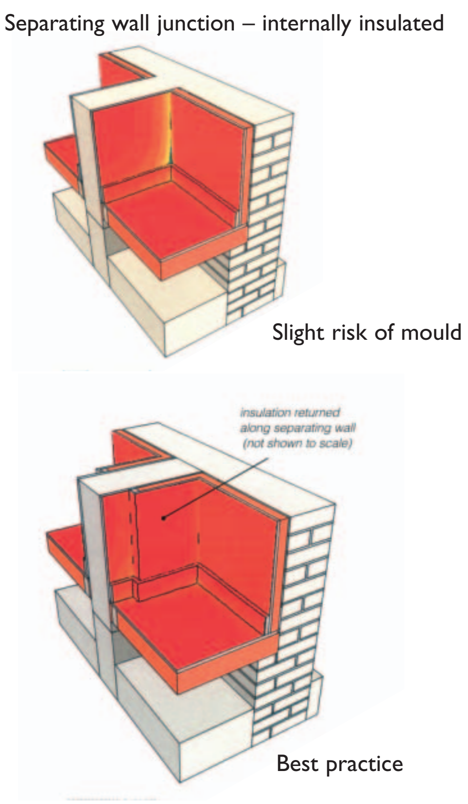

Figure 8

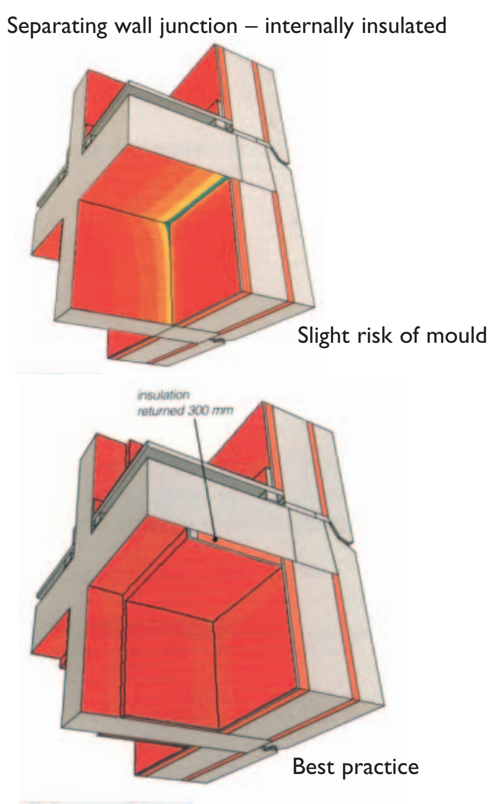

Figure 9

Design Considerations

The depth of the insulated return can sometimes be conveniently contained in a small room but in larger rooms it is usually more aesthetically and practically acceptable to extend the insulation to the whole length of the internal wall. If the whole ceiling is being battened out and the floor above the ceiling is not being insulated, the ceiling insulation should only extend 300mm from the external wall.

Supports for fitments and fixtures

The position of any fitment or fixture (kitchen or storage fitments, sanitaryware, boilers, radiators, etc.) that needs to be fixed to the wall, must be identified before dry lining is installed and adequate supports provided.

Provision of services

The penetration of the vapour control layer by services should be avoided wherever possible. Where possible, service outlets should be re-located on adjoining internal partitions.
Where services do penetrate the vapour control layer, ensure that the hole is well sealed with vapour resistant tape or silicon sealant. Services should be installed before dry lining starts.

Dry lining, based on a framing system, can ensure adequate space for locating most wires or pipes. Where laminates are bonded to the wall, the space behind the insulation board may be inadequate, making it necessary to cut a channel either in the wall or in the insulation.

Avoid contact between PVC-insulated electrical wiring and polystyrene insulation, as this can cause the PVC sheathing to age prematurely. Cables covered by insulation should be protected by cover strips, to prevent overheating and reduce the risk of short-circuiting and fire. The rating of cables that are routed through the insulation should be increased. For example, cables serving cookers, shower units and other appliances with high electrical loads will require larger cabling. Other circuits do not normally exceed their current-carrying capacity when covered with insulation. More detailed guidance is given in BS 7671 Requirements for electrical installations: IEE Wiring Regulations Sixteenth edition (details on page 11).

Sound transmission

When the insulation is returned along a separating wall, care should be taken to maintain an acceptable level of sound reduction between dwellings. The use of plastic thermal laminates returned along masonry walls can, due to resonance in the lining, show a marked reduction in sound insulation. Where sound insulation is important, a mineral wool thermal laminate wallboard should be bonded directly to the wall surface. Alternatively, an independent timber frame, fixed clear of the wall at floor and ceiling only, should be used. The frame should be infilled with glass or mineral wool batts 50mm thick. The frame should, preferably, be covered with two layers of 12.5mm wallboard with joints staggered.

Environmental Considerations

The Green Guide to Housing Specification (Anderson and Howard, BRE, 2000) provides a useful reference for construction products, giving A,B,C environmental ratings for over 250 specifications. This definitive guide, developed over 20 years and supported in its current form by the National House-Building Council (NHBC), is predominantly based on life cycle assessment data from the DETR-supported BRE Environmental Profiles scheme. The Guide contains an extensive list of references to all of its sources of data.

The use of insulation in the building fabric will significantly reduce the operational environmental impact of the building over its lifetime. This benefit will outweigh the embodied environmental impact of the insulation materials. To minimise the embodied impact however, specifiers should avoid foam insulation materials that use blowing agents which cause ozone depletion or global warming, such as HCFCs or HFCs. Alternative blowing agents such as carbon dioxide or pentane are less environmentally damaging.

For best overall environmental performance, look to renewable or recycled materials such as cork, recycled cellulose, flax or sheep's wool, foams blown using pentane or CO_2 and low density mineral wool or glass wool, all of which have high ratings in the Green Guide to Housing Specification and have similar insulation properties to mineral wool and expanded polystyrene. Lower density glass and mineral wools should be used in preference to denser ones where possible, as their environmental impact increases proportionally with their weight.

Standards and Regulations

British Standards Institution
389 Chiswick High Road, London W4 4AL.
Tel: 020 8996 9000
Web: www.bsi.global.com

British Standards (BSI)
To order BSI standards telephone 020 8996 9001.

BS 8211: Part 1:1988. Energy efficiency in housing Code of practice for energy efficient refurbishment of housing

BS 8212: 1995 Code of practice for dry lining and partitioning using gypsum plasterboard

BS 5628: Part 3: 2001 Code of practice for use of masonry materials and components, design and workmanship

BS 7671: 1992 Requirements for electrical installations - IEE Wiring Regulations Sixteenth edition

The Stationery Office
The Stationery Office, London
Tel: 0870 600 5522
Web: www.tso.co.uk

Regulations (National Details)
These documents can be obtained from The Stationery Office, London www.tso.co.uk/bookshop.

- The Building Regulations 2000 (England and Wales) Part L1 are set out in The Building Regulations 2000, Approved Document L1 Conservation of Fuel and Power
- The relevant Building Standards for Scotland are set out in The Building Standards (Scotland) Regulations 1990, 6th amendment, Technical standards to Part J, Conservation of Fuel and Power
- The relevant Building Standards for Northern Ireland are set out in Building Regulations (Northern Ireland) Part F Conservation of Fuel and Power

Good Practice Guide 138

Energy Efficiency Best Practice in Housing

Internal wall insulation in existing housing

Further reading

Energy Efficiency Best Practice in Housing
The following publications are available from the Energy Efficiency Best Practice in Housing helpline on 0845 120 7799 or by visiting the website at www.est.org.uk/bestpractice.

Good Practice Guides (GPG)
Cavity wall insulation in existing housing (GPG 26)

Energy efficient refurbishment of existing housing (GPG 155)

Minimising thermal bridging when upgrading existing housing (GPG 183)

BRE
The following are available from www.brebookshop.com
Tel: 01923 664262
Email: brebookshop@emap.com

Reports
Thermal insulation: avoiding risks (BR 262)

Improving the habitability of large panel system dwellings (BR 154)

Assessing traditional housing for rehabilitation (BR 167)

Green Guide to Housing Specification (BR 390)

Digests
Dry rot: its recognition and cure (Digest 299)

Wet rot: recognition and control (Digest 345)

Defect Action Sheets
External walls – dry lining; avoiding cold bridges (Design) (DAS 78)

Solid external walls: internal dry lining – preventing summer condensation (Design) (DAS 133)

Good Building Guides
Choosing between cavity, internal and external wall insulation (GBG 5)

Outline guide to assessment of traditional housing for rehabilitation (GBG 6)

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