May 1992

BEST PRACTICE PROGRAMME

Good Practice Case Study 108

ENERGY EFFICIENCY IN HOUSING

Low-energy sheltered housing in Scotland

An assessment of the benefits of a package of low-energy measures for Scottish sheltered housing.

BENEFITS

- **Reduced heating costs.**
- **Thermal comfort at an affordable price.**
- **Efficient heating and hot water generation with reduced environmental pollution.**
- **Elimination of tenant complaints regarding high heating bills, condensation and mould growth.**
- **Lower maintenance and operating costs for the building owner.**

INTRODUCTION

Modley House, Ellon, Aberdeenshire, owned and managed by Gordon District Council, is a new sheltered housing scheme which features a package of energy efficiency measures incorporated into the building design. The low energy measures include standards of fabric insulation in excess of the requirements of the Scottish Building Regulations in force at the time of design (1989), the use of condensing boilers for space heating, a conventional boiler with flue heat recovery for domestic hot water, optimised heating controls and low-energy lighting throughout. The scheme was designed by Grampian Regional Council Architects Department on behalf of Gordon District Council.

The Housing Department of Gordon District Council has a policy to offer to their tenants high quality accommodation at affordable rents. Modley House was designed in keeping with this principle. A monitoring programme undertaken at Modley House has provided support for the decisions made by Gordon District Council at the design stage and strengthened their commitment to apply energy efficiency measures to their housing stock in general. The tenant benefits through the provision of heating at an affordable price. In addition the Authority benefits because warmer room temperatures should reduce the incidence of condensation and mould growth which prolongs the interval for internal maintenance.

The monitoring programme was undertaken for a period of 12 months to assess the economic viability of the scheme, the performance of the energy measures and to investigate the social benefits to the tenants and building owner. The Energy Efficiency Office funded the monitoring scheme as a part of its Best Practice programme.

Modley House, Ellon - southerly facing aspect

Energy Efficiency Office
DEPARTMENT OF THE ENVIRONMENT

(R5)
CI/SfB 1978 843(56) (Y7)

THE PROJECT

Modley House comprises 32 self-contained flats, wardens' accommodation, common lounge, lobby and utility rooms within an attractive two-storey block flanking a southerly-facing central courtyard. There are 28 two-apartment and 2 three-apartment flats occupied by the tenants. The resident wardens and their families occupy 2 four-apartment flats situated at the extremities of each wing. As it is not possible to separate the heating and electricity services attributed to the wardens, their contribution is considered equivalent to 1.5 flats each, giving a total of 35 flats for purposes of comparison.

Centralised space heating and hot water services are provided from a plant room situated on the north side of the building. The main entrance lobby is also on the north side of the building.

The development is designed on integrated low-energy principles. A feasibility study employing computer modelling techniques was used initially to investigate the most cost-effective combination of energy measures. The feasibility study was funded by the Energy Efficiency Office.

From the feasibility study a package of energy efficiency measures was selected which was easily incorporated into the building design. A further criteria had to be satisfied in that the scheme needed to be applicable to other sheltered and similar schemes planned as part of the Authority's future new build programme, ie the scheme had to provide a model which could be replicated with only minor modification throughout the whole region for sheltered and similar housing.

	Walls	Roof	Ground floor	Windows
Modley House	0.26	0.21	0.15	1.6
Building Regulations standard (1991)	0.45	0.25	0.45	5.7

Table 1 Comparison of the Modley House and the Building Regulations standard (1991) U values [W/m²K]

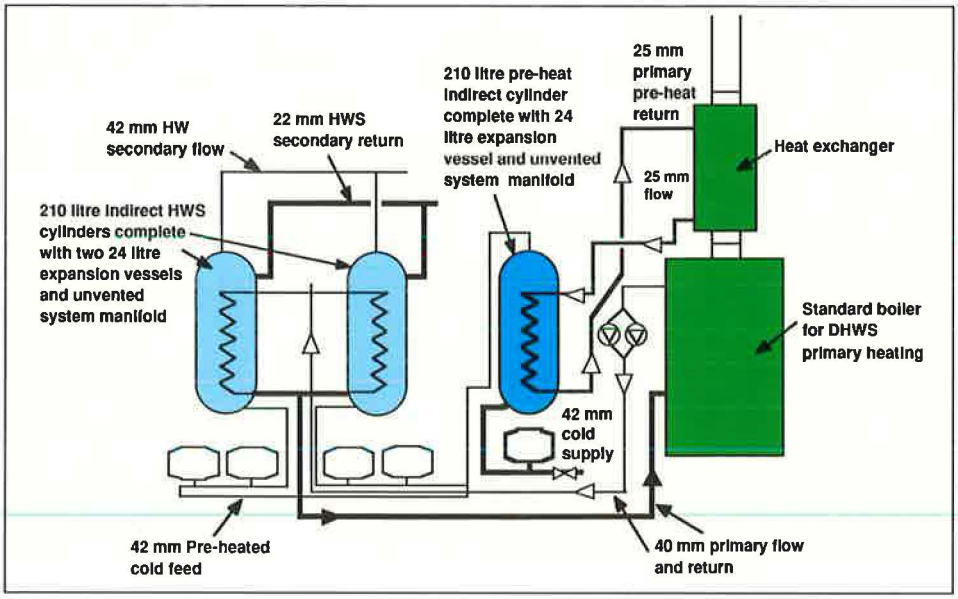

Figure 2 Domestic hot water system

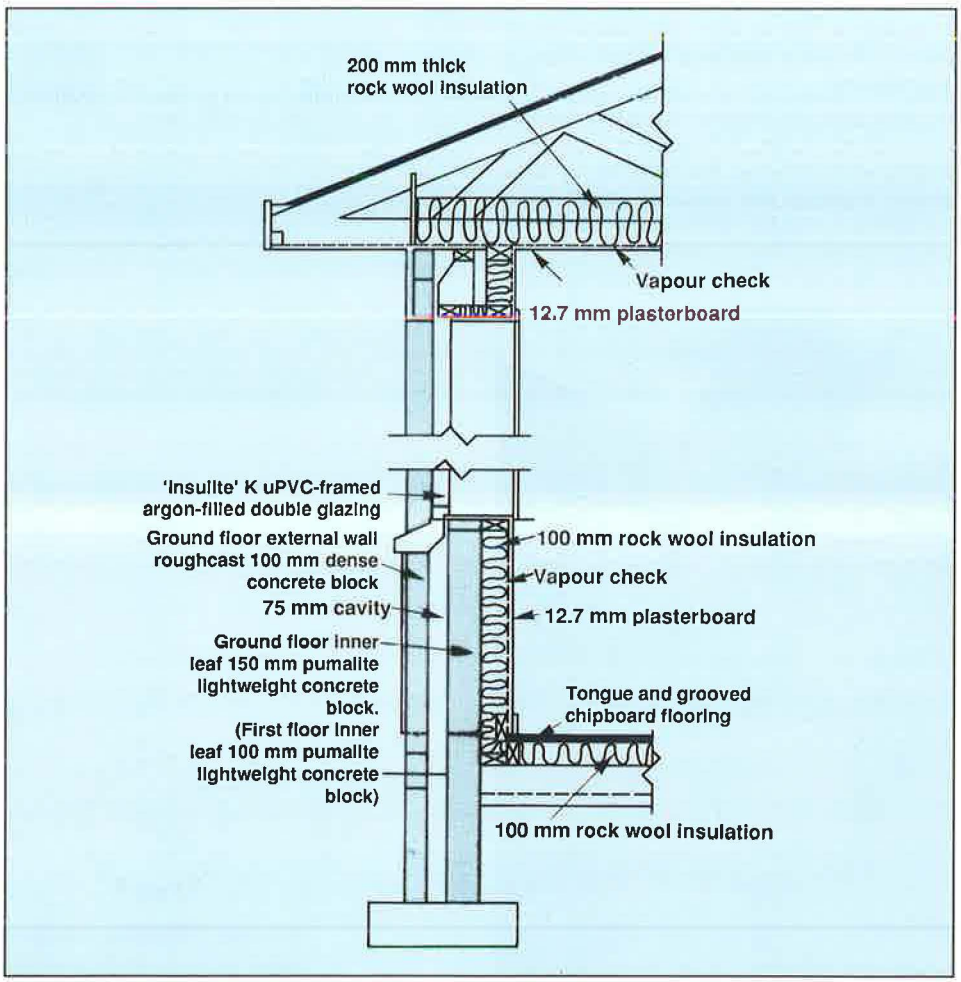

Figure 1 The high standard of thermal insulation achieved

Figure 1 shows some of the main features of the building fabric which is designed to achieve lower U values in the walls, roof and ground floor in comparison with the 1991 Building Regulation requirements in Table 1. Double glazed argon-filled uPVC windows of U value 1.6 W/m²K (including frames) are used throughout the building. The southerly aspect of the flats and living areas maximises passive solar gain. In addition draught-proof entrance lobbies prevent unneccessary heat loss. A further feature is the use of low-energy lighting using compact fluorescent tubes in the tenants' flats and all common areas.

Space heating is provided by a Hoval condensing boiler, rated at 150kW output, with controls that incorporate external weather compensation and optimum start. The condensing boiler supplies a low pressure, wet central heating system, with radiators situated in the flats and common areas. The radiators are fed from micro-bore manifolds connected to the common flow and return headers using 22mm bore tubing. Sediment filters are fitted to these pipes to avoid the risk of choking. Thermostatic radiator valves (TRV's) were used to control the temperatures in individual rooms.

The domestic hot water system (Figure 2) includes several novel features. The system is fed directly from the cold water mains which eliminates the need for storage tanks and allows the use of smaller pipes to deliver hot water to the flats at mains pressure. A heat recovery unit is installed in the boiler flue to heat water in a pre heat cylinder of 210 litres capacity. The domestic hot water boiler is a Hoval 75kW conventional gas-fired unit heating twin 210 litre indirect hot water cylinders. Each cylinder is fitted with two 24-litre expansion vessels and has an unvented manifold system.

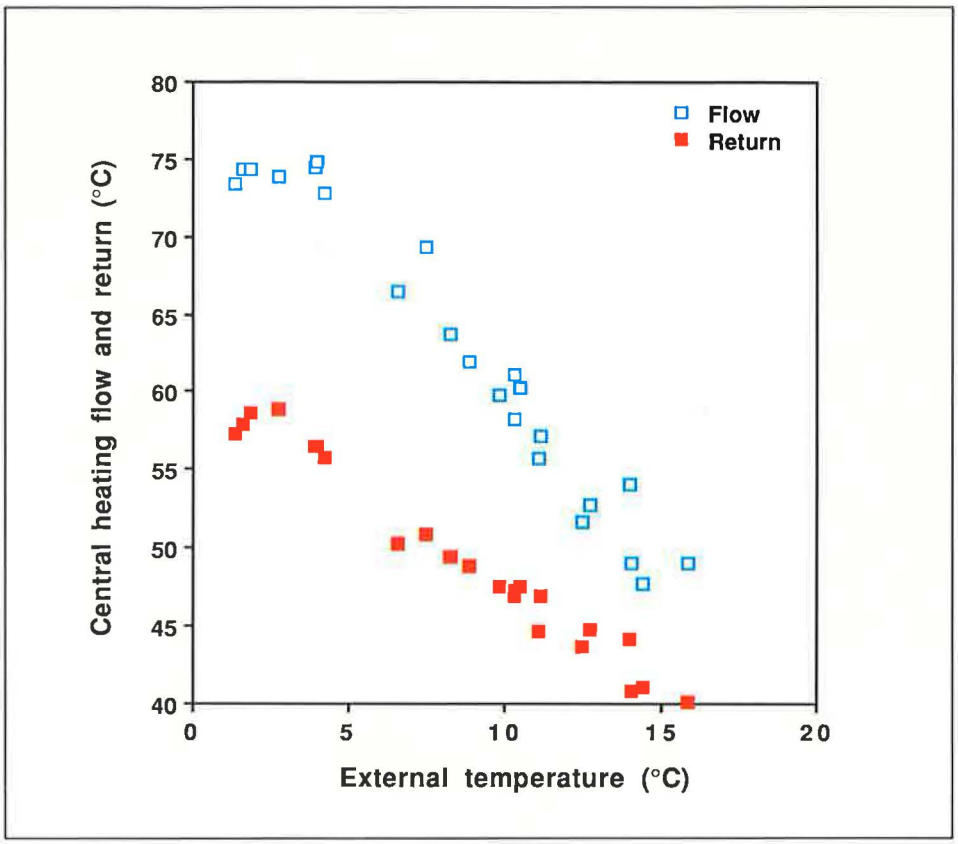

Figure 3 Effect of external air temperature on flow and return temperatures by the action of the optimiser

ENERGY AND COST SAVINGS

The efficiency of the central heating boiler was 80-84% except during a five-week spell of hot weather when it fell slightly to 78-79%. An external compensator was used to reduce the output from the heating system according to weather temperatures during the main part of the day. Figure 3 shows the reduction of flow water temperature as the external temperature increased.

The quantity of hot water delivered from the energy supplied is the most important factor in a domestic hot water system. At Modley House this was just under 50 litres per person per day (43 people including the wardens and their families) at a mean secondary temperature of 63°C. Domestic hot water accounted for 42% of the total energy used. The flue heat recovery system improved the performance of domestic hot water production by over 16%. Without the flue heat recovery system the overall efficiency of hot water generation would have been very low.

Table 2 shows the energy used during the monitoring period at Modley House compared with the average values from similar buildings which are built to conventional design. Modley House compared favourably in terms of running costs and performance with other sheltered housing developments in Gordon District.

SYSTEM PERFORMANCE

A 12 month monitoring programme was essential to investigate the performance benefits, buildability and economic viability of the energy efficient package installed. An essential feature of the monitoring programme was the tenants' reaction to the low-energy building and the heating and lighting services provided. As there is no identical control building without the energy features, Gordon District Council made available historical fuel records from their other sheltered housing stock.

Analysis of the temperature data gathered from selected flats and common room indicated that the internal temperatures were maintained throughout average to severe winter weather. Although, in hot, sunny conditions solar heat gains raised temperatures above target levels leading to some tenants complaining.

Persistent problems with the choking of filters in the 22mm supply pipes to the flats, particularly shortly after the building was commissioned, interrupted the heat supply to individual flats. Faults in the circulation pumps also caused some early disruption to the heating and hot water services. Both problems have subsequently been resolved and no further disruption has been reported.

Overall the tenants were well pleased with the design and comfort levels achieved in their flats. Some tenants admitted to using electric heaters in their living rooms occasionally, usually in the event of a heating system malfunction. Most tenants accepted the use of TRV's to control their heating.

The low-energy lighting aspect will be fully reported in a separate Case Study.

Energy source	Modley House 2-room flat		Conventional 2-room flat (average)		Difference totals
	Test flat	Total	Control	Total	
Gas	55.3	1,937	68.5	2,398	461
Electricity	11.2	392	13.2	462	70
Total	66.5	2,329	81.7	2,860	531

Table 2 Comparison of annual energy use [GJ/a] with typical sheltered housing stock

The boiler room at Modley House

ENVIRONMENTAL BENEFITS AND CONCLUSIONS

Low energy lighting - north corridor

A recent replication of Modley House, James Pressley Court, Huntly, used 1% less energy for heating and hot water services. The development closest to Modley House in terms of age and size, but lacking the energy-saving measures, used 23% more total energy (18% more electricity and 24% more gas). Based on the 1989 energy costs this amounted to an annual saving at Modley House of £2,710 which is £77.43 per two-apartment flat or £1.49 per tenant per week. This saving reduces the weekly cost of heating and electricity services from nearly £6.50 to £5.00.

Comfort standards are the same, or in many cases better than those of conventional sheltered buildings, and this is achieved at a more affordable price.

The total overcost of the energy measures at Modley House was £29,450 (about £920 per flat) at 1989 prices which on the savings achieved gives a simple payback period of 10.9 years. The Authority consider this additional outlay which accounts for an extra 2% increase in costs on a total construction cost of over £1.3m, to be a good return on capital investment even though the heating services will need replacing several times during the 60 years predicted life of the building. For the majority of the life of the building the local authority will be saving on operating costs.

ENVIRONMENTAL BENEFITS

In addition to the annual energy saving of 531 GJ for the site there is an environmental benefit. Reducing energy consumption also reduces the emission of atmospheric pollutants, particularly carbon dioxide - the main greenhouse gas. The energy saving is equivalent to an annual reduction in carbon dioxide emission of 41,500kg (25,400kg from gas and 16,100kg from electricity). Savings of this magnitude could have considerable impact on the environment if replicated throughout the UK in all new sheltered and similar buildings.

SOCIAL SURVEY

Of the 26 flats (out of a total of 32 flats) who responded to the questionnaire most of the tenants were pleased with their accommodation. Some thought that the domestic hot water was of an adequate temperature, a few thought it too cold. The majority liked the showers although five would have preferred a bath. The common bathrooms were used fairly infrequently during the first half of the monitoring period.

Most tenants achieved comfortable room temperatures by adjusting the radiator valves or opening windows. A common complaint in the summer was overheating when the sun shone. In December five tenants admitted to using electric heaters but only when the radiators were faulty. The use of additional heating was rare and generally confined to the coldest days or when the heating system failed. The survey also revealed that there was no evidence of any particular condensation and mould growth problems.

There was no opportunity to undertake formal social surveys of the tenants in other sheltered schemes in the area.

MAIN CONCLUSIONS

- The integrated package of energy measures produced a 23% reduction in energy costs, equivalent to a saving of 15.2 GJ per flat per annum, 531 GJ/a for the building. In cash terms this is equivalent to £2,710 per year or £77.43 per flat, at the 1989 fuel prices.
- The simple payback period for the capital investment of £29,450 at 1989 prices is under 11 years. In terms of the 60-year predicted life for the building fabric this is a good investment, although it is appreciated that the building services will need replacing several times during the life of the building.
- Centralised heating using temperature compensation creates a generally comfortable environment, although some tenants occasionally used additional heaters in very cold weather.
- The direct mains fed hot water system with flue heat recovery achieved a substantial increase in efficiency (16%) and equal pressures in hot and cold water supplies.
- In terms of affordable warmth, the measures achieved an annual saving of nearly £1.50 per person per week. This is equivalent to reducing the weekly fuel bill from £6.50 to about £5.00. In the Gordon District the tenants pay a fuel charge with their rent. Whilst the saving is not directly passed to the tenant, ultimately all the tenants in the district will benefit if the local authority can save on operating costs through energy efficiency.
- The Authority also benefits directly from lower operating costs, and from lower maintenance costs due to the warmer room temperatures reducing the incidence of condensation and mould growth.
- Comfort conditions at Modley House were generally very high and acceptable to the majority of tenants.
- Overall the low-energy building performed well with adequate heating provision in all flats regardless of their position within the building.

ACKNOWLEDGEMENTS

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