

# KILDONAN, SOUTH UIST

## INSULATION TO WALLS, ROOF, WINDOWS & DOOR



The views expressed in commissioned case studies are those of the authors and do not necessarily represent those of Historic Scotland or the Scottish Government.

While every care has been taken in the preparation of this case study, Historic Scotland specifically exclude any liability for errors, omissions or otherwise arising from its contents and readers must satisfy themselves as to principles and practices described.

This case study was published by Historic Scotland, an executive agency of the Scottish Government.

This publication is a web publication and is available for free download from the Historic Scotland website: [www.historic-scotland.gov.uk/refurbcasestudies](http://www.historic-scotland.gov.uk/refurbcasestudies)

This publication should be quoted as:  
Historic Scotland Refurbishment Case Study 6

ISBN 978 1 84917 102 1

© Crown copyright 2012

You can contact us at:

Historic Scotland  
Conservation Directorate  
Longmore House  
Salisbury Place  
Edinburgh EH9 1SH

Phone 0131 668 8600

Email [hs.conservationgroup@scotland.gsi.gov.uk](mailto:hs.conservationgroup@scotland.gsi.gov.uk)

Web [www.historic-scotland.gov.uk/conservation](http://www.historic-scotland.gov.uk/conservation)

### ***We welcome your comments***

If you have any comments or queries about our Refurbishment Case Study series, please get in touch with us either by email at [hs.conservationgroup@scot.gov.uk](mailto:hs.conservationgroup@scot.gov.uk) or by phone on 0131 668 8660.

Historic Scotland Refurbishment Case Study 6

## **KILDONAN, SOUTH UIST**

INSULATION TO WALLS, ROOF, WINDOWS & DOOR

MOSES JENKINS

## Contents

|   |    |
|---|----|
| 1. Introduction.....                          | 5  |
| 2. The site.....                              | 5  |
| 3. Pre-intervention thermal performance ..... | 6  |
| 4. Improvements to external walls .....       | 6  |
| 5. Improvements to coom ceilings .....        | 7  |
| 6. Improvements to windows .....              | 8  |
| 7. Improvements to floors.....                | 9  |
| 8. Improvements to external door .....        | 10 |
| 9. Post-intervention thermal performance..... | 10 |
| 10. Conclusion .....                          | 11 |

## Acknowledgements

Historic Scotland would like to thank all partners participating in this case study:



## 1. Introduction

This report describes works undertaken to improve the thermal performance of the walls, roof space and other elements of a detached rural cottage on the island of South Uist. The project, part of an area trial scheme, was delivered by the Sustainable Uist community organisation with funding and guidance provided by Historic Scotland. The aim of the project was to demonstrate methods and materials that could be used to upgrade the thermal performance of a building type commonly perceived as being difficult to treat, which were sympathetic to the aesthetic and fabric requirements of the building. As with previous *Refurbishment Case Studies*, this report gives details of the work that was carried out to each building element followed by the measured thermal improvement.

## 2. The site

The building used in the trial is located at Kildonan on South Uist. It is a mass masonry building constructed around 1935, of cement mortared whinstone rubble. It has a pitched slate roof with two dormer windows on the front elevation (Fig. 1). The loft space is floored and a coom ceiling has been used to allow this space to function as two bedrooms. Internally the walls are lined with v-groove timber lining; which had decayed significantly in some rooms. One gable wall was plastered 'on the hard' (i.e. directly onto the masonry). The property had been vacant for some time prior to the project and was unoccupied for the duration of the work. It lies in an exposed rural location where wind and driving rain are a significant factor. The hard impervious stone, combined with it being bonded with a cement mortar, meant that the walls would probably become damp at various times of the year, and thus the vapour permeability of the upgrade measures and their ability to disperse water vapour would be properly tested in relatively extreme conditions.



Fig. 1. The house at Kildonan, South Uist

### 3. Pre-intervention thermal performance

The thermal performance of the external walls in both the ground and upper floor rooms was measured, as was the performance of the upper floor ceiling, prior to commencing the work (Table 1). The measurements were undertaken by Edinburgh Napier University and the results were broadly in line with other testing work carried out for Historic Scotland. Further details of the methodology for obtaining U-values can be found in *Historic Scotland Technical Paper 10*, and a full report of the monitoring work for this site is published in *Technical Paper 17*.

| Building element          | U-value (W/m <sup>2</sup> K) | Notes  |
|---------------------------|------------------------------|--|
| Ground floor, floor       | 3.9                          | Thin concrete screed (40 mm) over beach sand |
| Ground floor, south Wall  | 2.1                          | Mass masonry / concrete                      |
| First floor, north wall   | 2.1                          | Mass masonry / concrete                      |
| First floor, coom ceiling | 1.6                          | V-groove timber lining to slated roof        |
| First floor, dormer cheek | 1.7                          | Mass concrete                                |
| First floor, ceiling      | 1.9                          | V-groove timber lining to slated roof        |

Table 1. The thermal performance of building elements prior to upgrade work

### 4. Improvements to external walls

#### ***Measure 1 - Wood fibreboard insulation***

As previous wall linings had decayed to such an extent as to make their retention impractical, three of the four external walls on the ground floor of the building were insulated using wood fibreboard. This was fitted between timber strapping to a thickness of 100 mm and fixed directly onto the masonry (Fig. 2).



Fig. 2. Wood fibreboard between timber straps prior to application of plasterboard

Plasterboard (without any vapour barrier) was applied over the wood fibreboard, taped and filled, and painted with clay paint to finish. These materials achieved the aim of making the insulation measure entirely vapour permeable.

### ***Measure 2 - Calcium silicate board insulation***

The fourth wall of the ground floor, which had previously been plastered 'on the hard', was insulated using calcium silicate board 50 mm in thickness (Fig. 3). This was applied directly to the masonry using a moisture permeable adhesive mortar and mesh reinforcement was then fitted over this to allow a two-coat plaster system to be applied as a finish. This was finished with a clay paint to ensure full vapour permeability.



Fig. 3. Solid wall insulation using calcium silicate board, left open to show the layers

## **5. Improvements to coom ceilings**

In the upper floor, the coom ceiling was insulated with the same wood fibreboard used on the ground floor walls. Rather than fitting between new timber framing, here the same material was inserted behind the existing v-groove timber wall lining, to a thickness of 50 mm. This was achieved by removing some of the boards to allow the insulation to be inserted (Fig. 4) and refastening the existing boards. By using the correct thickness of wood fibreboard, a void was left (about 10 mm) to allow air circulation between the top of the insulation and the underside of the sarking board. This ensured the free ventilation of the void space and ensures dispersal of any water ingress from rain being driven under the slates in extreme conditions. The small area of flat ceiling below the roof apex was also insulated using 100 mm thick wood fibreboard.



Fig. 4. Wood fibre insulation to the coom, showing re-fixed timber linings

## 6. Improvements to windows

### *Measure 1 – Timber double glazed windows*

The existing windows at the property were UPVC replacements which, as well as being aesthetically displeasing, had started to fail. The decision was taken to replace these with new timber double glazed sash and case windows. Due to constraints of funding and time, only one trial window could be manufactured and installed. A pattern from similar buildings of the same date was used to inform pane configuration. In order to retain and develop local trade skills, this was manufactured by a contractor on the island. Had UPVC replacements been procured, there would have been no contribution to the local economy or such development of local skills. The trial double glazed sash and case window was manufactured and fitted successfully (Fig. 5).



Fig. 5. The new timber double glazed window



### ***Measure 2 – Polycarbonate secondary glazing***

As a trial improvement with relevance to buildings in exposed locations, secondary glazing was fitted. This was a proprietary product consisting of polycarbonate sheet fixed to the internal side of the window frame using magnetic strips. These strips held the panel firmly in place, but can be removed by the occupants (Fig. 6) for cleaning etc as required.

These improvements have resulted in a thermally well performing and aesthetically pleasing window suitable for such a property.



Fig. 6. New double glazed window with polycarbonate secondary glazing in place

### ***Measure 3 – Insulation to the dormers***

On the first floor, budget considerations obliged the retention of the existing windows, but the dormers in which the windows sit were upgraded. This was achieved by the application of an aerogel board, 10 mm thick, applied to the cheeks and pitches of the dormers. This was then taped and filled, and finished with a clay paint.

## **7. Improvements to floors**

The original floor construction comprised a thin layer of concrete, 40 mm thick, laid directly on a beach sand base. As this floor was stable with no cracking it was decided to insulate this element with an aerogel-backed board 30 mm thick. The sections are laid onto the concrete and glued at the edges. Due to the slightly raised floor height it was necessary to take down internal doors and trim an equal amount off the bottom.

## 8. Improvements to external door

The existing door was a two-panel timber door of standard construction, with thin infill panels 6 mm thick. The technique for upgrading such a door is relatively straightforward using thin insulation set onto the panels. The frame of the door (the styles and rails) are of reasonable thickness and thus do not need improvement. In this case the thermal performance of the panels was improved with 10 mm thick aerogel held behind a new 6 mm plywood sheet. The edges were finished with new mouldings to make a neat junction with the rails and styles (Fig. 7) and then painted.



Fig. 7. The insulated door prior to painting

## 9. Post-intervention thermal performance

### *Walls*

The improvements in thermal performance made by the interventions can be seen in Table 2. Of the measures undertaken to improve the performance of walls, the 100 mm wood fibreboard between framing gave the most significant improvement, from a pre-intervention U-value of 2.1 to an improved U-value of 0.4. The other measure undertaken to the walls (50 mm calcium silicate board) gave a more modest improvement from a U-value of 2.1 to 1.0. Although this was a significantly lower level of thermal improvement, the calcium silicate board was 50% thinner and was applied directly to the masonry without the need for framing. In certain refurbishment situations, such as where there is a cornice or other feature, this slimmer material is likely to be appropriate.

### ***Coom ceiling***

The 50 mm thick wood fibreboard used behind the existing v-groove timber lining in the coom ceiling gave a U-value improvement from 1.6 to 0.8. The small area of flat ceiling, insulated using 100 mm of wood fibreboard, was improved from 1.9 to 0.4. These results are significant as they show that a good level of improvement can be achieved in a coom ceiling, an area of a building often considered difficult to treat.

### ***Floor***

The most significant improvement was achieved by the floor insulation where 30 mm of aerogel board shows an improvement in U-value from 3.9 to 0.8.

### ***Dormer***

The dormer window results are modest, but this is probably due to the thin material used. In other dormer situations more space within the existing dormer frame would permit thicker insulation (See *Refurbishment Case Study 5*).

| <b>Building element</b>   | <b>Pre-intervention U-value (W/m<sup>2</sup>K)</b> | <b>Post-intervention U-value (W/m<sup>2</sup>K)</b> | <b>Measures undertaken</b>                      |
|---------------------------|--|---|---|
| Ground floor, floor       | 3.9  | 0.8   | Aerogel board                                   |
| Ground floor, south wall  | 2.1  | 1.0   | Wood fibreboard                                 |
| First floor, north wall   | 2.1  | 0.4   | Calcium silicate board                          |
| First floor, coom ceiling | 1.6  | 0.8   | 100 mm wood fibre behind existing timber lining |
| First floor, dormer cheek | 1.7  | 1.2   | Aerogel board                                   |
| First floor, ceiling      | 1.9  | 0.4   | -   |

Table 2. Pre and post-intervention results

## **10. Conclusion**

The energy efficiency measures installed in the cottage at Kildonan, South Uist demonstrates a variety of ways in which the thermal performance of a building of this type can be improved. There was also a benefit in seeking to develop a more local supply chain for building elements, although it has to be accepted that the scale of the demand needs to be greater. The measures outlined here are described further in the Historic Scotland Short Guide *Fabric Improvements for Energy Efficiency in Traditional Buildings*.

## Historic Scotland Refurbishment Case Studies

Available at [www.historic-scotland.gov.uk/refurbcasestudies](http://www.historic-scotland.gov.uk/refurbcasestudies)

- 1 Five Tenement Flats, Edinburgh  
*Wall and window upgrades*
- 2 Wells o' Wearie, Edinburgh  
*Upgrades to walls, roof, floors and glazing*
- 3 Wee Causeway, Culross  
*Insulation to walls and roof*
- 4 Sword Street, Glasgow  
*Internal wall insulation to six tenement flats*
- 5 The Pleasance, Edinburgh  
*Insulation of coom ceiling, attic space and lightwell*
- 6 Kildonan, South Uist  
*Insulation to walls, roof and windows*
- 7 Scotstarvit Tower Cottage, Cupar  
*Thermal upgrades and installation of radiant heating*