Energy Efficiency Office
DEPARTMENT OF ENERGY

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NOVEMBER 1989

Energy Efficiency Demonstration Scheme
Expanded Project Profile 283

Condensing boilers in Communal Domestic Heating Systems, Irlam, Manchester

Condensing boilers in Communal Domestic Heating Systems, Irlam, Manchester

Potential users
All those providing heating in large residential buildings in both the private and public sectors.

Payback period
1-2 years.

Savings achieved
342 gigajoules/a (3237 therms/a), worth £1,245/a at the gas price of £3.64/GJ.

Host organisation
Anchor Housing Association
269A Banbury Road
Oxford OX2 7HU
Tel No: 0865 311511

Monitoring contracor
RW Gregory & Partners
Consulting Engineers
135 Dickensen Road
Manchester M14 5HW
Tel No: 061-248 6411

Equipment suppliers
CONDENSING BOILERS
Broag Ltd
Seagold Boilers Ltd
Thyssen Road, Mollymillars Lane
Wokingham RG11 2PY
Tel No: 0734 783434

WATER HEATING BOILERS
Andrews Industrial Equipment Ltd
Marston Road
Wolverhampton WV2 4LX
Tel No: 0902 28111

Installation contractor
Robert Heyworth Group Ltd
Heyworth House
Dakota Avenue
Salford M5 2PU
Tel No: 061-872 9555

Holly and St Clement's Courts, Irlam.

The aims of the project

The improved combustion efficiency of gas-fired condensing boilers offers the potential for substantial energy savings and correspondingly reduced fuel bills, both for new and retrofit installations. This demonstration investigated the installation, energy savings and cost-effectiveness of condensing boilers when used as replacements for existing standard boilers in a communally heated sheltered housing scheme at Irlam, Manchester, owned by the Anchor Housing Association.

An earlier demonstration (Expanded Project Profile 121) showed that substantial energy savings could be achieved in this type of building by matching heating plant closely to the predicted load and by separating the space and domestic hot water heating services. This project adopted these principles but improved the efficiency of the heating system still further by installing gas-fired condensing boilers as an alternative to conventional boilers. The heating bills were reduced by nearly 21%, saving a further £1,246 per year, in comparison to similarly sized, but conventional boilers.

The monitoring programme verified the energy savings and confirmed that the occupants continued to enjoy satisfactory levels of comfort.

How energy was saved at Irlam

The fundamental difference between a condensing boiler and a standard boiler is the inclusion of an enlarged (or secondary) heat exchanger surface. The enlarged heat exchanger allows the condensing boiler to extract heat that is wasted in conventional boilers. Heat is recovered from the hot flue gases, reducing their temperature considerably in the 'non-condensing' mode of operation. In addition, providing conditions within the boiler are suitable, latent heat will be recovered from the water vapour generated during combustion – the 'condensing' mode of operation.

In most retrofit applications, providing the various components (flue, heat emitters, controller etc.) are functioning satisfactorily, much of the existing heating system can be used with the new condensing boiler. In a typical retrofit situation the radiators are likely to be over-sized because other energy efficient measures have usually been added since the building was constructed. This will help reduce the return water temperature, encouraging the condensing boiler to operate in the condensing mode. Providing the heating controls are adequate and functioning correctly, the same controls may be used as for conventional boilers, though the use of an external weather compensator is recommended.

At Irlam the Anchor Housing Association owns and operate two nearly identical sheltered housing blocks on the same site. The accommodation in each block comprises 32 self-contained flats (one and two bedroom), a common room, laundry and warden's flat. The flats are linked by covered passageways. Space and domestic hot water heating is provided by centralised boilers, installed in plant rooms within each block. Heating is distributed to the accommodation by a low-pressure hot water system using panel radiators in the flats and common areas. The tenants have limited control of the heating, basically confined to turning their radiators on, or off.

The site featured in an earlier demonstration involving the separation of space and hot water heating services and the matching of heating plant more closely to the predicted peak load demand; see EPP 121. The original 20-year-old heating plant in one of the blocks, St Clement's Court, was replaced with two modern Potterton boilers (each rated at 73 kW) for space heating and two low-capacity, rapid recovery Andrews Industrial water heaters for domestic hot water. Monitoring showed that savings of 15% on total operating costs (energy and maintenance) can be achieved when these measures are adopted.

Further savings were anticipated through the use of condensing boilers. To prove this new technology in a retrofit situation, two Broag condensing boilers (each rated at 75 kW) were installed for the space heating in the second block, Holly Court. Similar Andrews heaters were provided for domestic hot water, separating the space heating and hot water services. The Broag condensing boiler is shown in schematic form in figure 1.

A new stainless steel flue was constructed at Holly Couirt because the original brick flue was in need of major repair. The condensing boilers and hot water heaters used a common flue arrangement.

Broag boilers in Holly Court boiler room.

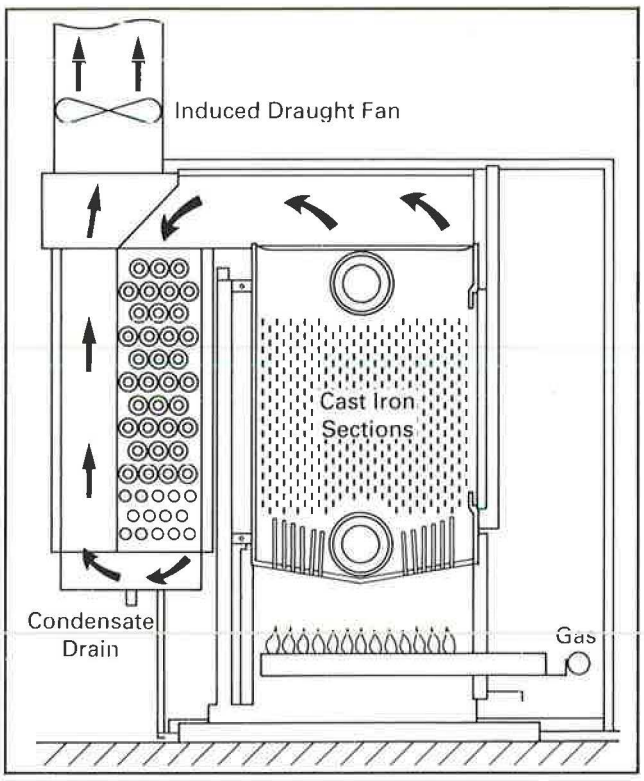


Figure 1. Section through a Broag condensing boiler.

A monitoring programme, undertaken over two winters and a summer, compared the operation of the condensing boilers in Holly Court with that of the conventional boilers in St Clement's Court. The physical monitoring tasks were similar in both blocks and required the regular logging of boiler efficiency, hot water flow rate and temperature, energy consumption and room temperatures in entrance halls and selected flats. Interviews with the tenants and wardens were undertaken in support of the physical data. In addition observerations were made on the installability of the plant and any maintenance requirements. Figure 2 shows the layout of the heating system and position of some of the monitoring equipment.

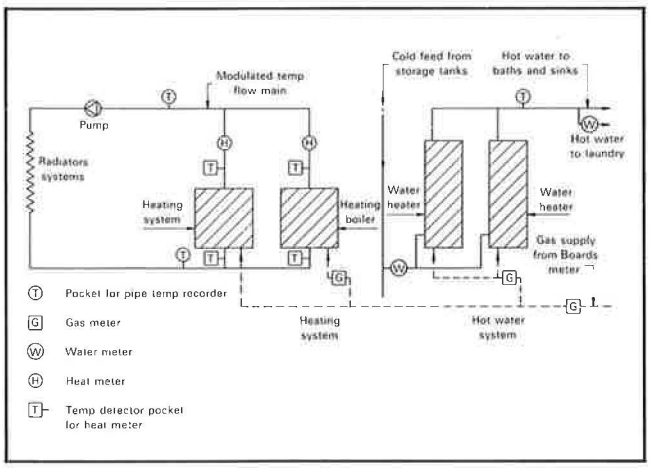


Figure 2. Diagram of heating system in Holly Court.

A 25% grant towards the replacement and installation of the plant, together with the full costs of monitoring, was provided by the Energy Efficiency Office under their Demonstration Scheme. The project was managed on their behalf by the Building Research Energy Conservation Support Unit. RW Gregory & Partners, Consulting Engineers, was appointed to undertake the monitoring through their Manchester office.

Energy and cost savings

Over a 52 week period St Clement's Court used 1,665 GJ of gas for space heating. Holly Court used 1,323 GJ over the same period, representing a saving on fuel of 342 GJ, or nearly 21%, (figure 3).At the current gas price of £3.64 per GJ this is worth £1,245 per year.

The seasonal operating efficiency of the condensing boilers was 86%, an improvement of fifteen percentage points over that of the conventional boilers (71%). A similar difference in gas consumption should occur each year with correspondingly good annual cash savings.

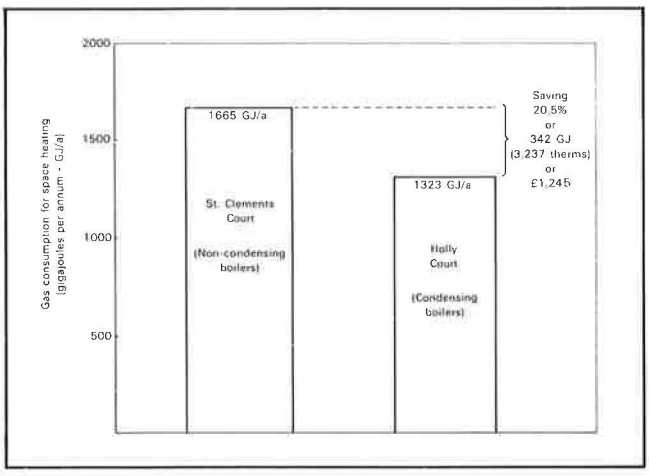


Figure 3. Summary of savings on operating costs.

In Holly Court the heating plant operated for a longer period than St Clement's Court. Operation of the heating is at the discretion of the warden and can vary, particularly if the weather is changeable. In terms of average gas consumptions per hour, Holly Court used 0.24 GJ/hr, while St Clement's used 0.4 GJ/hr. A saving of 40% for the condensing boilers. Typical monthly gas consumptions for each block are shown in figure 4.

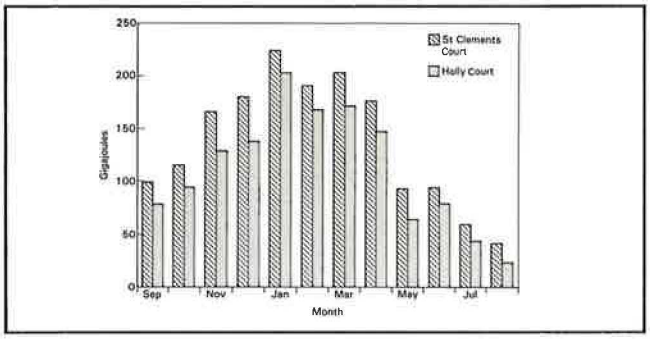


Figure 4.Typical monthly gas consumption in both blocks.

The temperatures attained in both blocks were broadly similar. Minimum temperatures on average approached that of the 21°C design temperature for category II sheltered housing, ranging from 19-22°C. The maximum temperatures during the heating season averaged 24-26°C in both blocks. Interviews with the tenants confirmed that these temperatures were acceptable for comfort. The monitoring period included the cold winter of 1986/87 when the average noon temperature was only 5°C, compared to 7°C for the following winter.

The capital cost of supplying, installing and testing the condensing boilers is £6,853 at 1989 prices. A similarly sized system comprising standard boilers will cost £4,880. The difference of £2,000 represents the over-cost of the condensing boilers. In comparison with the standard boilers in St Clement's Court, the condensing boilers saved £1,245 per year on space heating costs, giving a simple payback (the time taken to recover the additional investment) of under 1.7 years. This represents an extremely attractive investment for operators of this type of building.

The savings take account of the space heating only and do not include the cost of replacing the flue. Whether condensing boilers were used, or not, the flue would have needed replacement. Furthermore, the economics of separating the heating systems have not been included, as this is fully explained in EPP 121. Comparing the heating system in Holly Court with the original plant would have produced even greater savings on operating costs. But it is more likely that most replicators will be faced with the choice of installing either non-condensing or condensing boilers.

Replication potential

The scheme is not restricted to application in sheltered housing. Any building in which large, centralised boilers are used for heating could equally benefit from the installation of condensing boilers. Other suitable buildings include student accommodation, handicapped peoples' homes, hostels, hotels, offices, schools etc.

This demonstration has concentrated on the use of condensing boilers in a typical retrofit situation where worn out heating plant needs replacing. It is inevitable that the heating plant will need replacement several times during the life of the building. When this occurs the opportunity arises for the building owner to reduce operating costs for a comparitively small additional investment. Modern heating design and the use of highly efficient heating boilers will recover this extra cost in a relatively short period of time. The techniques demonstrated are applicable to a wide range of retrofit (and new build) applications and building owners, heating designers and installers are well advised to consider these measures before embarking on future heating schemes.

Anchor Housing Association

The Anchor Housing Association is one of the major asociations providing accommodation for elderly people in sheltered housing. Their estate currently comprises some 21,000 flats in 650 buildings situated throughout the UK. The Association is a non-profit making body and a registered charity.

The Anchor Housing Association is fully aware of the energy needs in sheltered housing through the records of fuel consumption in their building stock. The Association has undertaken many energy efficient initiatives, including building fabric measures as well as improvements to the heating systems. The Association has also produced a design guide for building services which provides their contractors with an energy efficient brief for refurbishment and new build schemes.

Anchor Housing Association's experience

The site at Irlam, Manchester, is somewhat unique in that it has two nearly identical sheltered buildings. Originally both buildings were provided with similar boiler plant supplying the heating and hot water services via calorifiers.

An energy efficiency demonstration completed in 1984 showed that savings could be achieved by using separate boilers for space and hot water heating. The project realised an annual energy saving of 14% and a further small saving on maintenance cost, see EPP 121. The site provided an excellent oppoortunity for the monitoring of further energy efficient measures, particularly condensing boilers for which little independent information was available at the time.

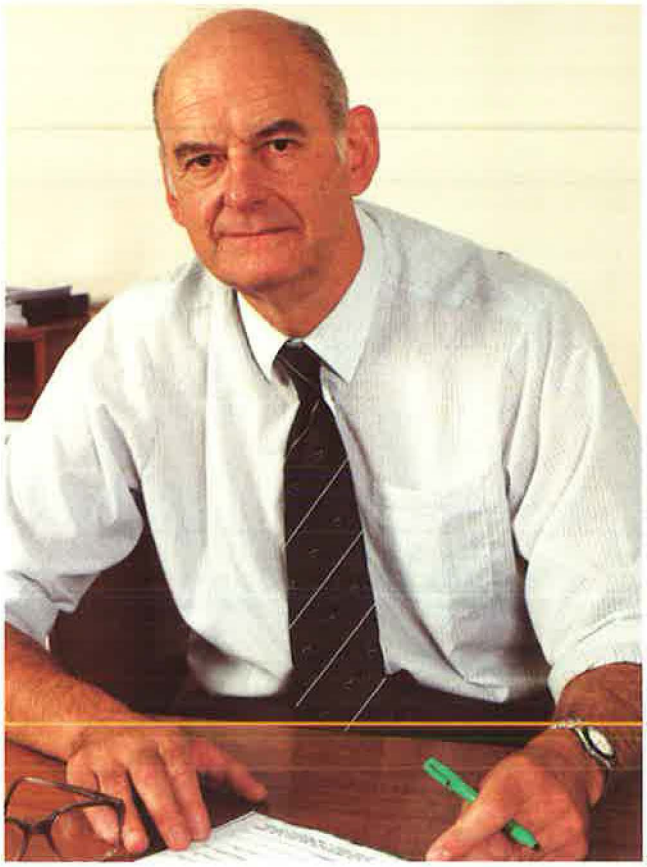
The heating plant in Holly Court was replaced using condensing boilers for the space heating and Andrews water heaters for domestic hot water. The performance of the condensing boilers was compared directly with the performance of the standard atmospheric boilers installed in St Clement's Court for the earlier demonstration.

The result has been a convincing demonstration of the energy that can be saved through the use of condensing boilers. The payback of less than two years makes good economic sense for this scheme. Since the benefits of these appliances have been clearly demonstrated Anchor Housing Association has been confident to specify their use whenever possible, including similar sheltered housing schemes and in a commercial application—the Association's new offices in Oxford.

Anchor Housing Association has always maintained a positive, forward-looking attitude to the economic use of energy.

Subsequent experience following this demonstration has shown that a combination of condensing and standard (atmospheric) boilers can be installed, their number and rating being dependent on the load pattern. In sheltered housing with total heating loads in the range 150-250 kW it has been found convenient to use two boilers each sized for half the load. Using a step controller the condensing boiler operates in the milder weather and the atmospheric boiler fires as a back-up when further heat is required, such as on colder days.

Self monitoring has shown that this combination is only about 5% less efficient than the Holly Court scheme. But the payback period is reduced to about 12 months. The arrangement represents an even more attractive investment since less capital outlay is involved, and this arrangement will be adopted by Anchor Housing Association on all new projects. A detailed examination of a novel heating technology of this type could not have been undertaken without the support of the Energy Efficiency Office's Demonstration Scheme.



David Fox.

David Fox
Principal Engineer
Anchor Housing Association

Best Practice programme

The work described here was carried out under the Energy Efficiency Demonstration Scheme. The Energy Efficiency Office has replaced the Demonstration Scheme by the Best Practice programme which is aimed at advancing and disseminating impartial information to help improve energy efficiency. Results from the Demonstration Scheme will continue to be promoted: however, new projects can only be considered for support under the Best Practice programme.

For copies of reports and further information on this or other projects, please contact the Enquiries Bureau at the:
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Information on participation in the Best Practice programme and on energy efficiency generally is also available from your Regional Energy Efficiency Office.