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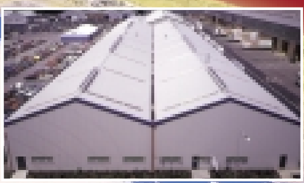
Energy Efficient Buildings
Retrofit Solutions



BRUFMA

Contents

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Mr Tom McGuinness
BRUFMA President

BRUFMA is a UK based Trade Association which represents the rigid polyurethane insulation products industry.

Executive Summary

Huge improvements can be made to the energy efficiency of buildings by ensuring that the optimum level of insulation is installed. The benefits of using the most thermally efficient insulation are not only limited to big reductions in energy bills but for many companies minimising heat loss forms an integral part of their strategy to limit the environmental impact of their business and also reduce the size of their Climate Change Levy payments.

Recent changes to the Building Regulations/Standards will ensure that new constructions comply with a demanding energy efficiency specification but retrofitting existing buildings is also crucial and legally required by the new regulations when carrying out a major refurbishment or change of use. One of the key aims of the Climate Change Levy is to encourage businesses to improve the level of insulation in buildings.

This document discusses the background to the drive for improved energy efficiency, gives details on retrofit applications utilising optimum solutions such as cavity wall insulation, spray applied polyurethane insulation, internal insulated linings, external insulation boards and linings and polyurethane insulated panels. Studies quantifying the significant improvements that have been achieved are presented. These stem largely from the fact that many industrial buildings and associated equipment are not insulated at all.

A further document detailing insulation solutions for new build is also available from BRUFMA [reference 1].

The document describes how everyone benefits from adopting the most thermally efficient insulation:

- businesses significantly reduce their costs;
- the impact of industry and commerce on the environment is minimised;
- home owners and occupiers dramatically reduce energy bills and
- the Government delivers on their greenhouse gas emission targets.

Furthermore, all the solutions advocated in this document are in compliance with the English, Welsh, Scottish and Northern Irish Regulatory requirements for fire.

Roof spraying externally with PUR insulation

Retrofitting a roof with PUR boards

Retrofitted roof with PUR panels

Introduction

Climate change is one of the most serious environmental threats facing the world today. The UK has a target to reduce its greenhouse gas emissions by 12.5% below 1990 levels by 2008 to 2012 following agreement of the Kyoto Protocol in December 1997 and a subsequent meeting of the European Union in June 1998. The Government and the devolved administrations also have a domestic goal to cut emissions of carbon dioxide by 20% below 1990 levels by 2010. The Government and the devolved administrations have developed a Climate Change Programme [Reference 2] to set out how the UK plans to deliver its Kyoto target and move towards its domestic goal.

A major contribution to delivering these targets is the reduced carbon dioxide emissions achieved by improving insulation, either of new constructions or of existing buildings through retrofit action.

New Building Regulations

The new Building Regulations Approved Documents L1 & L2 (Conservation of Fuel and Power) and the Technical Standards Part J both introduced in 2002[References 3, 4 and 5], ensure that all new constructions are built to increased insulation requirements which are characterised by greatly reduced U-values.

In domestic housing, for example, the required U-value (measured in $W/m^2.K$) for roofs insulated at rafter level has been reduced from 0.35 to 0.20. For non-domestic roofs, an even greater improvement has been stipulated and U-values for roofs have gone from 0.45 to 0.20. In both domestic and non-domestic applications, walls are now required to have a U-value of 0.35 in England and Wales and 0.30 in Scotland as opposed to 0.45 previously.

A separate BRUFMA document entitled

Building Regulations for the Conservation of Fuel and Power
Impact Assessment

addresses issues related to new buildings and the new regulations [Reference 1]. The aforementioned document also discusses the requirements in the case of alteration of a building or a change of use.

Climate Change Levy

The Climate Change Levy (CCL) has been devised by the UK Government as a fiscal route to encourage UK industry and commerce to use less energy. Although it is essentially a tax on all non-domestic energy use, the CCL is not intended to increase the tax burden but to promote improvements to energy efficiency.

The levy is charged on all energy supplied to industrial, commercial and agricultural users, as well as publicly administered services. Individual businesses make payment through utility bills and it is the energy supplier who registers with and pays the levy to Customs and Excise.

The amount of levy payable is based on the quantity of fuel supplied rather than its value as for VAT and varies depending on fuel type. The rates for each type of fuel are as follows:

- electricity – 0.43 pence per kilowatt hour;
- natural gas – 0.15 pence per kilowatt hour;
- solid fuel e.g. coal and coke – 1.17 pence per kilogramme and
- liquid petroleum gas for heating – 0.96 pence per kilogramme.

Depending on the mix of fuels used, the CCL could significantly increase individual business's energy bills if no action were taken. The Government's Enhanced Capital Allowances (ECA) scheme provides financial support to companies who wish to invest in energy saving technologies [Reference 6]. However, improving the actual insulation and air tightness of buildings dramatically reduces heat loss and minimises heating costs. Heating constitutes a large percentage of many businesses energy use.

Retrofit Applications

Insulation products can be of enormous benefit when used in the following applications:

- cavity wall insulation;
- external spraying of polyurethane on roofs;
- internal spraying of polyurethane insulation;
- application of insulation boards and lining products both internally and externally and
- refurbishment using metal faced insulated roof and wall panel systems.

Insulation Products

Insulation products fall mainly into three classes:

- Mineral derived – mineral wool, glass wool, vermiculite, cellular glass;
- Oil-derived – rigid cellular plastic foam insulations - polyurethane (PUR), polyisocyanurate (PIR), phenolic, polystyrene and
- Plant/animal derived – cellulose, cotton, flax, wool, cork.

In choosing the optimum insulation product for a particular situation it is not only important to consider initial thermal efficiency requirements but also to consider how well this initial thermal performance is maintained over the long term. Thus it is not only necessary to establish the saving achieved initially but is also a legal requirement under the European Construction Products Directive (CPD) [Reference 7] to maintain this performance for 25-50 years.

The efficiency of loose fill fibrous products may suffer in the longer term due to "settling" of the product which can leave areas bereft of insulation. The tendency of these products to settle may be exacerbated by vibration and moisture uptake. When inorganic fibrous insulation products are exposed to moisture ingress their thermal performance is immediately degraded.

Because of their closed cell nature, rigid cellular plastic foam insulation products are resistant to moisture ingress. Also they do not settle. Their insulation efficiency (as measured by their low thermal conductivities even after ageing) is significantly better than those of their plant, animal or mineral derived competitors. Polyurethane, polyisocyanurate and phenolic offer the lowest thermal conductivities of all the cellular plastic insulation products.

PUR and PIR are by far the most versatile of these products and in most retrofit applications represents the only practical insulation solution.

Table 1 Thermal Conductivities of common insulation products

Insulant	Typical Thermal Conductivity (W/m.K)
Phenolic	0.018-0.028
PUR/PIR	0.022-0.028
Extruded Polystyrene	0.029-0.039
Expanded Polystyrene	0.034-0.037
Rock Mineral Fibre	0.034-0.040
Glass Mineral Fibre	0.037-0.044
Urea Formaldehyde	0.040

Table 1 compares typical thermal conductivities of commonly used insulation products. A lower value means better thermal performance and consequently reduced insulation thickness to meet a specific performance requirement.

Combining the benefits of very low thermal conductivity, versatility in application and long-term consistent performance, makes PUR/PIR insulation the optimum solution for most retrofit applications.

Cavity Wall Insulation

Buildings with traditional cavity wall construction have great potential to have their thermal performance improved by filling the cavity with an insulating product. In some cases where the cavity already contains an insulant but it has failed due to settling or moisture ingress, it may be possible to remove the failed product and replace it with a more suitable alternative.

In general, installation of cavity wall insulation involves a site inspection by a qualified installer or application expert to assess the suitability of the walls and plan the job. The actual installation entails drilling holes in the external leaf and injecting the insulating product. Mineral fibre and polystyrene beads can be blown into the cavity. In the case of polyurethane insulation, two reactive liquids are mixed and the resulting foam system is injected into the cavity where it expands to form a rigid low density insulating foam with excellent adhesive and structural properties. The foam bonds the inner and outer leaves together and thus eliminates the problem of wall-tie failure.

Insulation Performance

Table 2 compares the improvements that can be achieved by installing the various cavity wall insulating products at a cavity thickness of 50 mm in the conventional cavity wall. The lower the U-value the better the insulation performance.

Table 2 Possible improvements in U-value of cavity walls

Insulating Product (Thermal Conductivity W/m.K)	U-value (W/m².K)
None	1.50
PUR (0.025 W/m.K)	0.40
Mineral Fibre (0.039 W/m.K)	0.57
Expanded Polystyrene beads (0.037 W/m.K)	0.55
Urea Formaldehyde (0.040 W/m.K)	0.58

Based on 102.5 mm inner and outer brickwork with 50 mm cavity.

Clearly major improvements can be achieved and since a large percentage of a building's heat loss is through its walls, the installation of cavity wall insulation will cut the cost of heating dramatically. Polyurethane insulation offers the optimum performance of all the insulation options.

Inserting the PUR foam system into the wall cavity

Benefits and Features of Injected Polyurethane Insulating Systems

They:

- provide the best thermal performance of all practical full cavity insulants;
- ensure continuity of insulation and don't settle;
- give a useful life in excess of 50 years with a constant thermal performance;
- eliminate the risk of water penetration;
- are resistant to moisture ingress;
- provide wall stabilisation, especially useful where wall ties are failing or have failed;
- have a British Standard specification and code of practice for their installation (References 8 and 9);
- are installed by experienced specialist contractors with no disruption to the occupants or other ongoing activities;
- are BBA approved for use in any exposure zone;
- are non-fibrous;
- do not harbour pests or vermin and
- have no geographical restrictions.

Some Additional Points

Mineral fibre insulants used for cavity wall insulation can be affected by settlement which can leave areas of the wall uninsulated. They are also affected by moisture uptake, which degrades thermal performance. A 1% change in moisture content by volume in mineral fibre insulants can reduce their thermal performance by between 75% and 105% (Reference 10).

Because of its hydrophilic nature the use of urea formaldehyde insulation is restricted by its British Standards (References 11 and 12) to areas of the country where the levels of wind driven rain are minimal.

Ensure that contractors installing cavity wall insulation are fully qualified, work according to British Standards and use BBA approved systems.

Upper surface of injected PUR foam in masonry cavity

Case Study – Kirkgate House, Rydecroft

The use of polyurethane cavity wall insulation at Kirkgate House, a high rise block of flats in Edinburgh, was the major contributor to a massive improvement in energy efficiency of the building and a marked reduction in heating bills following its refurbishment in 1990. The building continues to provide residents with warm, economical and structurally sound accommodation. The full details of this refurbishment are given in reference 13.

A similar high rise block of flats, Rydecroft, was retrofitted by the Liverpool Housing Action Trust (reference 14).

Aerial view of some of the Rydecroft tower blocks retrofitted with PUR cavity insulation.

Image courtesy of Sustain Journal.

Background – Kirkgate House

Kirkgate House is one of eight similar buildings which were constructed with brick and block cavity walls with a 75 mm block inner leaf, a 75 mm cavity and a 100 mm thick outer brick leaf with an external render coating. The flank walls have 180 mm thick cavity infill panels with facing brickwork. Under the living room windows there are lightweight panels. The windows were single glazed in timber frames.

A consultant's report had highlighted the building's poor insulation, raised concern over its structural integrity and identified water penetration problems typical of those frequently occurring in high rise buildings in exposed areas.

A complete over cladding system for the block was contemplated as a solution to the poor insulation problem, however, this option would have resulted in a refurbishment cost in the region of £1 million, which was considered too expensive. After further evaluation, polyurethane cavity wall insulation was identified as the preferred option.

Retrofit Improvements

The walls were insulated by injecting both the 75 mm and 180 mm cavities with polyurethane foam insulation which stabilised the brickwork at the same time.

The panels beneath the living room windows were replaced with new timber-framed aluminium faced panels incorporating 30 mm of polyurethane foam insulation.

Vents were used to replace the original single glazed windows with double glazed U-PVC units with trickle vents.

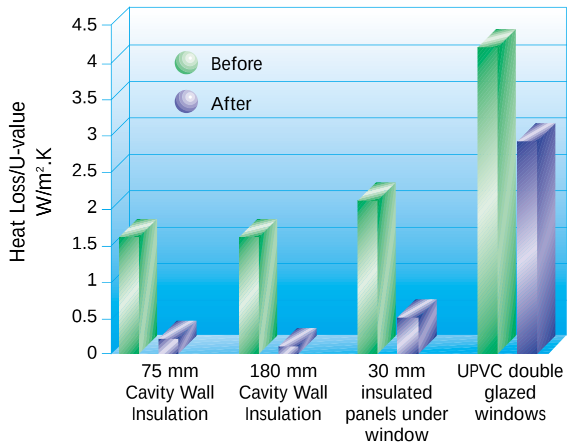
Thermal bridging was minimised by treating parts of the building with aluminium flashings and mineral wool insulation.

In addition, the building was treated with a repair compound to stabilise damaged slab edges, brickwork and concrete sills and then treated with a water-repellent masonry coating.

Costs and Benefits

Table 3 lists indicative refurbishment costs at January 1990 prices. Polyurethane cavity wall insulation constituted only 12% of the overall cost of the project, however as Figure 1 illustrates, its use contributed enormously to reducing heat loss from the building as well as enhancing its structural integrity.

Figure 1. Individual reductions in heat loss



The project as a whole reduced for a mid-floor flat the heating cost from £3.75/wk to £0.85/wk, the heat loss rate from 165 to 98 W/°C and the CO_2 emissions from 7.6 to 5.8 tonnes/year.

Table 3 Refurbishment costs

Retrofit Measure	Total for 64 flats £
Energy-related	
Cavity wall insulation	41,369
Window replacement	122,976
Aluminium flashing and Insulation	61,230
Other	
Preliminaries	68,789
Provisional sums	7,084
Concrete and brickwork repairs	7,075
Protective coatings	35,977
Total	
(costs exclude VAT)	**344,500**

Results – Rydecroft

This similar high rise block renovation was performed by the Liverpool Housing Action Trust which resulted in the following data:

After checking over two years following completion of the renovation:

- National Home Energy Rating (NHER) ratings increased from 7 to 8 to in excess of 9 for individual flats;
- Tenants electricity and gas bills together were reduced by 22.5%;
- This gave an equivalent saving in CO_2 emissions and;
- 15 or 16 tower blocks were similarly refurbished which saved the public purse approximately £8 million at the time.

Spray Applied Insulation

Roofs, agricultural buildings, storage tanks, ducting and pipes are all commonly insulated using spray applied PUR/PIR foams. The work is carried out by experienced contractors who use specialised equipment to mix two liquid components together and spray the mixture (system) onto the substrate. The system undergoes a rapid chemical reaction, expanding and curing to give a continuous layer of insulating foam which bonds onto the substrate.

Spray applied PUR/PIR insulation systems can be applied externally to very uneven surfaces, vertical surfaces and even to the undersides of roofs, ceilings and floors and to the internal surfaces of walls. They are applied in layers of up to 50 mm thick and when thicker insulation is required layers can be applied one on top of the other to reach the final required thickness of insulation. During the process the expanding foam fills and seals any gaps, cracks and open joints thereby improving the air-tightness of the building and often sealing water leaks in addition.

In external roofing applications, with the suitable weather-resistant top protective coating that is normally applied, the high mechanical strength of sprayed PUR/PIR insulation means that it can easily withstand normal foot traffic.

Insulation Performance

Table 4 compares the thickness of insulation of different materials to achieve different U-values.

Table 4

Insulant Material	Thickness (mm) U-value 0.20 W/m².K	Thickness (mm) U-value 0.35 (W/m².K)
PUR/PIR (0.023 W/m.K)	110	65
Extruded Polystyrene (0.034 W/m.K)	165	95
Expanded Polystyrene (0.036 W/m.K)	175	100
Mineral Wool (0.040 W/m.K)	190	110

Based on 1.4 mm steel profiled roof deck on 15 degree pitch with specified thickness of insulation applied externally.

Spray applied PUR/PIR insulation is an extremely versatile and robust method of improving the insulation and energy efficiency of buildings. It offers a unique combination of features and benefits that cannot be matched by any other insulation solution.

Benefits and Features

Spray applied PUR/PIR insulation systems:

- provide the best thermal performance of all available insulants;
- ensure a continuous layer of insulation and eliminates/minimises thermal bridging;
- have a useful life in excess of 50 years;
- are not affected by normal foot traffic;
- can greatly improve air-tightness and reduce heat-loss through air leakage;
- are resistant to moisture ingress;
- are applied according to British Standard specifications and code of practice (References 15 and 16);
- are applied by experienced specialist contractors and
- are BBA approved.

Some Additional Points

Mineral wool flat roof insulants have the potential for incomplete thickness recovery from repeated foot traffic, which would impair the thermal resistance and could result in ponding thereby increasing the possibility of failure of the weathering membrane.

Ensure that contractors applying sprayed PUR/PIR insulation are fully qualified and work according to British Standards.

Check fire performance requirements and ensure that the insulation complies with regulations.

Roof spraying externally with PUR insulation

Case Study – Engineering Factory Roof

As early as 1983, sprayed polyurethane insulation was externally applied to an engineering factory roof. The result was a major reduction in heat loss and substantially lower energy bills.

Background

The factory was used for the manufacture of large precision engineering products and had a total floor area of 19,621 m^2. It consisted of two main sections, one comprising a machine and assembly shop, the other made up of a fabrication shop and a small number of offices.

The walls were a combination of brick, glazing and sheet metal and the average height of the building was 13.6 m. The roof was constructed of protected metal sheeting supported on purlins with patent glazing covering 38% of its area.

Before retrofit measures were undertaken, heating of the factory was supplied by thirty-nine 98.4 kW gas-fired warm-air units mounted at a height of 4 m throughout the factory, and by three 300 kW floor mounted gas-fired warm-air units in the fabrication shop. The factory was also fitted with seventy air recirculating fans to reduce the temperature gradient, but these were seldom used because of the discomfort caused by the high air speeds they generated at ground level.

As the project was part of a Government scheme to demonstrate energy efficiency, energy consumption was monitored before and after the insulation was applied.

Retrofit Improvements

Polyurethane insulation was spray applied directly onto the external surface of the roof metal and glazing to a thickness of 35 mm.

The insulation was covered by spray applied elastomeric coating to give a 0.5 mm thick weatherproof finish.

Original mercury vapour lamps were replaced by 400-watt high-pressure sodium types increasing illumination levels within the factory even though the glazing in the roof had been covered with insulation. Changing the lighting system also contributed to savings and reduced the cost of annual electricity consumption by £12,000.

Costs and Benefits

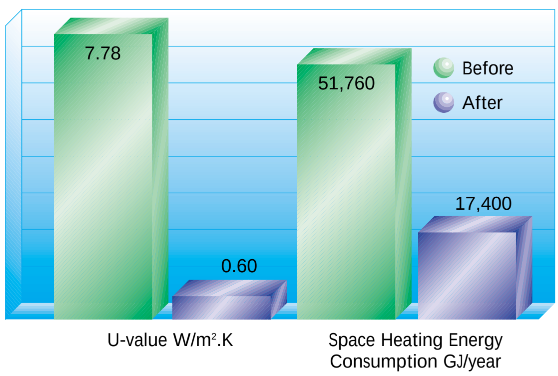
The project costs are detailed in table 5. The net annual savings realised as a direct result of installing roof insulation were estimated at £100,562/year, which means a simple payback period of 2.3 years.

Table 5

Element	Cost £
Roof survey	8,000
Essential repairs	10,000
Insulation and application	208,000
Independent project supervision	9,000
Total	**235,000**
Saving per annum	**100,562**

An improvement in U-value of the roof element from 7.78 W/m^2.K to 0.6 W/m^2.K illustrates the magnitude of the reduction in heat loss as a result of the retrofit insulation. Results from the energy consumption monitoring exercise demonstrated that energy used for space heating following the insulation of the roof dropped from 51,760 GJ/year to 17,400 GJ/year. These benefits are shown graphically in Fig 2.

Figure 2. Retrofit improvements



About two thirds of the original heaters in the factory were permanently switched off following the retrofit action as they were no longer necessary to maintain a comfortable working temperature.

There was no disruption to normal working during the refurbishment as the insulation was applied externally.

Internal Insulated Linings

External Walls

Approximately 45% of the UK's housing stock is of solid wall construction and originates from before 1944, with a significant percentage of that being pre-1919 (Reference 17). Buildings with a solid wall construction or those that are not suitable for cavity fill insulation can achieve significant energy efficiency improvements from the fitting internally of an insulated lining board (rigid insulation with a bonded plasterboard facing).

There are two common ways of fixing the insulated lining board, the first is using plaster-dab or adhesive bonding and the second is to nail/mechanically fix the insulation to timber battens/metal furring system which are fixed to the existing structure. Fixing the insulation away from the wall creates a service zone where electric cables and central heating services can be hidden, but more importantly it prevents any moisture that has penetrated the external skin entering the occupied area of the building.

Ceilings

The use of an insulated lining board on the underside of a ceiling in a loft or sloping roof situation significantly reduces the effects of cold bridging which in turn reduces the thickness of insulation required between joists required to meet the relevant thermal performance.

The fitting of an insulated dry lining board can be carried out by a competent handyman, but it is recommended that professional help or technical advice is sought from the manufacturer regarding cold bridging around any apertures and that a condensation risk analysis be carried out on the proposed construction.

Insulation Performance

Table 6 shows the required insulation thicknesses and therefore the impact on the habitable area of different insulation products bonded to a plasterboard lining. The construction assumes that a 12.5 mm thick plasterboard is fixed to 50 x 20 mm deep battens, which are mechanically fixed to a 215 mm solid brick wall thus creating a service zone. The lower the U-value the better the insulation performance.

Table 6

Insulating Product (Thermal Conductivity λ-value)	**Thickness required to achieve U-value² of** 0.45	0.35	0.30	0.27
PUR/PIR (0.022-0.023 W/m.K)	47.5	62.5	77.5	87.5
Extruded Polystyrene (0.029 W/m.K)	62.5	82.5	97.5	112.5
Mineral Wool (0.040 W/m.K)	77.5	107.5	127.5	147.5

* laminated to a 12.5 mm plasterboard (0.18 W/m.K)

By using thermally efficient rigid PUR/PIR insulation bonded to plasterboard the energy efficiency of a building can be easily and economically improved whilst minimising loss of floor-space.

Benefits and Features of Rigid PUR/PIR Insulated Plasterboard Laminates

- superior thermal performance;
- minimal cold bridging;
- condensation control;
- non-fibrous;
- easy to handle and install and
- BBA Approved.

Retrofitting internally with PUR boards

External Insulation Boards and Linings

External Insulated Render Systems for Walls

Approximately 45% of the UK's housing stock is of solid wall construction and originates from before 1944, with a significant percentage of that being pre-1919 (References 17). Buildings, with a solid wall construction, where internal space is at a premium, or those that are not suitable for cavity fill insulation, can achieve significant energy efficiency improvements from the fitting externally of an insulated lining board and render system.

By improving the appearance and weather-proofing, external insulation and render systems are particularly cost effective when the envelope of the building is in need of upgrading / repair.

There are two common ways of fixing the insulated lining board, the first is using render bedding and the second is to mechanically fix the insulation to the existing structure.

Insulated render systems are proprietary and utilise different mechanisms for attaching insulation to the wall structure, site-work guidance should be sought from the system manufacturer along with comprehensive condensation analysis calculations and robust details on avoiding cold bridging.

Insulation Performance

Table 7 compares the thickness of insulation required to achieve different U-values based on a standard construction of 13 mm dense plaster internally on a 215 mm solid brick wall. It can be seen that PUR/PIR offers the thinnest solution. (No allowance has been made for external render finish).

Table 7

Insulating Product (Thermal Conductivity λ-value)	Thickness required to achieve U-value* of 0.45	0.35	0.30	0.27
PUR/PIR (0.026-0.027 W/m.K)	50	65	75	85
Expanded Polystyrene (0.037 W/m.K)	65	90	105	120
Mineral Wool (0.040 W/m.K)	70	95	115	125

* Reference 18

By using thermally efficient rigid PUR/PIR insulation externally the energy efficiency of a building can be easily and economically improved without sacrificing valuable internal floor area.

Benefits and Features of External Rigid PUR/PIR Products Behind Render System

- superior thermal performance;
- minimal cold bridging;
- condensation control;
- non-fibrous;
- easy to handle and install;
- transforms and upgrades the appearance of existing dwellings and
- BBA Approved Products.

External Insulation for Flat Roofs

There are a number of reasons why a flat roof might be refurbished; the waterproof membrane may have reached the end of its serviceable life or become damaged. It may be that a change of use is intended as occupiers with flat roofs can increase their living space by converting the roof area for use as a terrace or roof garden. Refurbishment is the ideal time to increase the level of insulation.

Commonly the insulation is either fully adhered in hot bitumen or mechanically fixed to the existing deck once a vapour control layer has been fitted.
A waterproofing system is then fitted over the insulation. When mechanically fixing the insulation the effect of the fixings as cold bridges needs to be accounted for in any U-value assessment.

The fitting of the insulation and the waterproofing system should be carried out by fully trained contractors in accordance with the manufacturer's guidelines.

Tapered Roofing Systems

There are many critical factors that must be taken into consideration when refurbishing a flat roof. Two of these, insulation and rainwater run off, can be addressed with a single system: rigid PUR/PIR tapered system.

Tapered systems are available in a range of facings which mean they can be used under most waterproofing systems.

On existing roofs, a series of rigid PUR/PIR tapered boards and a waterproofing system can be laid on top of the original waterproofing providing this is sound. This eliminates the need for stripping down the roof to deck level, and the provision for a vapour check is not required.

The existing insulation/substrate and waterproofing must be sound to provide a satisfactory surface for the rigid PUR/PIR tapered system. In all cases, the risk of interstitial condensation must be fully assessed.

Insulation Performance

Table 8 compares the thickness of insulation required to conform with current building regulations, based on an existing 150 mm concrete deck with a skim coated single layer of plasterboard with an un-vented cavity between it and the deck creating a suspended ceiling. The insulation has been waterproofed with 3 layers of built-up felt which is protected using a layer of mineral chippings. The lower the U-value the better the insulation performance. (No allowance has been made for air gaps or fixings).

Table 8

Insulating Product (Thermal Conductivity λ-value)	Thickness required to achieve U-value* of 0.25	0.22
PUR/PIR (0.027 W/m.K)	95	105
Expanded Polystyrene (0.029 W/m.K)	100	115
Mineral Wool (0.040 W/m.K)	135	160

* Reference 18

The use of high performance PUR/PIR insulation on a flat roof refurbishment is an effective way of improving the thermal performance.

Benefits and Features of External Rigid PUR/PIR

- superior thermal performance;
- minimal cold bridging;
- condensation control;
- non-fibrous;
- easy to handle and install;
- BBA Approved Systems and
- FM Approved Systems.

Benefits and Features of External Rigid PUR/PIR Tapered System

- insulation and drainage in one system;
- no water ponding problems;
- high performance insulation;
- minimal cold bridging;
- no load bearing implications;
- resistant to passage of water and
- lighter than screed to falls system.

Retrofitting a roof with PUR boards

Insulated Roof and Wall Systems

The latest pre-engineered insulated roof and wall cladding solutions for industrial, commercial and RMI (Repair and Maintenance) projects successfully combine aesthetics with a practical approach to construction - reflecting the demands of today's specifiers and regulatory controls. Not only can they be applied to accentuate a building's horizontal or vertical planes but, also, crucially offer the assurance that comes with effective thermal performance, simplicity of site assembly, durability and minimal maintenance.

Refurbishment Matters

The reality is that even before the Building Regulations changed a worrying number of existing structures did not even achieve the old minimum, mandatory, thermal performance levels, a proportion that is sure to grow given the much stricter U-values for roofs now in place under Approved Document L2 and Technical Standard: Part J.

It is in the area of refurbishment that proven insulated roof and wall panel technology is having most impact. There is the potential to transform appearance and enhance property values, and given the current climate of energy conservation/ever-tighter regulation - to realise considerable bottom-line benefits for the occupiers.

The Problem – Before Refurbishment

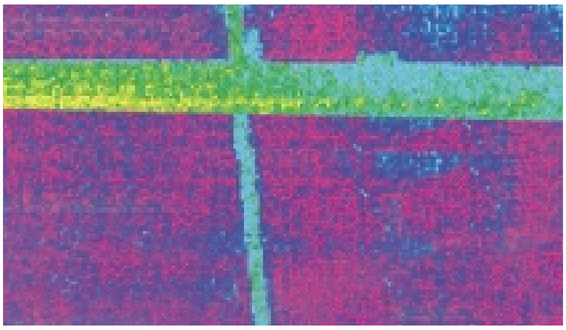
Taking the example of a traditional, single-skin asbestos roof on a twenty year-old building with no insulation, this can lead to problematic interstitial condensation and far from satisfactory working conditions. Added to this is rapid heat loss – obvious in thermographic images - and consequently, heightened energy costs.

Asbestos Cladding to Roof & Wall

Before refurbishment

Assuming an internal temperature of 16 degrees Centigrade for a building with a floor area of 5000 m^2, then the cost of heat losses to the occupiers - through the building fabric - can mount up to £41,000 in just one year.

There is also the question of regular maintenance to be considered. Often older roofs can be fragile and unsafe to walk or work on. The existing roof and wall cladding may be made from asbestos, known in the past for its construction-friendly qualities but now, more usually, associated with health concerns. If this remains in place then companies may be liable for employee risk insurance claims.



Thermographic image of single skin asbestos roof showing lack of insulation and major heat loss.

The external appearance of a building should not be overlooked, as this impacts directly on people's perceptions of the business operating inside.

The Solution – After Refurbishment

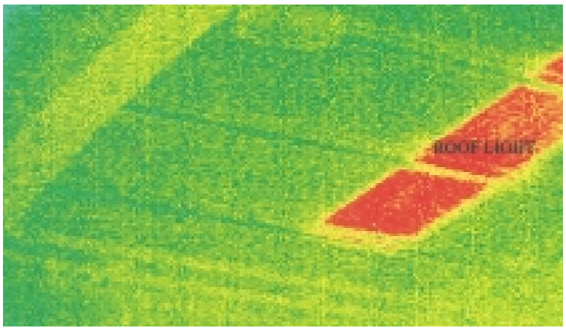
For those who decide to go down the refurbishment route, the results that can be achieved on the roof and walls even from a visual point of view are dramatic.

PUR/PIR Roof and Wall System

Of course, the benefits of adopting an insulated roof panel cladding system are much more than just about aesthetics, a number of other difficulties can be successfully overcome. Given that roofs of older buildings must now attain the same U-value standard as new build when they are to be substantially replaced, an insulated panel system that fully complies with Building Regulations/Standards is essential.

After refurbishment

Now applying this type of energy-friendly solution to the earlier example with a 5000 m^2 floor area, with the benefits of consistent thermal performance, guaranteed U-values and low air leakage, up to £38,000 of heating costs can be saved per year.



Thermographic image of PUR/PIR roof panel showing that the insulated panels are performing well with no air leakage at joints.

Looking at the actual process of installation for builders and contractors tasked with refurbishment, a factory-manufactured single component construction system has significant advantages over built-up alternatives:

- critical, site assembly time can be halved;
- consistent build quality; 25 years to first maintenance cycle;
- panels are supplied as a system with ancillaries, including roof lights and flashings;
- insulated panels' light-weight and strength means that they can be readily fixed to the existing building's structure and
- non-fragile construction means that workers can safely examine the roof, post installation.

Ultimately, by adopting pre-engineered insulated panels for the roof and other critical areas of the building envelope, specifiers tasked with rejuvenating commercial buildings can deliver long-term financial and aesthetic rewards.

Case study – Westway, Glasgow

The first phase of development at Westway - one of Scotland's most important industrial landscapes in Renfrew, Glasgow, is complete. The milestone, which reflects an initial investment of £3 m, also signifies the launch of a new modern approach to industrial and commercial property first introduced by Prestbury West Coast Caledonian Ltd partners, Tom Hunter and Nick Leslau in February 2002.

Insulated panels were used in this large-scale project for the refurbishment of one of the units on the site, the sizes of which range from 10,000 sq.ft to 210,000 sq.ft. Under the direction of project architect, Bob Fletcher of Fletcher Bennett, a new gatehouse, marketing suite, increased security and signage have been completed, together with the refurbishment of Block K, one of the largest buildings on site covering an area of 210,000 sq.ft. Work included a complete re-cladding to elevations and roof, new mechanical and electrical servicing and loading and yard facilities.

Before refurbishment


After refurbishment

The roof of the building is clad in insulated panels in goosewing grey. A high specification system was used with low air leakage properties, thus complying with recently introduced building regulations to reduce energy costs and CO_2 emissions. Being a factory manufactured one-piece component, site installation is significantly reduced by up to 50% against comparable alternative roofing methods. The system offers a reliable thermal performance that eliminates cold bridging and interstitial condensation, and includes an anti-condensation side lap tape for enhanced protection against the elements. One of the system's major benefits is its high-speed site installation, which saves costs in terms of labour and time, invaluable for larger buildings such as at Westway.

For strength and durability, these panels were manufactured to offer the maximum performance. They were made from hot dipped zinc coated steel with a Colorcoat HPS200 Plastisol high performance coating applied to the weatherside of the panel. This is designed to achieve high levels of durability as well as colourfastness and enables the panels to be highly resistant to damage in transit and on-site.

Prestbury Investment Holdings Ltd teamed up with entrepreneur, Tom Hunter's West Coast Capital company to buy Westway, with the plan to turn the site into one of the most innovative industrial and distribution parks available in the UK, with tailor made commercial packages on offer to tenants. The location was a key factor in acquiring the site as it is in close proximity to Glasgow Airport and the motorway and plans have already been approved to build a link bridge directly to the airport.

Says John Whitehurst, managing director of Prestbury Investment Holdings Ltd: "This first phase has been a massive refurbishment of one of Scotland's largest and best known industrial and distribution parks and it was important that the work was carried out cost effectively and on time with products, materials and systems that will prove durable and produce optimum performance."

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A list showing the main applications of Rigid Polyurethane and Polyisocyanurate Foams and suppliers of Components for Rigid Foams is given overleaf

Applications of Rigid Polyurethane and Polyisocyanurate Foams

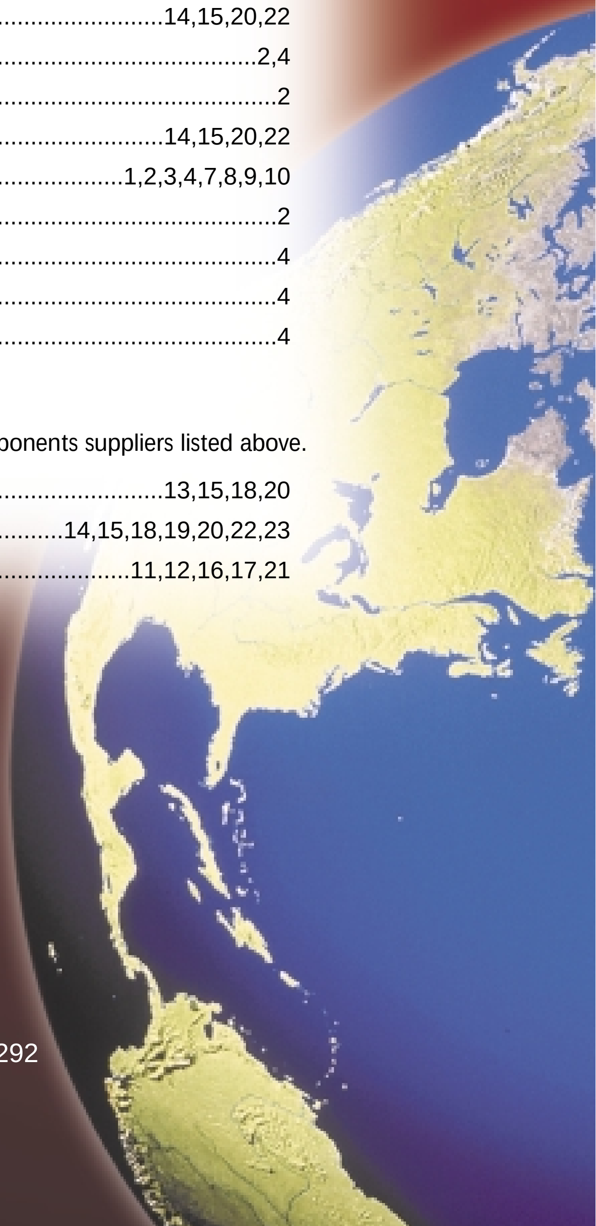
The following list shows the main applications of Rigid Urethane Foam. The numbers given against each application refer to the Foam Products Manufacturers and Foam Systems Suppliers listed.

Flat roofs	6,7
Pitched roofs	1,3,4,5,7,8,9,10
Composite claddings	1,3,5,7,8,9,10
Domestic linings	2
Industrial linings	1,4,7,8,9,10
Cold rooms	1,4,7,8,9,10
Refrigeration/Cold stores	1,3,4,7,8,9,10
Containers	2,4,8
Transportation	2,4
Marine insulation and buoyancy	2,4
Pipe insulation	2,4
Model building	2,4
Moulded components	2,4
Portable buildings	1,2,3,4,5,6,7,9
In-situ insulation by dispensing and spraying	14,15,20,22
Tank insulation	2,4
Cavity wall insulation - partial filling	2
Cavity wall insulation - in-situ, injected complete filling	14,15,20,22
External wall insulation	1,2,3,4,7,8,9,10
Under floor insulation	2
Low temperature and cryogenic insulation	4
HVAC (Heating, Ventilation & Air Conditioning)	4
SIPS (Structural Insulated Panels)	4

Components for Rigid Foams

The numbers given against each type of component refer to the components suppliers listed above.

Raw materials and Foam systems	13,15,18,20
Foam systems	14,15,18,19,20,22,23
Blowing agents	11,12,16,17,21



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