REPORT ON PHASE I OF THE E.I.K. PROJECT

CITY OF BIRMINGHAM
HOUSING DEPARTMENT

November 1980

1. INTRODUCTION

1.1. Background

56% of U.K. delivered energy is used to service buildings, with housing as the largest single user at 26% (Romig and O'Sullivan, 1979). Public sector housing accounts for about 9% (H.D.D., 1979). Figure 1.1. illustrates these statistics and also identifies the fuel mix within housing, perhaps the most notable aspect of which is the high use of electricity which when viewed in conjunction with Figure 1.2. reveals the background to the financial difficulties which are increasingly being encountered in the area of domestic energy purchase. These two aspects of the energy conservation debate, i.e. the significance to national energy use and the stress on individual user, spearhead the motivation for investigative work in this field.

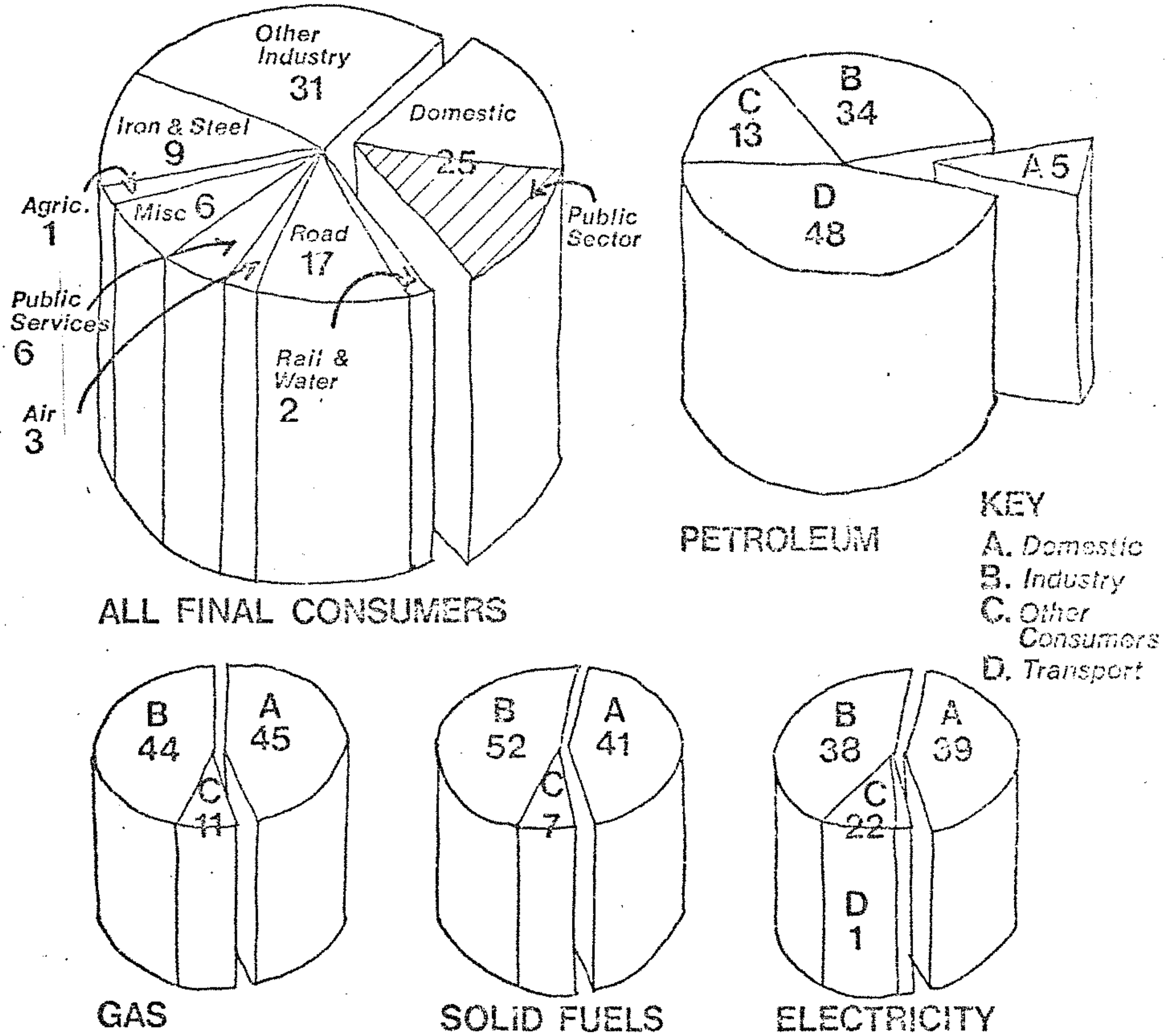
The debate as to whether to invest in energy savings in existing or new buildings cannot fully be resolved here but salient comments are:-

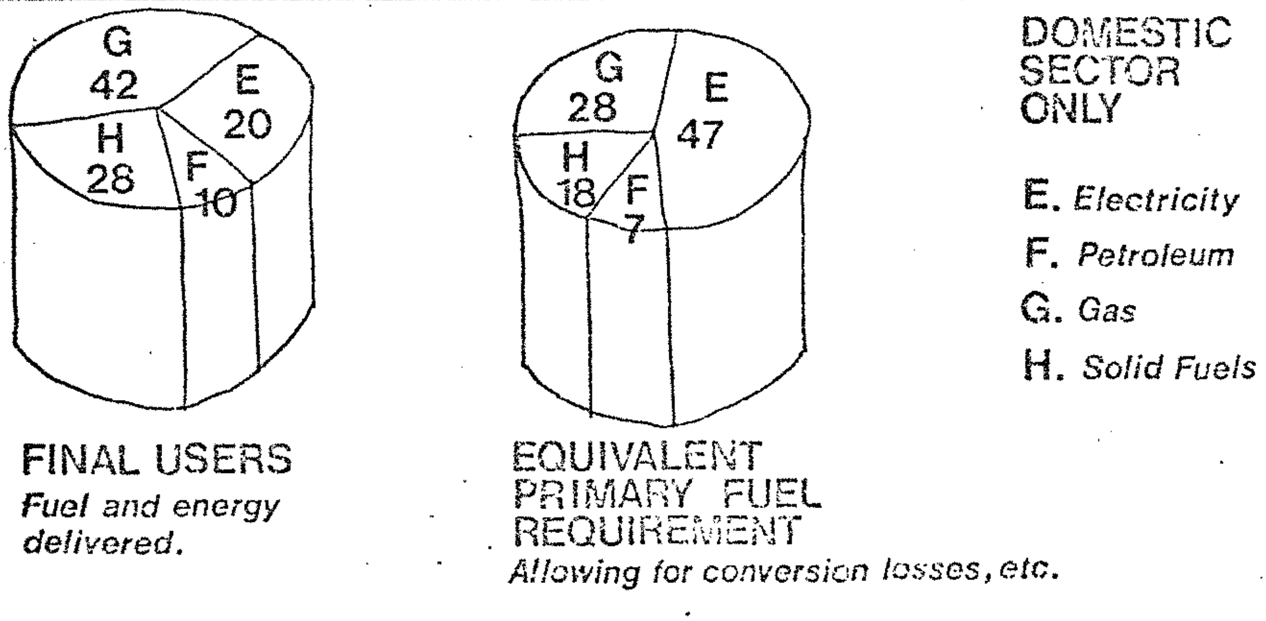
- currently existing dwellings will constitute 80% of the housing stock in 2000 (Figure 1.3)
- attempts to influence this sector through legislation, etc (e.g. changes in Building Regulations) can only achieve improvements in the much smaller number of new buildings
- theoretical reductions in energy consumption of up to 50% appear reasonably 'cost effective' in new buildings whereas 20-30% seems to be the upper range for existing buildings (e.g. P.S.A., 1977; Kasabov, 1979; D.E.S., 1979). Although these savings generally can be realised in non-domestic building and in new buildings, in existing housing the actual savings can be low (H.D.D., 1979b; McNair, 1980). This under-achievement and its impact on cost effectiveness (Freund, 1979) stems primarily from the U.K. tradition of partial heating with consequent low average internal temperatures, e.g. Danter (1951); Anderson (1978); H.D.D. (1978); Pickup and Miles (1979). Attempts have been made to correlate the under-achievement directly with the whole house average temperature (Minogue, 1979) but this is simplistic and effects such as internal heat distribution are now recognised as important (Campbell, 1979)

U.K. ENERGY CONSUMPTION BY FINAL USERS IN 1976 (HEAT SUPPLIED BASIS)

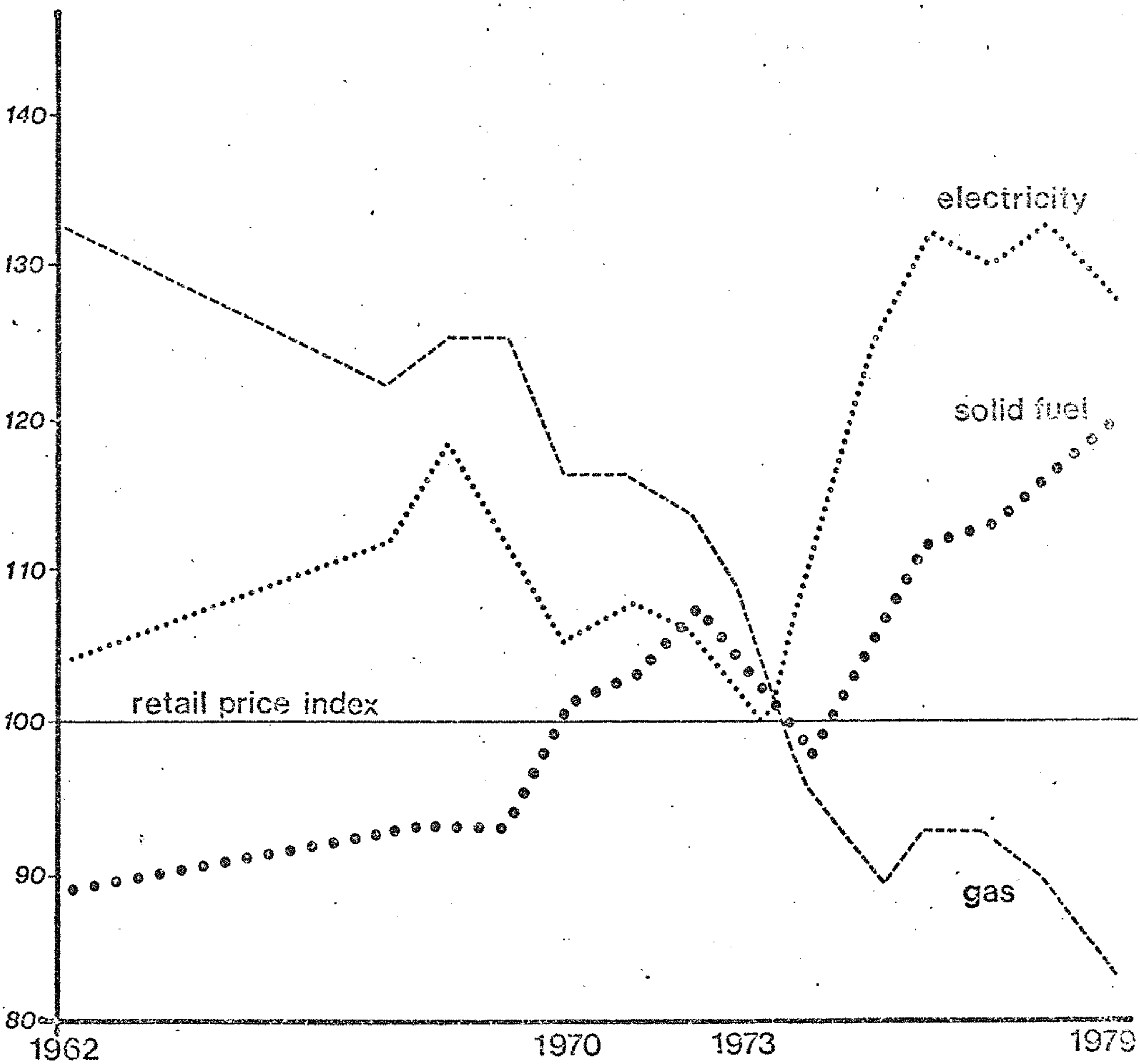
Pecentage shares by Sector and Form of energy

Source : U.K. Energy Statistics





INDEX OF FUEL PRICES COMPARED WITH GENERAL RETAIL PRICE INDE
IN THE U.K. (retail price index at 15 January 1974 = 100)



ESTIMATED CHANGES IN THE HOUSING STOCK IN GREAT BRITAIN

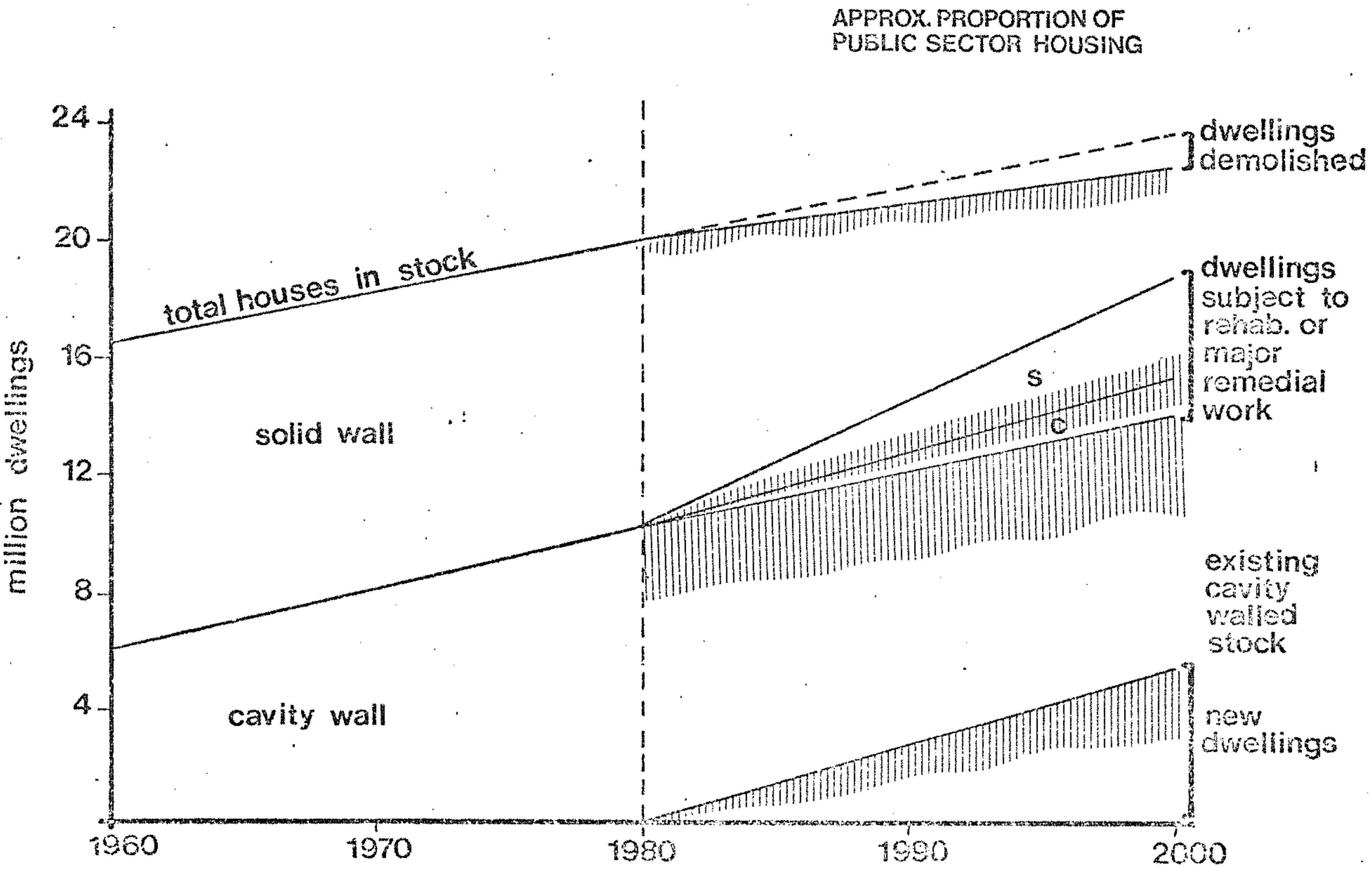


Fig. 1.3

- despite intentions of running planned maintenance programmes many authorities find that repairs and remedial work often occur on an ad hoc basis in response to politically sensitive problems. Few authorities can be aware of the physical conditition of their domestic buildings in a structured way and information retrieval from records often proved time-consuming as well as inaccurate because the sources are dispersed throughout the different departments and frequently out of date.

After recognition of the importance of national policies to reduce energy consumption, the need for improving the thermal efficiency of local authority dwellings must assume a high priority. Such an improvement programme requires a solid base for retrievable information about the age, condition and thermal efficiency of large numbers of widely differing building types which does not exist at present.

The main objective of the Better Insulated Homes Programme, which was to evaluate the energy savings generated by doubling insulation standards for walls and roofs over the 1975 regulations, also included important sub-objectives which explore:

(a) Construction feedback
(b) Energy savings
(c) User information.

Results from the programme are in process of analysis but it has become clear that energy conservation cannot be optimised simply by concentrating on insulation alone, and that the interaction between a number of other factors - user preferences, ventilation, the permeability of the structure and the possible effects of extra insulation upon construction - remains uncertain. All of these factors will apply to the existing stock which varies enormously in size, construction, occupancy and condition. Improved insulation may be very expensive for a significant proportion of occupied dwellings so that a flexible range of appropriate methods for reducing energy consumption is required. It is unlikely that a uniformity of performance over the whole stock is possible, but it seems reasonable to suppose that different levels of improvement can be optimised by varying methods which are appropriate to the characteristics of particular buildings.

The Directorate has begun to explore the issues involved in collaboration with the City of Birmingham through research designed to identify strategies and tactics for improving the energy performance of the 150,000 dwellings owned by the City. This stock includes a wide variety of building types mostly built after 1919 but with a minority of older buildings acquired under municipalisation schemes - consequently the Birmingham stock cannot compare directly with national statistics (this is discussed later) but was known to include a wide variety of representative dwelling types thus affording a reasonably complete view.

1.2. Objectives and Methodology

The principal objective is to develop a methodology which housing authorities can use selectively to assist in most advantageously including existing housing in any attempts to achieve thermal improvements.

This has three components:-

- to gain more reliable data on the nature of the existing stock
- to develop strategies and tactics for improving the energy efficiency of existing housing in the public sector
- to prepare an Energy Improvement Kit embodying the experience of this and other HDD exercises in a format more readily usable by local authorities and other building owners.

The work is being undertaken in three stages:-

1. Survey and analysis of the existing Birmingham Local Authority stock.
2. Examination of typical dwelling types and the development of a range of energy conservation measures.
3. The monitoring of the performance of representative dwellings before and after improvement.

This report is primarily concerned with the results of Phase1; Phase II (including 2 and 3 above) currently in progress will be reported in due course.

1.3. Phase 1 Project

Following the decision by H.D.D. to approach Birmingham City Council preliminary discussions were held with representatives of the City Architect's and City Engineer's Departments. Both of these Departments are involved in the design of heating equipment and energy insulation measures in Council owned buildings of all types, and have a particular interest and involvement in the provision and improvement of heating installations in Council houses. As discussions progressed it became apparent that a major part of any work to be carried out would involve a survey and analysis of the City's housing stock. It was agreed that the City Housing Department should undertake a survey on behalf of the City Council under a research contract with the H.D.D. in consultation with a multi-disciplinary research group drawn from the principal parties involved.

A working group was eventually formed which included representatives from City Housing, Architect's and Engineer's Departments, H.D.D. , D.O.E. West Midlands Regional Office and the Birmingham School of Architecture. The potential disadvantages of such a large and varied involvement were undoubtedly outweighed by the benefits afforded by its multi-disciplinary nature essential to a project of this kind.

The working group produced an Interim Report of their work in January, 1979, for the Department of the Environment which contains far more detail on the preparation for, and logistics of, the survey. This Final Report briefly summarises the Interim Report and gives information on the initial analysis of the data collected and its implications.

2. PHASE 1 - THE SURVEY

2.1. Background

To date surveys of energy consumption in housing have either been drawn from national statistics of a general nature (e.g. B.R.E., 1975; Romig and Leach, 1977) or from small sample detailed investigations (e.g. Electricity Council, 1971 and 1975; H.D.D., 1979b).

The former group necessarily involves a considerable degree of homogeneity of data so that factors critical to the development of an energy improvement policy are 'lost' in the statistics. For example, experience has shown that the openings in a wall are critical to any improvement technique utilising internal or external cladding. The latter group of surveys is usually confined to a few variables relating to a particular project and rarely represent the wide variety of housing and occupancy types. The Birmingham survey represented the first large proportion sample of U.K. local authority housing for which it was possible to set a specific 'energy' questionnaire. Consequently the working group spent a considerable time identifying relevant parameters and evolving a methodology which formed a reasonable compromise between the desired level of information and its practical achievement. In particular it was apparent from an early stage that simple generalisations often 'missed' valuable information and occasionally could be misleading so that if a very coarse survey was to be employed it would provide little more than is already available. However, any attempt to improve on this so as to adequately detect and describe local effects required a sharp increase in sophistication. The major problem for the working group was to keep this complexity to a minimum, until further analysis enables a smaller more detailed survey of a representative sub-sample.

The chosen method of a large random survey (clear data from about 5,000 dwellings or 3% was obtained) and using unskilled personnel (½ hour per house) to be followed by a detailed survey of a carefully selected 0.02% sample, contrasts with the method used in the Swedish Survey of Buildings in 1977 (where a selected sample of 0.02% (3,000 from 1.5 million) of all buildings was surveyed by skilled staff (Bergstrom and Hammarsten, 1978; Hammarsten, 1979; Hammarsten and Norten, 1979). Initial results suggest that a smaller sample would have been valid and that greater quality and quantity data would have been valuable. Whether these are compatible with realistic survey costs is not yet clear.

2.2 The Questionnaire

A working group spent a considerable time identifying and rationalising indicators relevant to energy consumption and conservation. Briefly, this took the usual form of a period of 'expansion' during which the early survey methodologies or 'lists' of options (e.g. for construction and services) became more and more unmanageable. This prompted considerations of visual recording, etc. but eventually the necessity for transcription of data, through numerical format, to a computer, combined with a requirement for flexibility/universality led to a coded matrix format for the majority of data. The matrix allows numerous possible permutations of key parameters to be 'contained' within a manageable two dimensional array, whilst the use of coding facilitates changes without undue complication. The final survey form and coding (Appendix 1) reflect these principal pressures incorporated in a layout based upon ergonomic and computer transcription considerations.

It is worth outlining some of the factors considered in the preparation of the survey questionnaire. Many of the factors are obvious and well documented elsewhere - some were rejected and do not appear in the questionnaire and undoubtedly others which should have been included are missing. They fall into 3 broad categories:

a) Fabric,
b) Services,
c) Occupants.

a) Fabric

The principal issue is the heat lost by the dwelling

$$(UA + Cv) \times \Delta t \times \text{duration of heating}$$

Where UA = summations of the product of U values as Areas of each element of the building envelope (W/m^2 deg C x m^2)

Cv = ventilation allowance (W/deg C) = 0.36 NV where

N = No. of air changes per hour; and V = volume (m^3)

Δ t = average temperature difference between in and out doors (deg C)

We are concerned with those factors which influence U, A, N and V. This is deceptively simple since even a superficial consideration reveals that these derive from a plethora of architectural decisions: e.g. U - 'contains' all constructional information, A & V - contain all form/fenestration/size, etc. information, and N - contains all air infiltration information.

Fabric factors which influence the above are:-

House type. The principal item is the surface to volume ratio. Dwellings are conventionally divided into the following categories: detached houses, semi-detached and end terrace houses, top-floor flats, mid-terrace houses, and intermediate flats, and although these descriptions were retained in the questionnaire to facilitate comparison with existing statistics, they do not necessarily correlate with energy use and more detailed information was required if subsequent analysis was to identify house energy types.

Size. The number of rooms was rejected since room sizes have changed considerably. Total floor area is more valid. An assessment of the number of bed spaces was retained.

Form and Construction. Once it was agreed that simple assessments of house type and size were insufficient, the next stage of sophistication was an assessment of areas and construction for all elements of the building envelope. The assessment of areas presented problems of survey methodology and the time required for each survey. Eventually it was decided to rely on measurement and estimation. A standard 2.5 m floor spacing was assumed, in order to ease computation. Measurements needed to be presented in a consistent manner and a model of 6 'elevations' was used (4 walls, ground, roof) and areas of each element in each elevation were presented as a set of data. This approach was supported by considerations of recording constructional information alongside areas. Construction identification proved to be an item of major difficulty since a full knowledge of this is required if 'U' values are to be ascribed to the various elements. Pilot surveys revealed an enormous diversity of construction (even lists of simple wall constructions rapidly achieve 50+). Assessment was limited to an identification of external and internal surfaces. The nature of the construction between these surfaces could often be implied but in the case of framed structures, or those containing unknown amounts of insulation, this is less likely to be accurate. However, the date of construction can often indicate a likely 'U' value to ascribe in these cases.

Ventilation was of great concern because of its significance (30-50% of heat loss) and indeterminate nature. Various attempts were made to employ existing models but there was no evidence that their additional complexity would be rewarded by more accurate data and eventually ventilation assessment was rationalised to an identification of those key factors which could either be assumed to have some bearing upon a standard assumed ventilation rate and/or have some other significance such as type of openings, lobbies, durable draughtstripping, outside w.c. only, exposure.

b) Services

Only space and water heating were included and similar problems of identification as for construction arose here - the number of possible heating systems proliferating with every discussion/pilot survey until a similar methodology of identifying key parameters evolved. In any heating system these are fuel distribution system, heat emitters and controls and surveyors described systems by these parameters. Actual as well as design or installed heating systems were recorded both for living and sleeping areas, with provision for a principal and secondary system to be recorded for each.

The formats used for fabric and services had the advantage of universality but suffered from a tendency to complicate the description of simple systems, especially in the case of the domestic hot water provision.

c) Occupancy

Not only do residents influence energy consumption and hence any potential for savings but occupancy characteristics are relevant to any social policies for energy improvement, e.g. special treatment for the elderly and handicapped. To these ends a variety of factors relating to the occupancy and use of the building were included: ages, bedspaces, disability status, duration of heating, user response to heating system, and others were rejected, e.g socio- economic status.

Naturally many other factors were considered and omitted for various generally pragmatic reasons, e.g. orientation, condensation, general condition, fuel bills, energy consuming appliances, seasonal differences in hot water provision, temperature and ventilation preference and use.

References to Appendix 1 will clarify the nature of the questionnaire and the data it generated.

2.3. Logistics

During 1976 and 1977 Birmingham City Housing Department had for general housing management purposes formed a complete property file on the City's computer and this was used as the basis for survey sample selection. Of the various methods available a simple random sample by selecting every 25th address from the property file was chosen. Sample size was impossible to optimise with such a varied unknown population. As previously mentioned this was the first U.K. exercise of this scale and nature - preliminary 'desk work' could not assist since the archive material tends to be incomplete, inconsistent and incompatible with the requirements of this type of survey. Consequently as large a sample size as could be practically surveyed within the known constraints of time and money was selected. This was 4% or 6,200 dwellings. Letters of information were sent to all these dwellings prior to the survey.

23 surveyors were recruited from students on vacation, about half having some relevant experience. Surveyors were equipped with Housing Department identity cards, calculator, metre rule, etc. and after a 2 day training period worked in pairs for a further 2 days and then individually. Once the 'learning curve' had levelled out surveyors appear able to complete between 6 to 8 house surveys per day.

Each week concluded with a debriefing session from which minor modifications to the form, coding and rules of interpretation evolved. Questionnaires were submitted to a limited check shortly after their return, 'satisfactory' forms proceeding to data entry to the computer. Understandably all the dwellings initially selected could not be surveyed. A few had been demolished, purchased by tenants or were empty. Some direct refusals were encountered and in other dwellings tenants were out on each of the 3 visits allowed. These latter 2 aspects introduce a slight bias to the sample in that refusals mainly came from elderly or handicapped people and absent tenants would generally result from young workers.

These together with 'unacceptable' questionnaires (i.e. in which inconsistencies preclude useful analysis) reduced the survey sample to just over 4,700. Further details about the survey may be found in the Interim Report.

2.4 Fieldwork Conclusions

The Questionnaire

It became apparent at an early stage that, while a very simple superficial survey could be performed relatively easily, the next available degree of investigation required a jump to a much more intense and detailed level of study. The major problem has been to restrict the complexities which necessarily develop from such an increase in sophistication without over simplifying the content. Nevertheless the form employed was still rather complex necessitating a thorough training programme for surveyors (1 or 2 weeks rather than 2 to 4 days). This applies in particular to the coding system used to describe space and water heating, the latter undoubtedly being forced to fit the former. The excess of detail on the heating services was not matched by a similar level of information on the construction although to have been more precise would require surveyors skilled in this aspect. Additionally air infiltration and ventilation reveal themselves, as always, to be the great unknowns and no satisfactory method was found for improving upon standard assumptions.

Mounting and running a survey of this scale, (especially as it involved advance notification to tenants and a system by which they could establich contact with the City Housing Dept.) consumed much greater resources than originally envisaged. This was more a function of the scale rather than the nature of the survey, but the role of the City Housing Department in co-ordinating and organising the survey was crucial to its success. Experience suggests that this kind of full time commitment is essential in such investigations.

A major strength throughout the development and operation of the survey lay in the multi-disciplinary composition of the working group which made it possible for a range of priorities and viewpoints to be brought to the problem. Energy use in building is such a diverse phenomenon that traditional divisions of responsiblilities and skills are not viable if the problems are to be identified and resolved thoroughly.

3. SURVEY ANALYSIS

To date the analysis of the data has taken two principal forms:-

- statistical manipulation of raw data
- by ascribing assumed U values and ventilation rates based upon a knowledge of age, construction, etc. analysis of the thermal properties of the stock is possible.

3.1 Statistical Data

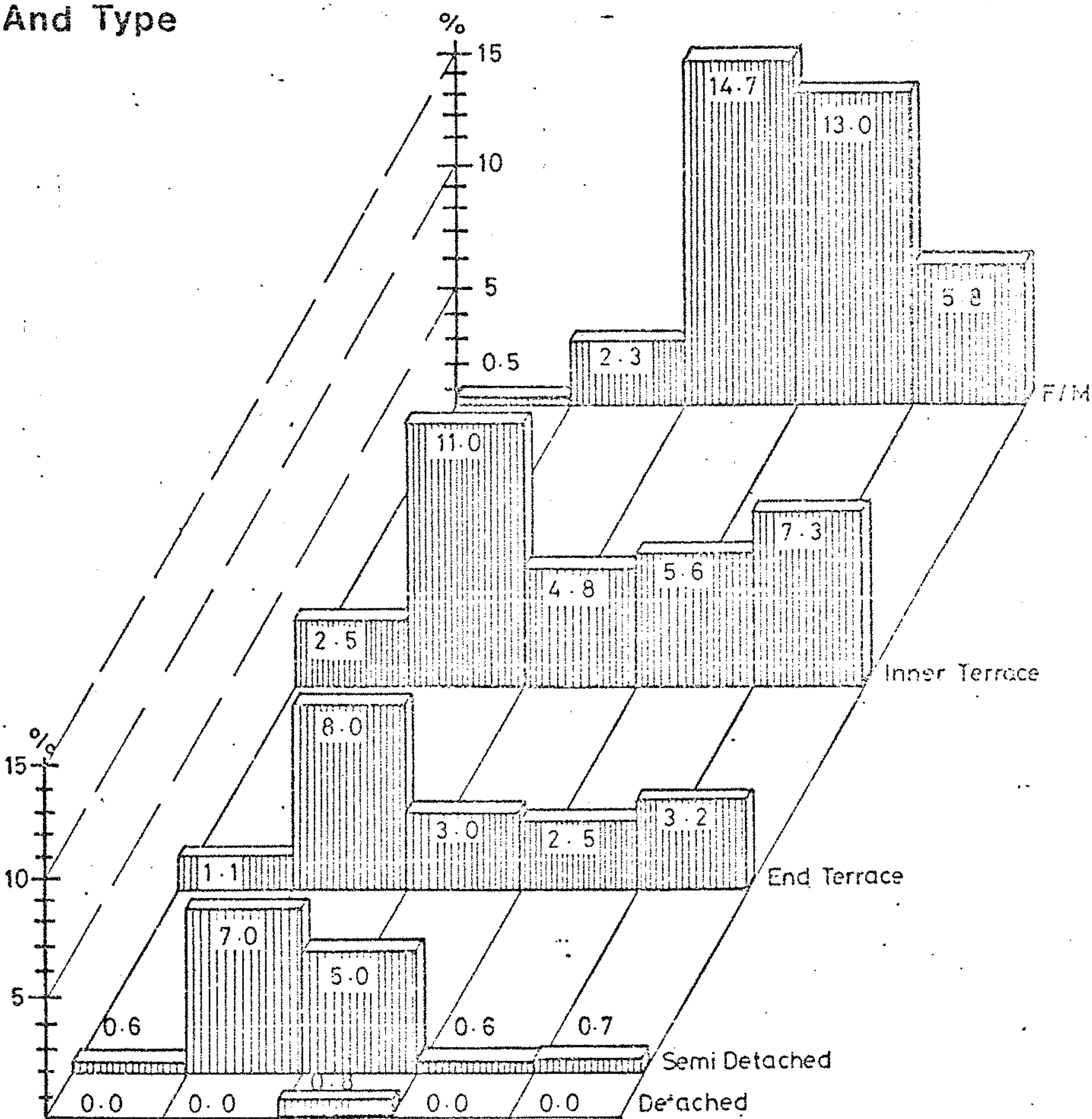
Appendix 2 gives a full acount of extracted data from which the following points have been drawn:

3.1.1. Age and Type

Figure 3.1. reflects the history of Council house building in the City of Birmingham. Under 5% of the total sample is composed of pre 1919 properties which have been acquired by the City. 28% of the sample properties were built in the inter-war years. A high proportion of the semi-detached, end terrace and inner terrace houses were built in this period on the large suburban estates developed around the old "villages" within the City boundary. Exactly the same proportion of the total sample was constructed during the years 1940-63. In this period the "prefabs" were erected. 40% of flats and maisonettes in the sample were also completed during these years. Many of these are in low-rise developments but multi-storey development was under way towards the end of the period. Of the buildings surveyed constructed between 1964 and 1969 almost 60 % were flats or maisonettes. This was the period during which the City undertook large scale tower block development in order to facilitate the slum clearance programme which was a major problem. A change in house building policy is reflected in the sample of post 1970 properties. A wide variety of types has been built with inner terrace properties being the most heavily represented in the sample. This reflects the ending of high-rise development and current attempts to provide an acceptable mix of dwellings in low-rise situations.

Fig: 3.1

Dwellings According to Age And Type



Pre 1919	1919 - 39	1940 - 63	1964 - 69	Post 1969	
4.7	28.3	28.3	21.7	17.0	Totals

Scale is percentage of sample

From the overall sample of 4,722 properties, 36% of properties surveyed were flats or maisonettes; 31% were inner terrace; 18% were end terrace; 14% were semi-detached and 1 % were detached.

Of concern is the relationship of the Birmingham and national stocks. This is illustrated by Table 3.1.

TABLE 3.1. - Distribution of Birmingham Authority Housing.

	Pre 1919		1919 -1939		1940 - 1963		1964+		All Ages		
Detached	0	(4.5)	0	(2.5)	1	(5.5)	0	(3)	1	(15.5)	[1]
Semi-detached	.5	(4)	7	(7.5)	5	(13)	1.5	(6)	14	(30.5)	[33]
Terrace	4	(16)	19	(4)	7.5	(6.5)	18.5	(5.5)	49	(32)	[35]
Flats/Maisonette	.5	(9)	2	(2.5)	14.5	(6.5)	19	(4)	36	(22)	[31]
All types	5	(33.5)	28	(16.5)	28	(31.5)	39	(18.5)	100	(100)	[100]
	[4]		[24]		[46]		[26]				

All figures are % of stock. ( ) = all UK housing (Romig and Leach, 1977)

[ ] = all UK Local Authority housing (NDHS, 1978)

The Birmingham Authority stock has much fewer older and detached/semi detached houses than the U.K. as a whole. It has less pre '63 housing than local authorities generally, the post '64 house building programme suggesting a large proportion of non traditional dwellings which may be more difficult to improve thermally. About 35% of the Birmingham sample is detached, semi or end terrace compared with about 55% nationally. This is significant to wall insulation programmes.

3.1.2. Occupancy

Figure 3.2 shows the relationship between the observed occupancy (Actual) and that provided for by the dwelling(Design). The design figures above are predictable. For example most of the semi-detached, end terrace and inner terrace types in the sample are designed for 4 to 5 persons. Those designed to accommodate 1 or 2 people are probably bungalows specifically designed for elderly. 85% of flats and maisonettes surveyed were designed for 2 to 4 persons. The sample also reflects the relative scarcity of larger dwellings, i.e. those designed to accommodate 6 or more people.

However comparison with Actual figures is more interesting. Over half of households contain only 1 or 2 people compared with a provision of 16%, so there is a significant number of small households which may not require whole house heating. Over 60% of the semi-detached and end terrace properties in the sample were occupied by 2 or 3 persons. 70% of flats and maisonettes were occupied by 1 or 2 persons. At the other end of the scale it would appear from the sample that there is some deficiency in the number of large properties. These disparities reflect the lack of mobility in the public sector, and also former municipal building trends. The emphasis on three bedroom houses in the inter-war years, for example, has created an imbalance in the dwelling mix which the City is currently trying to rectify by way of its new building and conversion programmes.
For a summary of design household size against actual household size see Table A2.4.

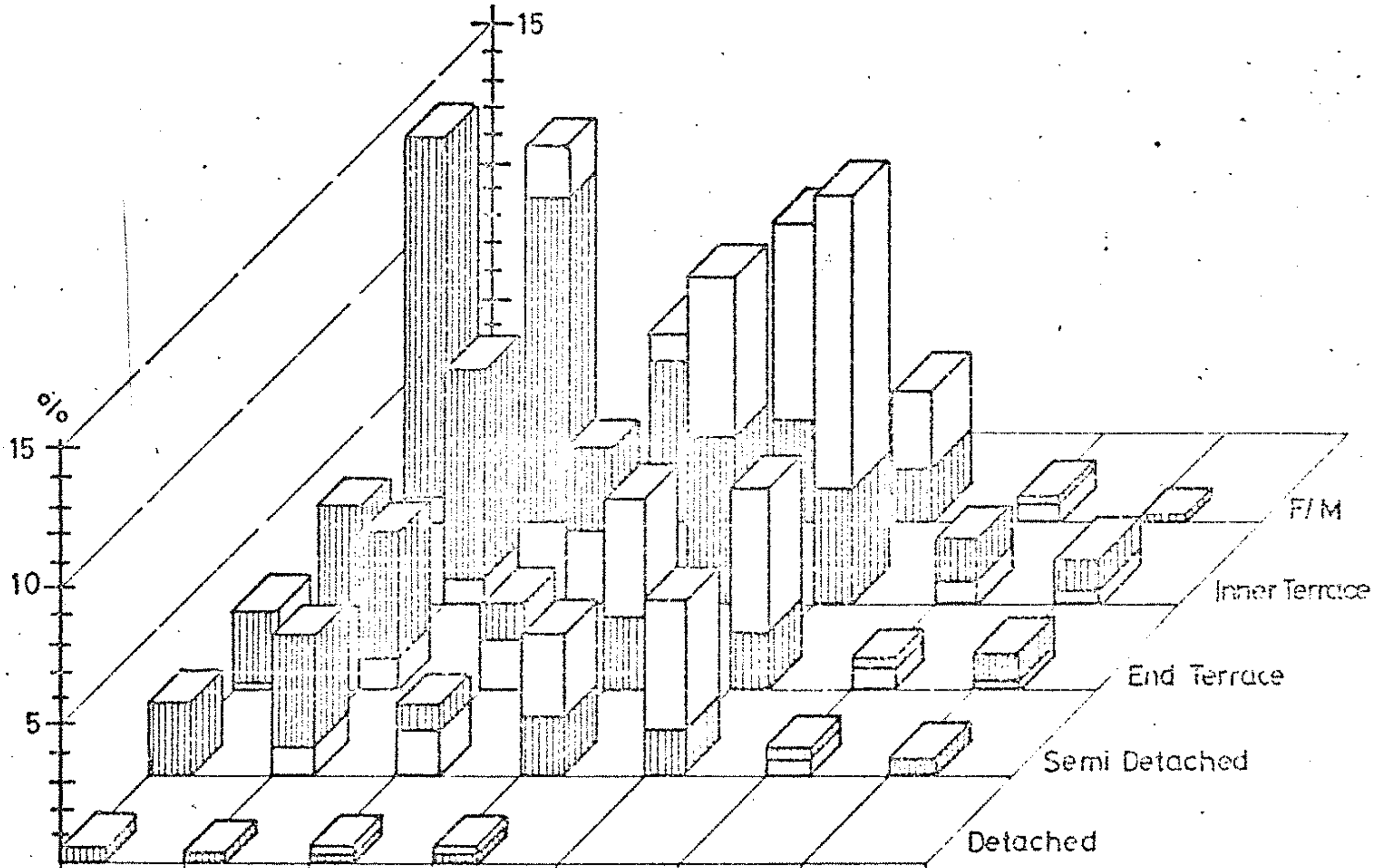
3.1.3. Fabric

Walls -

Fig. 3.3. shows the distribution of predominant wall type (there may be more than one type for an individual dwelling). Solid walls are predominant even in this younger stock but of equal note is the high proportion of 'other' constructions where any retrofit treatment is likely to be diverse and complex.

Virtually all of the detached properties have walls falling in to the "other" category, being prefabs.

Design and Actual
No of Persons by House Type



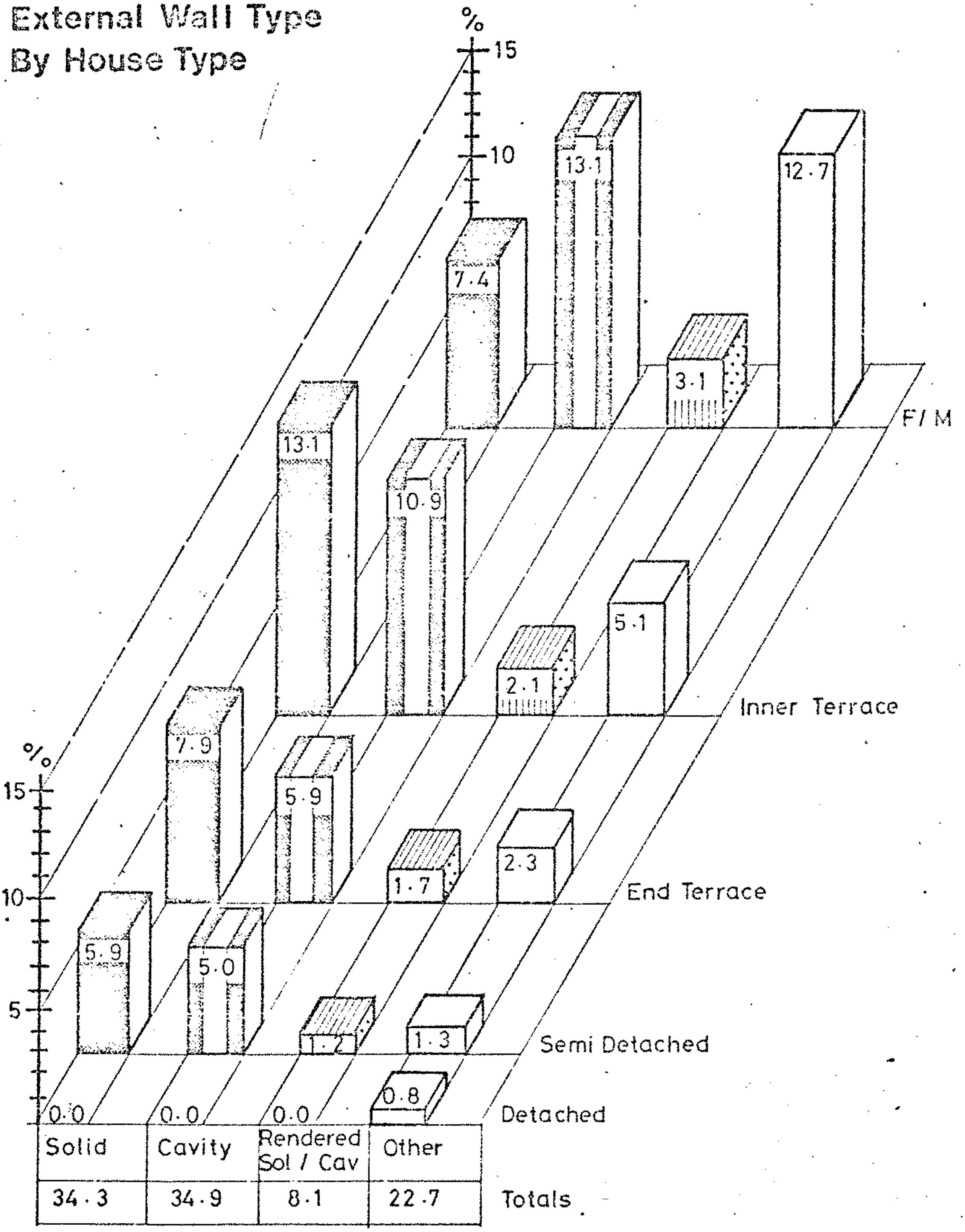
Persons	1	2	3	4	5	6	7 Plus
Design	0·7	15·9	12·3	34·9	32·7	2·3	1·2
Actual	23·0	31·1	16·1	13·7	8·7	4·3	3·1

Design (exceeds actual)

Actual (exceeds design)

Scale is percentage of sample

External Wall Type By House Type



Scale is percentage of sample

42.5% of the semi-detached properties surveyed were of solid wall construction, generally built in the inter-war years. A further 9% were of solid wall construction with a rendering on the face of the external walls. 36% of semi-detached properties had cavity walls, having been constructed in the post-war period. The remaining semi-detached are classified as "other" i.e. the major external wall component is other than solid or cavity brickwork, e.g. precast panels, sheet cladding, hung tiles.

The terraced dwellings in the sample show a very similar pattern to the semi-detached. Solid wall construction, rendered or otherwise, account for about 50% of the properties. Just over a third of these types have external walls of cavity construction.

These external wall types reflect the age distribution of the overall stock in the sample.

The flats/maisonettes category shows that 35% have external walls defined as "other". These are no doubt the system-built multi-storey blocks of flats which were prevalent in the 1960's.

Floors -
23% of floors are suspended (16% timber)
Roofs -
97% are pitched with lofts.

Windows and doors -
Only 7% of dwellings had draughtstripping and 17% had an entrance lobby. Rare occurrences of double glazing could be attributed to sound insulation programmes. The mean area of glazing is similar for all dwelling types but the range and proportion varies considerably.

TABLE 3.2. - Average Areas of Elements (m^2)

	Roof/ Floor	Wall	Windows mean	Windows range	Window as % of Ext. Wall
Detached	64	68	11	8 to 14	14
Semi-detached and End Terrace	41	74	13	5 to 21	15
Mid Terrace	41	48	13	6 to 21	21
Flat/Maisonette	56	39	11	5 to 17	22

Over 90% of semi-detached and terrace houses are of 2 storey construction, the remainder being either bungalows or 3 storey houses. 85% of flats/Maisonettes are in fact flats.

Of the total sample 23% of the properties had floor space of less that $60m^2$. 47% of the flats/maisonettes fell into this category, another 40% being in the next range of 60 - $80m^2$. Approximately 80% of the semi-detached, end terrace and inner terrace types had floor space areas of between $60m^2$ and $100m^2$ i.e. ground floor area multiplied by the number of storeys. The 6% of sample properties with over $100m^2$ of floor space are either large purpose built dwellings or amongst the houses acquired by the City.

3.1.4. Services

Table 3.3. summarises some of the findings.

TABLE 3.3 - Relationship between Fuels and Heating.

Fuel	Living Rooms Heating Design	Living Rooms Heating Actual	Sleeping Rooms Heating Design	Sleeping Rooms Heating Actual	Water Heating Actual	% Satisfield
None	0	0	40	43.5		
Electricity on peak	1	14.5	5.5	24	72	50
Electricity off peak	14.5	7.5	2.5	2	8.5	37
Solid	47	4	22	1	2.5	55
Gas	36.5	72	30	26.5	16	67
Oil	1	1	0	0.5	1	70
Manufactured fuels	0	1	0	2.5	0	

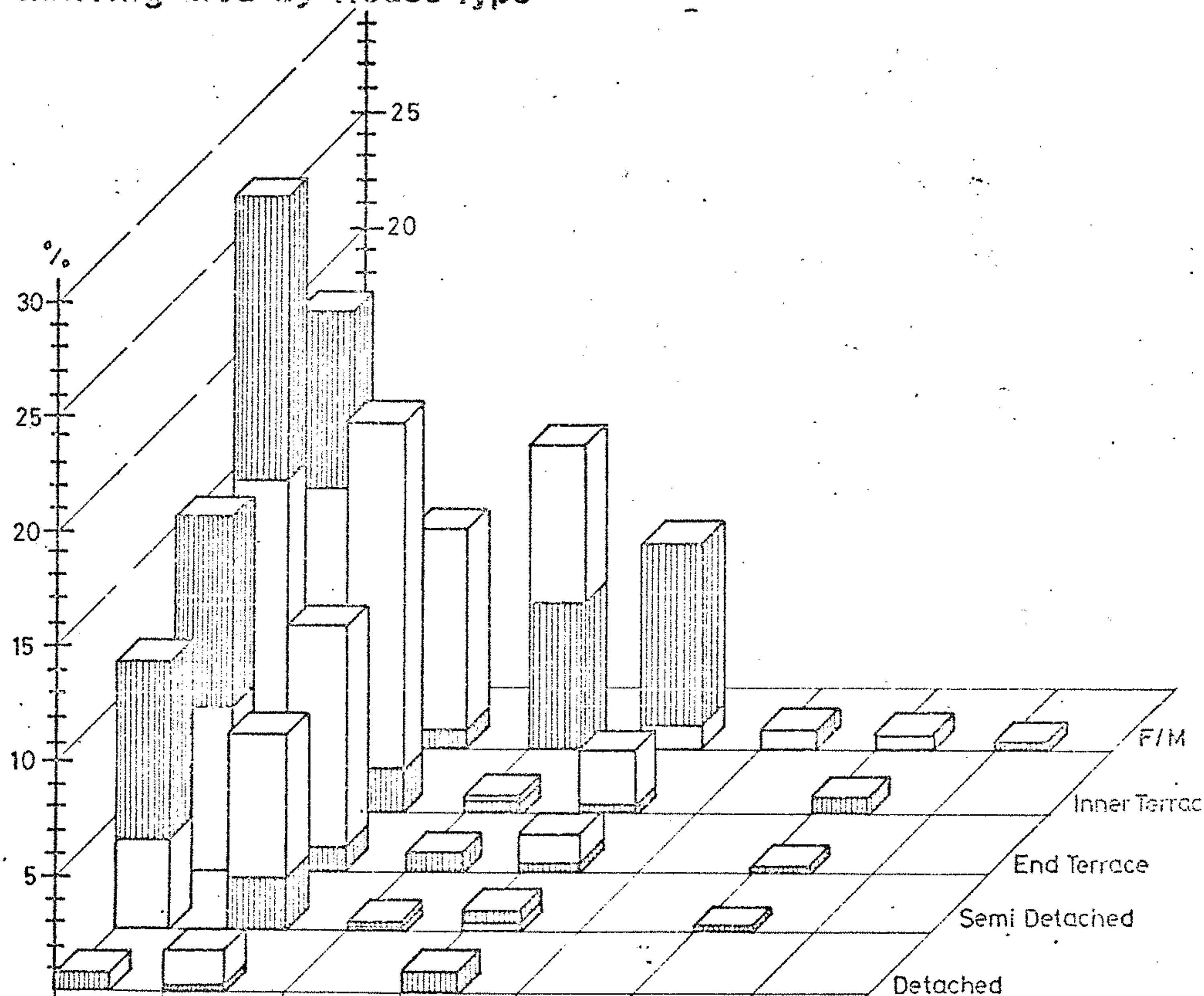
(All figures are % Birmingham stock)

Figure 3.4. illustrates the relationship of design and actual fuel use for living rooms for the various dwelling types.

Table 3.3. and Figure 3.4 reflect the mobility in fuel use (54% using a non design fuel) which agrees with the national trends (Leach, 1979) with a great decline in solid fuel and increase in gas use (mostly gas fires in living rooms). There has been a move from electric off peak systems probably to on peak electricity in those dwellings where other fuels are not available. Over 40% of dwellings do not heat bedrooms and this has already been referred to in the context of actual energy savings. Water heating is predominantly on peak electricity reflecting the small number of wet gas central heating systems. 21% of storage cylinders had no insulation, more than half of which are fuelled by solid fuel and this may be due to old systems with awkwardly shaped and positioned tanks.

Fig: 3.4

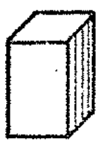
Design and Actual Fuel Type In living area by House Type



	Gas	Solid	El. off	El. on	Oil	Manuf.	None
Design	36·4	47·2	14·3	1·1	1·0	0·0	0·0
Actual	72·0	4·0	7·4	14·3	1·0	1·2	0·1

Design (exceeds actual)

Actual (exceeds design)



Design and Actual numericaly the same

Scale is percentage of sample

All of the dwellings heated by oil used it, quite possibly for lack of practical alternatives in a district heating scheme. The small number of dwellings with on-peak electric systems also tended to use them in the majority of cases, possibly for similar reasons. Gas, which was designed in 1,720 properties in the sample, was actually used in 92% to heat at least the main living areas. This indicated the popularity of gas and the lack of attraction of alternative fuels in terms of both cost and satisfaction. Just over half of the sample properties with off-peak electric systems were actually heated with an alternative fuel. As would be expected the vast majority of households with solid fuel systems preferred an alternative method of heating. In fact 80% of those that did employ a different system from that designed had moved away from solid fuel.

The figures indicating satisfaction have been correlated with the design fuel use in the living rooms although there may be some doubt as to the validity of this since it is to be expected that some replies related to an actual usage which has long since superseded the design fuel usage (especially solid fuel).
About 30% of dwellings had a central heating system.
70% of households in the survey heated their dwelling for at least eight hours a day during the winter months. The proportions across the dwelling types are very similar, although a lower percentage of flats/maisonettes than other types heat for this long. It is perhaps surprising, in view of the number of single-person and working households in the City, that such a high percentage do heat during the day in winter.

3.1.5. Satisfaction with Heating System

The survey form allowed for those households who said they were not satisfied with their heating system to give up to four reasons for their response. In all 2055 households out of 4722 expressed varying degrees of dissatisfaction with 3445 reasons given. Just over half of those dissatisfied gave only one reason. The breakdown of the reasons given in order of popularity is as follows:-

Heating too costly	42%
Dwelling too draughty	41%
Not warm enough	31%
Only heats certain rooms	31%
Other (specified on form)	16%
Dwelling too stuffy	4%
Prefer fire/focal point	2%

(all percentages of those dissatisfied)

As mentioned in the previous section there is some doubt as to whether the dissatisfaction reasons refer to design or actual system usage. It is also important to point out that the replies "Dwelling too draughty/stuffy" are more a function of the building than of the heating system and further responses to these questions may have been precluded by the original questions mentioning only the heating system.

Table 3.4. shows the correlation between satisfaction/dissatisfaction with heating with each dwelling type split into age groupings. The overall figures for all dwellings again show that approximately 56% of the sample were satisfied with their heating system.

TABLE 3.4. - Satisfaction with heating system by dwelling type and age group.

	Pre 1919		1919 - 39		1940 - 63		1964 - 69		Post 69		Totals	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Detached	0	1	0	0	16	20	1	0	0	0	17	21
Semi-detached	11	16	201	131	103	131	12	15	26	9	353	302
End Terrace	39	13	209	167	72	67	64	55	109	44	493	346
Mid Terrace	81	36	313	204	128	101	151	115	235	111	908	567
Flat/Maisonette	19	7	76	35	349	348	292	321	160	108	896	819
Totals	150	73	799	537	668	667	520	506	530	272	2667	2055

KEY YES = satisfied with heating system
NO = dissatisfied with heating system

By age groupings the most satisfied households were living in pre 1919 dwellings (67% satisfied) and in post 1969 dwellings (66% satisfied), the least satisfied were those living in dwellings built between 1940 and 1963 (50% satisfied). By dwelling types the households most satisfied with their heating system were those living in inner terrace houses with 62% satisfied, the least satisfied living in detached houses with only 45% satisfied. These figures are possibly explained by the areas of external wall in these two types affecting the heat loss. Particular categories of dwelling type/age groups showing the highest satisfaction with heating were: end terrace houses pre 1919 (75%), inner terrace house pre 1919 (69%), end terrace houses post 1969 (71%), inner terrace houses post 1969 (68%) and flats built 1919-39 (69%). Conversely the categories with the most unpopular heating systems area: semi detached house built 1940-63 (44%) and flats and maisonettes built 1964-69 (48%).

The effect that window size has on the groups discussed above is shown in Appendix 2 Table A2.8. Overall, households not satisfied with their heating system live in dwellings with 0.6 m^2 more glazing than those who are satisfied. All categories except two show a similar trend ranging from 0.1 m^2 to 2.0 m^2 more glazing. All of the above and other factors drawn from the data are clearly of significance in estimating the 'markets' for action and the implications of various policies. A difficulty arises in that, shortly, most of the obvious and simple measures will have been carried out (e.g. loft insulation, draught stripping) and further action is much more dwelling-specific such that coarse statistics of the type outlined here may be of reduced value.

3.2. Thermal Properties

As described above U values and ventilation rates were ascribed in accordance with the survey data - modified by contemporary building construction traditions. It was then possible to carry out a steady state thermal analysis for all dwellings. This was in an attempt to identify thermally representative dwellings referred to as 'energy types'. Initially two parameters were used:-

$$\text{Design heat loss in Watts}/^{o}\text{C} = (UA + 0.36\ NV)$$

$$\text{Volumetric heat loss in Watts}/^{o}\text{C}/\text{m}^3 = \frac{(UA + 0.36\ NV)}{V} = G$$

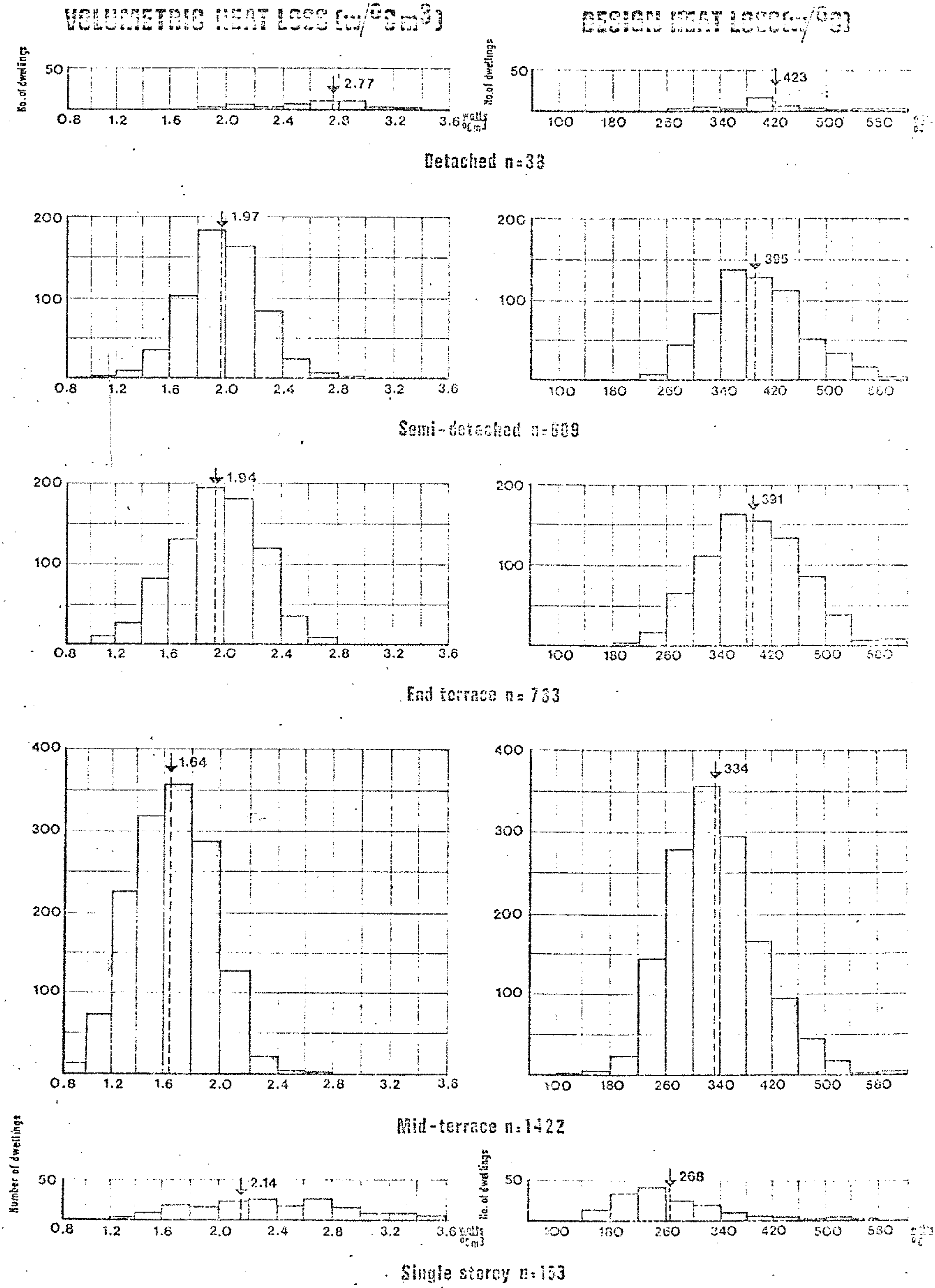
TABLE 3.4. - Dwelling types ranked by G. Value

Type	Mean Volumeric Heat Loss (G) $W/^{o}C/m^3$	Mean Design Heat Loss $W/^{o}C$
Ground floor flats in 5+storey blocks	1.61 (.9 to 2.3)	225 (20 to 320)
Mid-terrace	1.64 (.9 to 2.3)	334 (160 to 600)
Intermediate Flats in 5+storey blocks	1.66 (.9 to 3.3)	240 (120 to 440)
Flats in 3 to 4 storey blocks	1.69 (.9 to 3.5)	294 (120 to 600)
Flats in 2 storey blocks	1.79 (0.9 to 2.9)	244 (120 to 480)
End terrace	1.94 (1.1 to 2.7)	391 (200 to 600)
Semi-detached	1.97 (1.1 to 2.9)	395 (240 to 600)
Top floor flats in 5 + storey blocks	2.02 (1.1 to 3.1)	309 (200 to 480)
Detached	2.77 (1.3 to 3.5)	423 (280 to 600)

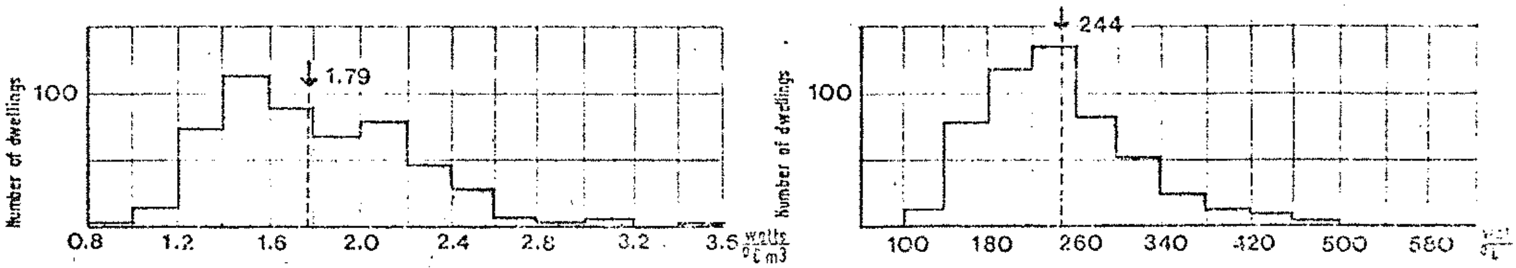
This is illustrated graphically in Figure 3.5.

Most of the variations can be explained in terms of form, age, construction and window areas.

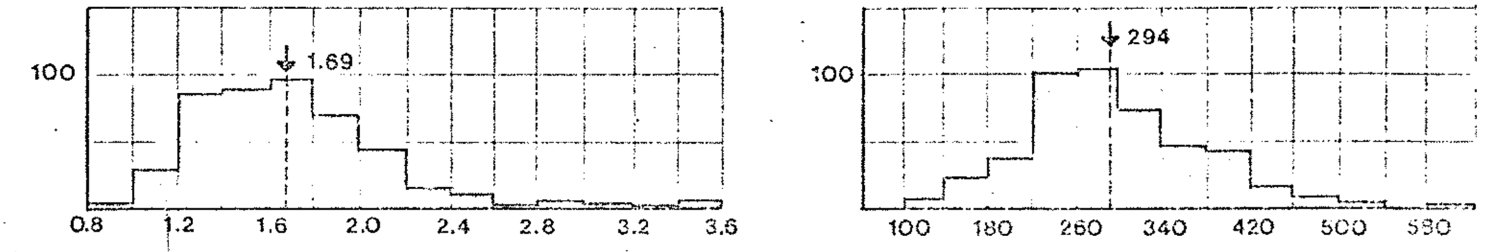
Fig. 3.5


VOLUMETRIC HEAT LOSS (w/°C m³)
DESIGN HEAT LOSS (w/°C)
No. of dwellings
2.77
423
Detached n=38
1.97
395
Semi-detached n=609
1.94
391
End terrace n=783
1.64
334
Mid-terrace n=1422
Number of dwellings
2.14
268
Single storey n=153
watts/°C m³
watts/°C

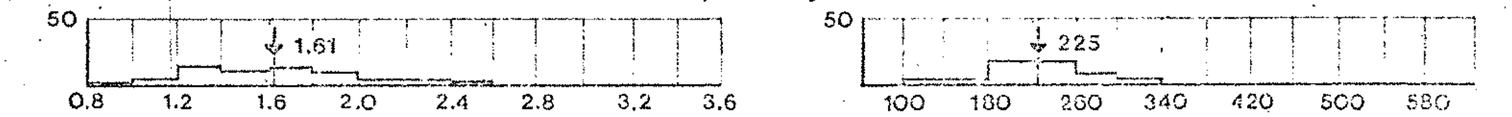
VOLUMETRIC HEAT LOSS (w/°Cm³) DESIGN HEAT LOSS (w/°C)



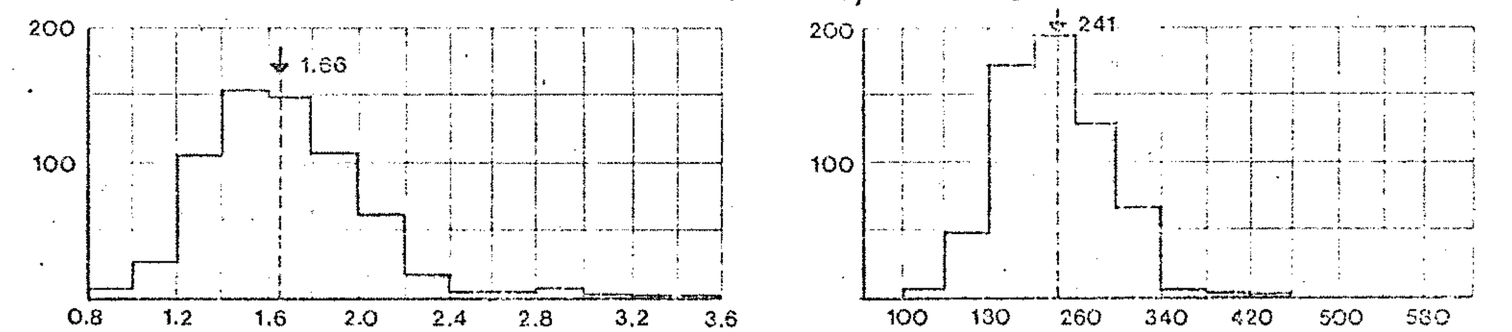
Flats in 2 storey blocks n:511



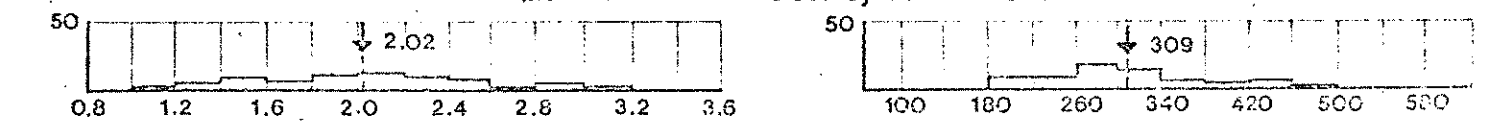
Flats in 3,4,5 storey blocks n:447



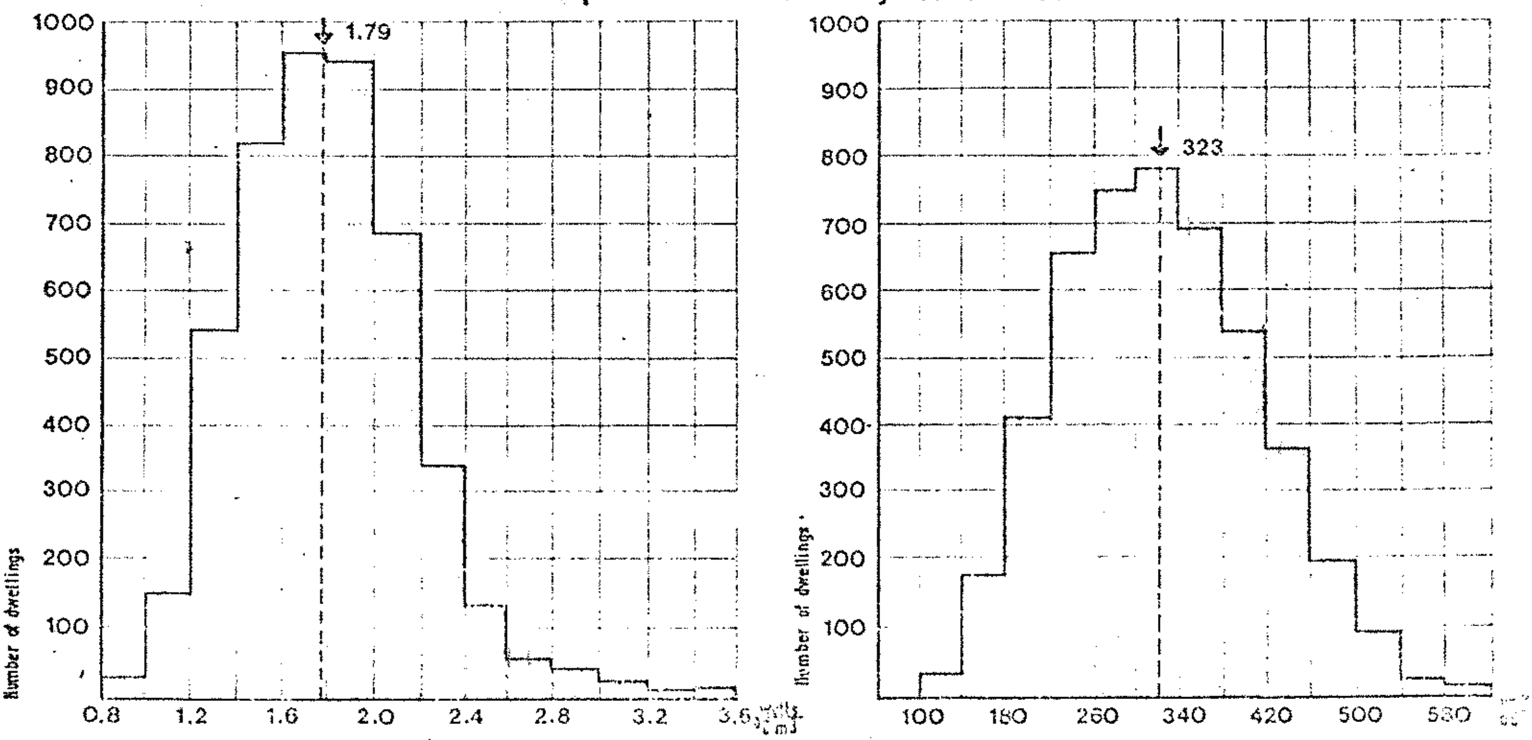
Ground floor flats ≥ 6storey blocks n:51



Mid-floor flats ≥ 6 storey blocks n:632



Top floor flats ≥ 6 storey blocks n:60



All dwellings n: 4,706

Form or dwelling type was generally seen to be of greater import than construction to the G values and this is in agreement with the relatively minor variations in U values and window areas in the existing stock (section 3.3.).

The following constructional factors appeared to be significant descriptors of energy performance:-

Wall:	cavity masonry	solid interior	Roof:	uninsulated
"	" "	board lined	"	"
"	" "	solid interior	"	insulated
"	" "	board lined	"	"
"	solid masonry		"	uninsulated
"	" "		"	insulated
"	'other' construction		"	uninsulated
"	" "		"	insulated

and the following dwelling forms:-

- single storey
- detached
- semi-detached
- end terrace
- mid terrace
- flats in 2 storey blocks: ground floor, top floor; end or mid terrace (4)
- flats in 3/4 storey blocks: ground, mid, top floor; end or mid terrace (6)
- maisonettes 3/4 storey blocks: ground, mid, top floor; end or mid terrace (6)
- flats in 5+ storey blocks: ground, mid, top floor; (3)

Of the 192 possible permutations generated by the 8 construction and 24 forms only 30 constituted more than 1% of the sample. These were regarded as indicative of 'Energy Types'. Further subjective considerations reduced this to between 20 and 25 dwellings which the inter-disciplinary group 'felt' to be representative of energy types. Such scientifically imperfect analysis is defensible in the context of an essentially pragmatic approach, and the lack of a reasonable alternative.
(See Appendix 3 for a description of these energy types.)
These energy types were used as a basis for selecting 25 dwellings as case studies for Phase II of the project.

The large scale of the survey was decided at a relatively early stage in response to the general ignorance of the thermal properties of the existing stock, i.e. the net was cast blind and wide. In the process of selecting dwellings for the Phase II case study stage an analysis of 750 dwellings (0.5%) revealed negligible differences to that for the larger sample (3.2%). This alone suggests the viability of a smaller scale survey. Additionally, however, there remains a general feeling that the data collected in this exercise although reasonably comprehensive is still insufficient. In developing the questionnaire it soon became apparent that there was not a continuum of degrees of sophistication between the superficial and the 'in-depth'. The scale of this survey and the surveyors dictated a superficial level but the use of an ergonomically appropriate form together with the elevational and coding systems made possible the achievement of reasonable 'depth'. This naturally necessitates suitable training of surveyors.

Also, it cannot be assumed that the necessary depth of information can be gathered easily by skilled surveyors and many readers will be familiar with the difficulty in accurately identifying certain constructions especially in post '60 housing. This suggests a requirement for new forms of surveying instrumentation and recent developments in the use of fibreoptics and infrared thermography are encouraging.

4. FURTHER WORK

PHASE II - CASE STUDIES

The 25 energy house types each constitute a case study aimed at fulfilling the objective of identifying strategies and tactics for energy improvement work. As with other work in this field the generation of a 'case law' is seen as a valuable goal in itself. To this end the 25 houses are being improved within the remit of Birmingham City Council via a 'live project' co-ordinated by the Housing Department and carried out by the Architect's and Engineer's Department. The live project is paralleled by a monitoring exercise largely resting with the Birmingham School of Architecture, aided by West Midlands Gas. The dwellings have been monitored during the 79/80 winter and will be 'improved' summer '80 and re-monitored in the 80/81 winter.

Monitoring has 4 principal aspects:

Energy use

Fortnightly reading of separate meters to heating, hot water, lighting and power.

Temperature

4 to 6 room temperatures are measured at half-hour intervals using recently developed individual compact microprocessor based recorders which enter each temperature reading into a memory. These readings are transcribed at regular intervals to a microcomputer where they are analysed. This has proved to be extremely reliable and labour saving. External temperatures are being monitored and meteorological records kept.

Behavioural aspects

The occupants are to be interviewed to identify household characteristics, use of appliances and space and window usage.

Practicalities

For the exercise to be of direct benefit to others the operational aspects of the project also require evaluation, e.g. design, construction, management, costs, etc.

Thermal upgrading of the 25 houses is currently being designed. A comprehensive range of measures is under consideration ranging from simple draught exclusion, roof insulation, etc. to comprehensive improvement packages involving solid wall insulation,heating system changes, etc. Strategically, improvements are seen to fall into three categories:-

First-aid

First line of defence work such as draught exclusion, system maintenance, roof and hot water tank insulation.

Optimum

A range of measures suited to individual houses and intended to represent the maximum that can be cost-effectively carried out. This may include cavity wall insulation, additional roof insulation, more thorough draught exclusion etc.

Rehabilitation

Older properties will at some stage be due for renovation and it is more cost-effective to include energy conservation measures during such work when only the marginal or extra cost is entered onto the cost-benefit analysis.

Experience to date is still anecdotal but the following comments seem pertinent:-

- There is a genuine difficulty in identifying constructional details especially in more recent non-traditional dwellings.

- Dwellings need to be regarded as total systems and apart from simple measures such as roof and cavity wall insulation other measures tend to become dwelling specific and highly sensitive to small scale details, e.g. external wall insulation is influenced by eaves details, external service pipes, etc. and internal insulation may be precluded by the nature of opening windows, etc. even insulating hot water cylinders can be precluded by certain details.

- Certain forms of construction are vey difficult to retrofit, e.g. where window frames are effectively loadbearing. A lesson for the future must be to design for subsequent change.
- Existing maintenance and improvement programmes offer considerable opportunity for introducing energy conservation measures, e.g. window replacement, timber floor repair, etc. but co-ordination with this may be difficult.
- Ventilation provision to gas appliances may be incompatible with extensive draught stripping exercises and ideally a direct air route to the applicance should be provided.
- There is a preponderance of living room heating (often to very high temperatures) with little or no heating elsewhere. In such circumstances the balance between whole house improvement to one level as opposed to living room only improvement to a higher level should be considered.
- Early analysis of temperature and energy data reinforces the importance of ventilation and free heat gains in the energy balance. Additionally the significance of party elements appears as an unknown, especially for example in the case of converted flats with intermediate lightweight floors.
- The repeatability of temperature profiles and energy consumption patterns suggests that monitoring could be effectively confined to short periods, e.g. 2 weeks in mid winter and spring or autumn. Such a 'concentrated visit' technique would allow more accurate assessment of occupancy factors, e.g. window openings, use of heating system, etc. However it is possible that occupants would be unduly influenced by such a short concentrated approach resulting in an exaggerated awareness of energy use.
- It is difficult to simulate rehabilitation in a dwelling which may not now justify it, but is representative of types appropriate for such renovation in the near future. This suggests that where rehabilitation programmes are in progress some immediate thought should be given to incorporating experimental energy improvements.

5. CONCLUSIONS

Mounting a survey of this scale requires a considerable resource allocation. Fortunately, the Birmingham City Housing Department had an adequate strength in depth to provide the necessary back up to cover the shortfall in estimated managerial requirement. Without this it is doubtful whether the survey could have been kept 'in control' and most of the data acquisition would have been wasted rather than, as it was, efficiently collated, checked and 'computerised'. This point cannot be overemphasized for the benefit of those intending similar exercises.

The analysis of the survey data, although not as complete as it will be is sufficient to indicate both the attractiveness and limitations of this level of data. It is attractive in terms of its 'analysability' i.e. it is possible to identify compositions and correlations but the usefulness of this to recommendations for improvements is revealed as limited when indepth information is obtained. For example, it may be assumed that since X% of the dwelling stock has solid walls then this is the potential 'market' for solid wall insulation. However, the feasibility of this option is extremely sensitive to detailed factors undetected by a survey of this kind and without this second level of information conclusions must be tentative.

The main value of this survey then may lie in the ability to employ the data gathered in more accurate speculation about 'energy types' and any further surveys could classify fabric, form and services according to their type rather than attempt to describe all from first principles. Such 'typology' is clearly of limited accuracy but may sacrifice little relative to the slightly more refined data obtained from surveys of much greater complexity and cost. There will always be need for more accurate data but perhaps this should be limited to a more precise understanding of typologies and current efforts should be directed towards this.

APPENDIX 1

THE SURVEY QUESTIONNAIRE

CALLS	
DATE OF SURVEY	
CHECKED IN	
CONTENTS CHECKED	
PUNCHED	

ROOF	
WALL	
FLOOR	

02 HRN	
SEQUENTIAL NUMBER	
AREA/SURVEYOR	
YEAR	
TYPE	
No. OF STOREYS	
FLOORS OF	
No. OF BEDROOMS	
No. OF PERSONS DESIGN/ACTUAL	
AGE GROUP No.'S	
DISABILITY	
Is loft insulated?	
Is dwelling heated all day in winter?	
Is heating satisfactory?	
If not, why not?	

HEATING

		D1	D2	A1	A2
LIVING AREAS	SYSTEM				
	FUEL				
	EMITTER				
	CONTROL				
SLEEPING AREAS	SYSTEM				
	FUEL				
	EMITTER				
	CONTROL				
WATER HEATING	SYSTEM				
	FUEL				
	EMITTER				
	CONTROL				

OTHER	

VENTILATION ETC.

WINDOWS WEATHERSTRIPPED	
FLUE	
MECHANICAL VENTILATION	
PORCH/VESTIBULE /LOBBY	
OUTSIDE W.C. ONLY	
ROOF VOID	
ROOF VOID ACCESS	
ROOF PITCH	
EXPOSURE CATEGORY	

Fig. A1.1a

3 / 2 □ 4 / 6 — Roof=5, Floor=6, Front entrance side=1

	03		04		05		06		07		08	
	Code	Area m2	Code	Area m2	Code	Area m2	Code	Area m2	Code	Area m2	Code	Area m2
ELEVATION	1		2		3		4		5		6	
WINDOWS												
FRAME / GLASS												
TOTAL AREA WINDOWS	W		W		W		W		W			
No. OF DOORS		1.8		1.8		1.8		1.8		1.8		
TOTAL AREA DOORS	D		D		D		D		D			
TOTAL DOORS + WINDOWS	W D		W D		W D		W D		W D		W D	0.
SOLID ELEMENT												
EXTERNAL / INTERNAL												
TOTAL SOLID ELEMENT	S		S		S		S		S		S	

Fig. A1.2

CODE REFERENCES

GENERAL

Yes = 1 No = 3

TYPE

1 = Detached 2 = Semi Detached 3 = End Terrace
4 = Inner Terrace 5 = Flat/Maisonette

DISABILITY

Is there anyone who is physically disabled in a way which affects their mobility:

1 = Seriously 2 = Partially 3 = No

HEATING SATISFACTION

If no, why not:

1 = Too costly
2 = Not warm enough
3 = Dwelling too draughty
4 = Dwelling too stuffy
5 = Only heats certain rooms
6 = Prefer fire/focal point
7 = Other

EMITTER/STORAGE

1 = None
2 = Fires – flue
3 = Fires – no flue (inc. gas conv.)
4 = Rad./rad.panel/nat.conv./fan conv.
5 = Ducted air
6 = Storage block
7 = Storage fabric
8 = Hot water cylinder uninsulated
9 = Hot water cylinder insulated

FUEL

1 = None
2 = Electricity on peak
3 = Electricity off peak
4 = Solid
5 = Natural gas
6 = Oil
7 = Manufactured fuel

HEATING – SPACE AND WATER SYSTEM

1 = None
2 = Room combustion/local heating/instantaneous
3 = House combustion/CH/back boiler
4 = District combustion – metered
5 = District combustion – non metered

LOBBY/PORCH/VESTIBULE

0 = None
1 = Front
2 = Back
3 = Back + Front

ROOF VOID ACCESS

1 = Bodily
2 = Visual
3 = None

CONTROL

1 = None
2 = Boiler stat
3 = Clock
4 = 1 Spacestat
5 = Individual roomstat

ROOF PITCH

0 = Flat
1 = Less than 12° but not flat
2 = 13° – 25°
3 = 26° – 60°
4 = 60° +

EXPOSURE CATEGORY

1 = Sheltered 2 = Normal 3 = Severe

WINDOW CONSTRUCTION

FRAME

1 = Casement
2 = Sash
3 = Pivot
4 = Non opening
5 = Louvres

GLASS

1 = Single glazed
2 = Double glazed

WALL CONSTRUCTIONS

EXTERIOR

0 = Communal wall
1 = Brick – solid
2 = Brick – cavity
3 = Rendered masonry – solid
4 = Rendered masonry – cavity
5 = Concrete – solid
6 = Concrete – pre-cast panels
7 = Tile hung/weatherboard
8 = Sheet cladding
9 = Wall in contact with ground

INTERIOR

0 = Party wall
1 = Solid
2 = Board lined

ROOF CONSTRUCTION

EXTERIOR

0 = Party ceiling
1 = Asphalt/felt (flat roof)
2 = Tiles/slates
3 = Rigid sheeting
4 = Applied sheet covering

INTERIOR

0 = Party ceiling
1 = Solid
2 = Board lined

FLOOR CONSTRUCTION

0 = Party floor
1 = Solid in contact with ground
2 = Concrete suspended over vent.
3 = Timber over vent. space

SURVEY QUESTIONNAIRE DETAILS

The methodology adopted is described in the text and Fig. A1.2 illustrates the coding system. Surveyors had, of necessity to make aggregate and value judgements and much of their training period was aimed at this.

Identification Description of House Type, Heating, Ventilation, etc

(see fig. A1.1a)

The top left of the form contained a 'print out' of the house address, etc., and adjacent to this certain key dates (calls, surveys, checks, etc) could be noted. Provision was made for 3 calls - this was felt to be the acceptable minimum if bias due to non representation of certain housing and occupancy types, e.g. single person dwellings, etc. was to be avoided.

The 'HRN' is the Housing Reference No. from City Computer files.

The sequential No. was a survey No. 1 to 6,000. Surveyors and the areas into which the city was divided were assigned numbers to assist cross checking.

The year refers to the date of acquisition by the Housing Department which will be different from the date of construction by significant amounts only for acquired property.

The 'type' of dwelling has already been discussed - section 2.2.

'No. of storeys' refers to the number of levels in the dwelling.

'Floors of ' locates the ground floor of the dwelling in its block, e.g. a 2 floor maisonette in a 4-storey block would be recorded as 3 and 4 of 4 (using the American 'levels' convention.)

'No. of bedrooms' these were defined as described in Section D.

'No. of persons' - 'Design' was assessed from the number and size of bedrooms, 'Actual' was assessed by interview.

'Age groups' - Nos. in each of 4 groups were to be assessed - 0 - 4, 5 - 16, 17 - 65, 65+.

'Disability' - assessed as described in code - seriously, implied 'confined to bed'or 'severely' in DHSS parlance and include chairbound individuals; partially, implied the use of mobility aids.

'Loft insulated' - this was only by interview - surveyors were not allowed to physically investigate.

'Is dwelling heated all day' - all day was taken as more than 8 hours.

'Heating' is described in the text. 'D1' (&'A1) refers to the predominant design (and actual) system in each zone giving due weighting to main spaces, D2 (and A2) allows secondary heating to be recorded. Note that coding 1 (none) is distinct from a zero entry - e.g. if D2 is entered as zero or blank this implies that the D1 system is installed throughout that zone, whereas if D2 is entered as 1, then the D1 system only exists in the main space(s), whereas there is no heating in the other space(s) in that zone. The codings of 'controls' are not mutually exclusive, and surveyors were asked to record the highest ranking control system. To be considered as a control the device had to be accessible to the occupant.

'Window weather stripping' - an overall assessment taking account of 'durable' weather stripping only and not for example self adhesive foamstrips:
'Flue' - based on vertical flues and chimneys.
'Porch', etc - defined as a 2 door entrance with sufficient space to close one before opening other.
'Roof void' - defined as space between ceiling and roof.
'Access' - means easy access for a person.
'Roof Pitch' - gives some indication of ease of insulation.
'Exposure' - after C.I.B.S. Guide Section A4 - Air Infiltration, i.e.

Sheltered - up to third floor in City Centres.

Normal - most suburban and country premises; fourth to eighth floor of buildings in City centres.

Severe - buildings in coastal areas or an exposed hill top sites, floors above the fifth in suburban and country districts, floor above the ninth in City centres.

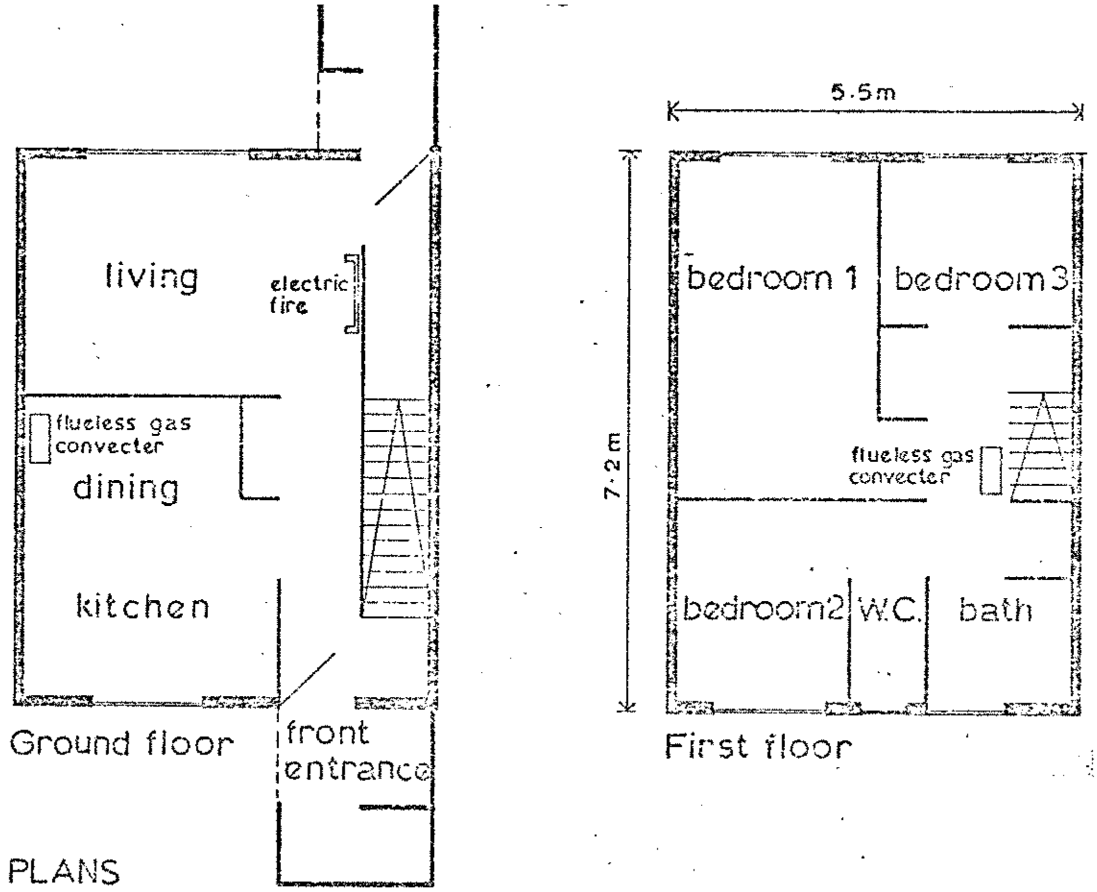
In the bottom right corner of this side of the form, surveyors were asked to record a sketch of the house plan with entrance and dimensions shown. This was a useful aid to surveyors in assessing wall areas overleaf and also helped subsequent inspection or checking of the form, providing visual communication of house form and identifying the main front entrance.

Areas and Constructions (see Fig. A1.1b)

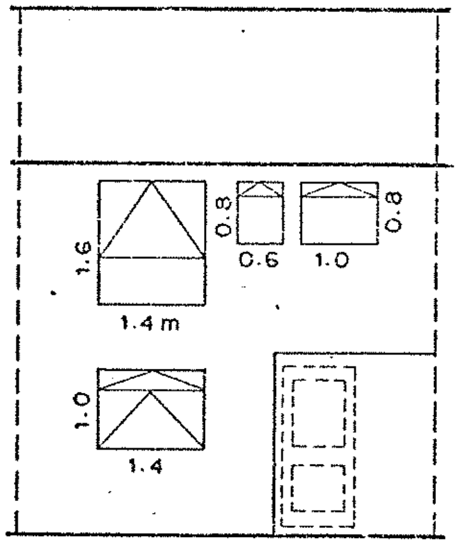
For each 'elevation' - filling the form in by working down the column formed a natural progression, e.g. the total area is plan dimension x 2.5 m x No. of levels; windows then recorded individually by estimation of area (or internal measurement), more than 6 being recorded in aggregate as a combined 6th window; total area of window and doors and therefore solid wall 'left over' then evolve; and composition of solid walling is recorded (there may be more than one type of construction - e.g. brick wall on first and tile hanging on second floor.)

This elevational treatment can 'handle' most complexities of rectangular form but to simplify measurement projecting and re-entrant features of less than 0.9m were ignored and regarded as being in the same plane as the main wall. The recorded roof area was the project areas of the roof on the horizontal plane. The area data recorded together with details of roof pitch, plan dimensions, etc. provide a full description of the house type and form.

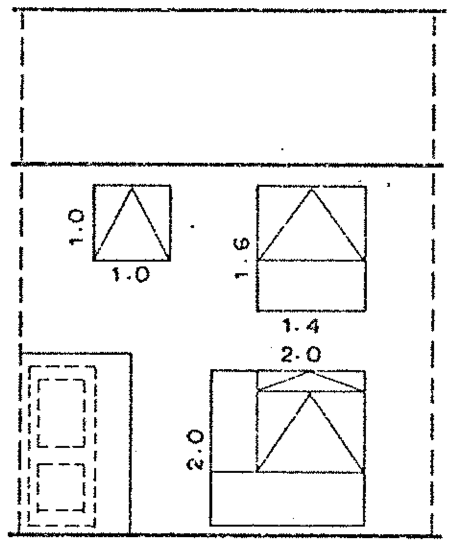
For a filled-in example of a mid terrace house see Figs. A1.3a, A1.3b and A1.3c.



PLANS

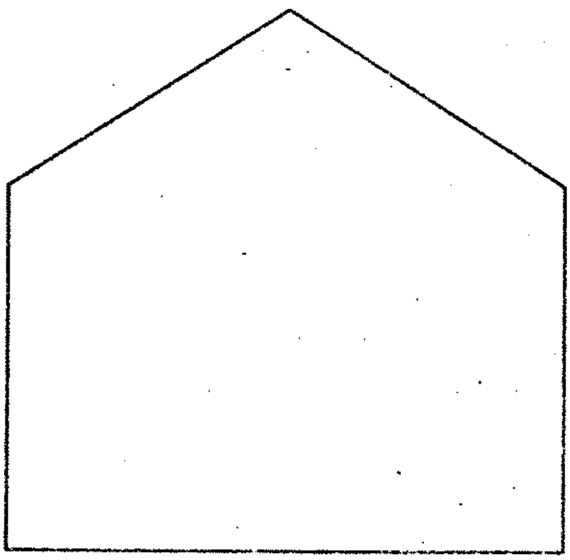


ELEVATION 1



ELEVATION 3

Fig: A1.3a



ELEVATIONS 2 and 4
viz party wall

Other information

Mid terrace two storey house.
Brick / block cavity wall - ground floor.
Tile hanging / block cavity wall - first fl.
Tiled roof and suspended ceiling.
No loft access.
No loft insulation.
Windows not weatherstripped.

Young couple and two children under 5
Installed electric underfloor heating
to ground floor only (hall thermostat).
Central heating never used - electric
and flueless gas convectors instead.
Electric immersion for hot water.

Fig: A1.3b

SURVEYOR'S NAME	
CALLS	
DATE OF SURVEY	
CHECKED IN	
CONTENTS CHECKED	
PUNCHED	

SUB SAMPLE

ROOF	
WALL	
FLOOR	

02 HRN			
SEQUENTIAL NUMBER			
AREA/SURVEYOR			
YEAR			
TYPE		4	
No. OF STOREYS		2	
FLOORS OF		1	2
No. OF BEDROOMS		3	
No. OF PERSONS	DESIGN/ ACTUAL	4	4
AGE GROUP No.'S		2	2
DISABILITY		3	
Is loft insulated?		3	
Is dwelling heated all day in winter?		3	
Is heating satisfactory?		3	
If not, why not?		1, 2, 6,	

HEATING

		D1	D2	A1	A2
LIVING AREAS	SYSTEM	3		2	2
	FUEL	3		2	7
	EMITTER	7		3	3
	CONTROL	4		1	1
SLEEPING AREAS	SYSTEM	1		2	1
	FUEL	1		7	1
	EMITTER	1		3	1
	CONTROL	1		1	1
WATER HEATING	SYSTEM	3		3	
	FUEL	2		2	
	EMITTER	9		9	
	CONTROL	1		1	

OTHER

VENTILATION ETC.

WINDOWS WEATHERSTRIPPED	
FLUE	
MECHANICAL VENTILATION	
PORCH/VESTIBULE /LOBBY	
OUTSIDE W.C. ONLY	
ROOF VOID	
ROOF VOID ACCESS	
ROOF PITCH	
EXPOSURE CATEGORY	

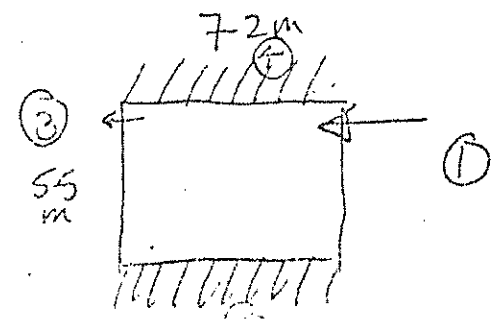


Fig: A1.3c

3 2 [ ] 4 Front entrance side=1	Roof=5, Floor=6	03		04		05		06		07		08	
		Code	Area m2	Code	Area m2	Code	Area m2	Code	Area m2	Code	Area m2	Code	Area m2
ELEVATION		1	27.5	2	36.0	3	27.5	4	36.0	5	39.6	6	39.[illegible]
WINDOWS	FRAME / GLASS	1 1	1.4			1 1	6.0						
		1 1	2.2			1 1	1.0						
		1 1	0.5			1 1	2.2						
		1 1	0.8										
TOTAL AREA WINDOWS		W	3.9	W	0.0	W	7.2	W	0.0	W	0.0		
No. OF DOORS		1	1.8	0	1.8	1	1.8	0	1.8	0	1.8		
TOTAL AREA DOORS		D	1.8	D	0.0	D	1.8	D	0.0	D	0.0		
TOTAL DOORS + WINDOWS		W D	6.7	W D	0.0	W D	9.0	W D	0.0	W D	0.0	W D	0.0
SOLID ELEMENT	EXTERNAL / INTERNAL	2 1	10.6	0	36.0	2 1	8.0	0	36.0	2 2	39.6	1	39.6
		7 1	10.2			7 1	10.5						
TOTAL SOLID ELEMENT		S	20.8	S	36.0	S	18.5	S	36.0	S	39.6	S	39.6

APPENDIX 2

TABLES

Appendix 2

INDEX TO TABLES

TABLE A2.1 AGE BY DWELLING TYPE

TYPE	AGE GROUP PRE 1919	1919-39	1940-63	1964-69	POST 1969	TOTAL
Detached	0.0	0.0	0.8	0.0	0.0	0.8
Semi detached	0.6	7.0	5.0	0.6	0.7	13.9
End Terrace	1.1	8.0	3.0	2.5	3.2	17.8
Inn Terrace	2.5	11.0	4.8	5.6	7.3	31.2
Flat/M	0.5	2.3	14.7	13.0	5.8	36.3
Totals	4.7	28.3	28.3	21.7	17.0	100.0%

(All figures as percentage of sample)

TABLE A2.2 NUMBER OF LEVELS BY DWELLING TYPE

TYPE	NO. OF LEVELS 1	2	3	TOTALS
Detached	0.8	0.0	0.0	0.8
Semi detached	1.0	12.9	0.0	13.9
End Terrace	1.2	16.3	0.3	17.8
Inn Terrace	1.1	28.9	1.2	31.2
Flat/m.	31.1	5.2	0.0	36.3
TOTALS	35.2	63.3	1.5	100.0%

(All figures percentages of sample)

TABLE A2.3

DESIGN/ACTUAL NO. OF PERSONS BY DWELLING TYPE

	NO. OF PERSONS PER DWELLING														
	1		2		3		4		5		6		7+		
TYPE	D	A	D	A	D	A	D	A	D	A	D	A	D	A	TOTALS
DETACHED	0.0	0.4	0.0	0.2	0.4	0.1	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8
SEMI DETACHED	0.0	2.4	0.7	4.9	1.3	2.2	4.9	2.0	6.2	1.3	0.4	0.7	0.4	0.4	13.9
END/TERRACE	0.1	2.8	1.0	5.6	1.5	2.9	6.9	2.5	7.1	1.9	0.8	1.0	0.4	1.1	17.8
INN/TERRACE	0.0	3.7	0.8	8.6	2.5	5.3	11.9	5.9	14.8	4.0	0.8	2.2	0.4	1.5	31.2
FLAT/M	0.6	13.7	13.4	11.8	6.6	5.6	10.8	3.2	4.6	1.5	0.3	0.4	0.0	0.1	36.3
TOTALS	0.7	23.0	15.9	31.1	12.3	16.1	34.9	13.7	32.7	8.7	2.3	4.3	1.2	3.1	100%

D = DESIGN

A = ACTUAL

(All figures percentages of sample)

TABLE A2.4

DESIGN HOUSEHOLD SIZE
AGAINST ACTUAL HOUSEHOLD SIZE

ACTUAL SIZE	DESIGN HOUSEHOLD SIZE								
	1	2	3	4	5	6	7	8+	TOTALS
1	34	525	145	238	138	7	0	0	1087
2	1	211	299	600	352	5	2	0	1470
3	0	17	100	322	296	18	4	0	757
4	0	1	25	268	332	19	3	0	648
5	0	0	10	126	248	18	10	0	412
6	0	0	1	64	115	17	4	0	201
7	0	0	1	20	45	12	11	0	89
8+	0	0	1	11	19	10	15	2	58
TOTALS	35	754	582	1649	1545	106	49	2	4722

TABLE A2.5 DISABILITY BY NO. OF STOREYS AND BY DWELLING LEVEL

DISABILITY	NO. OF STOREYS IN DISABLED PERSON'S DWELLING		TOTALS	LEVEL OF DISABLED PERSONS DWELLING	
	1	2+		Ground Floor	1st Floor +
PARTIAL	2.9	3.0	5.9	3.9	2.0
SERIOUS	1.0	1.8	2.8	2.2	0.6
TOTALS	3.9	4.8	8.7%	6.1	2.6

(91.3% sample not disabled)

(All figures percentages of sample)

TABLE A2.6

OCCURRENCE OF WINTER HEATING FOR MORE THAN 8 HOURS IN EACH DWELLING TYPE AND AGE GROUP

TYPE	OVER 8 HOURS YES/NO	AGE GROUPS					
		Pre- 1919	1919-39	1940-63	1964-69	Post-69	TOTALS
DETACHED	Yes	1	-	27	0	-	28
	No	0	-	9	1	-	10
SEMI DETACHED	Yes	19	261	158	20	27	485
	No	8	71	76	7	8	170
END/TERRACE	Yes	39	302	100	90	123	654
	No	13	74	39	29	30	185
INN/TERRACE	Yes	87	415	153	190	221	1066
	No	30	102	76	76	125	409
FLAT/M	Yes	13	80	464	376	173	1106
	no	13	31	233	237	95	609
TOTALS	Yes	159	1058	902	676	544	3339
	No	64	278	433	350	258	1383

70% yes

TABLE A2.7 HEATING DISSATISFACTION REASONS AGAINST NUMBER OF REASONS GIVEN

DISSATISFACTION		NUMBER OF REASONS GIVEN				
No.	REASON	1	2	3	4	TOTAL
1.	TOO COSTLY	347	252	152	104	855
2.	NOT WARM ENOUGH	142	243	152	109	646
3.	TOO DRAUGHTY	261	331	159	100	851
4.	TOO STUFFY	24	40	17	6	87
5.	ONLY HEATS CERTAIN ROOMS	162	257	113	103	635
6.	PREFER FIRE/FOCAL POINT	7	15	12	3	37
7.	OTHER (SPEC. ON SURVEY FORM	159	115	40	19	333
TOTALS		1102	1253	645	444	3444
TOTAL NO. HOUSEHOLDS		1102	627	215	111	2055

TABLE A2.8

AVERAGE WINDOW AREA IN EACH AGE GROUP & DWELLING TYPE, FOR HOUSEHOLDS SATISFIED WITH HEATING SYSTEM, THOSE DISSATISFIED & OVERALL.

TYPE		AGE GROUPS Pre-1919	1919-39	1940-63	1964-69	Post-69	TOTALS
DETACHED	OVERALL	19.0	-	10.7	16.5	-	11.0
	SATISFIED	-	-	10.8	16.5	-	11.1
	DISSATISFIED	19.0	-	10.6	-	-	11.0
SEMI DETACHED	OVERALL	13.2	13.2	13.8	14.5	10.8	13.4
	SATISFIED	11.3	13.1	13.6	13.9	10.4	13.0
	DISSATISFIED	14.7	13.5	14.1	15.0	11.9	13.8
END/ TERRACE	OVERALL	11.9	12.8	12.6	16.0	13.3	13.2
	SATISFIED	11.4	12.7	12.0	15.8	12.8	12.9
	DISSATISFIED	13.4	12.9	13.2	16.2	14.4	13.7
INN/ TERRACE	OVERALL	12.1	11.8	12.5	16.2	12.8	13.0
	SATISFIED	11.6	11.8	12.3	16.0	12.7	12.7
	DISSATISFIED	13.2	11.8	12.8	16.6	13.0	13.3
FLAT/M	OVERALL	9.9	8.9	11.3	11.8	9.3	11.0
	SATISFIED	10.2	8.9	11.2	11.2	8.9	10.5
	DISSATISFIED	9.0	8.9	11.5	12.3	10.0	11.5
TOTALS	OVERALL	11.9	12.2	12.1	13.5	11.6	12.3
	SATISFIED	11.3	12.1	11.8	13.2	11.4	12.1
	DISSATISFIED	13.2	12.4	12.3	13.8	12.0	12.7

(All figures are in m^2)

TABLE A2.9

DESIGN HOUSEHOLD SIZE AGAINST ACTUAL HOUSEHOLD SIZE, FOR HOUSEHOLDS SATISFIED AND DISSATISFIED WITH HEATING SYSTEM

ACTUAL SIZE	SATIS-FACTION	DESIGN HOUSEHOLD SIZE								
		1	2	3	4	5	6	7	8+	TOTALS
1	YES	19	328	76	116	96	3	0	0	638
	NO	15	197	69	122	42	4	0	0	449
2	YES	1	120	168	338	213	1	2	0	843
	NO	0	91	131	262	139	4	0	0	627
3	YES	0	11	43	185	154	11	2	0	406
	NO	0	6	57	137	142	7	2	0	351
4	YES	0	1	12	157	181	10	1	0	362
	NO	0	0	13	111	151	9	2	0	286
5	YES	0	0	8	62	145	4	5	0	224
	NO	0	0	2	64	103	14	5	0	188
6	YES	0	0	1	35	72	10	3	0	121
	NO	0	0	0	29	43	7	1	0	80
7	YES	0	0	0	13	21	5	5	0	44
	NO	0	0	1	7	24	7	6	0	45
8+	YES	0	0	1	5	9	5	8	1	29
	NO	0	0	0	6	10	5	7	1	29
TOTALS	YES	20	460	309	911	891	49	26	1	2667
	NO	15	294	273	738	654	57	23	1	2055

TABLE A2.10 SATISFACTION WITH HEATING SYSTEM BY DESIGN FUEL

DESIGN FUEL	SATISFACTION		TOTALS
	YES	NO	
NONE	0.0%	0.0%	0.0%
ELECTRIC ON	0.6	0.6	1.2
ELECTRIC OFF	5.3	9.0	14.3
SOLID	25.7	21.4	47.1
GAS	24.2	12.2	36.4
OIL	0.7	0.3	1.0
MANUFACTURED FUEL	0.0	0.0	0.0
SOLAR	0.0	0.0	0.0
TOTALS	56.5	43.5	100.0%

(All figures percentages of sample)

TABLE A2.11 DESIGN AND ACTUAL FUEL USE IN LIVING AND SLEEPING AREAS

FUEL	LIVING ROOM		MAIN BEDROOM	
	DESIGN	ACTUAL	DESIGN	ACTUAL
NONE	0.0%	0.1%	40.1%	43.3%
ELECTRIC ON	1.1	14.3	5.6	24.1
ELECTRIC OFF	14.3	7.4	2.4	1.9
SOLID	47.2	4.0	21.9	1.2
GAS	36.4	72.0	29.9	26.7
OIL	1.0	1.0	0.0	0.3
MANUFACTURED FUEL	0.0	1.2	0.1	2.5
SOLAR	0.0	0.0	0.0	0.0
TOTALS	100%	100%	100%	100%

(All figures percentages of sample)

TABLE A2.12 HEATING SYSTEM TYPE (DESIGN) ~~(ACTUAL)~~

ACTUAL FUEL	HEATING SYSTEM		TOTALS
	CENTRAL	LOCAL	
NONE	0.0%	0.0%	0.0%
ELECTRIC ON	0.2	1.0	1.2
ELECTRIC OFF	1.4	12.9	14.3
SOLID	0.2	46.9	47.1
GAS	26.5	9.9	36.4
OIL	0.9	0.1	1.0
MANUFACTURED	0.0	0.0	0.0
SOLAR	0.0	0.0	0.0
TOTALS	29.2	70.8	100.0%

(All figures percentages of sample)

DESIGN AND ACTUAL FUEL TYPE IN LIVING AREA BY DWELLING TYPE.

TYPE	FUEL TYPE																TOTALS
	NONE		ELECTRIC ON		ELECTRIC OFF		SOLID		GAS		OIL		MANUFACTURED		SOLAR		
	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	
DETACHED	0.0.	0.0	0.0	0.4	0.0	0.0	0.8	0.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.8
SEMI DETACHED	0.0	0.0	0.1	1.0	0.1	0.2	10.2	0.9	3.5	11.7	0.0	0.0	0.0	0.1	0.0	0.0	13.9
END/ TERRACE	0.0	0.0	0.1	1.3	0.3	0.3	10.5	1.0	6.9	15.1	0.0	0.0	0.0	0.1	0.0	0.0	17.8
INN/ TERRACE	0.0	0.0	0.1	2.5	0.6	0.5	16.3	1.3	14.2	26.5	0.0	0.0	0.0	0.4	0.0	0.0	31.2
FLAT/M	0.0	0.1	0.8	9.1	13.3	6.4	9.4	0.7	11.8	18.4	1.0	1.0	0.0	0.6	0.0	0.0	36.3
TOTALS	0.0	0.1	1.1	14.3	14.3	7.4	47.2	4.0	36.4	72.0	1.0	1.0	0.0	1.2	0.0	0.0	100%

73% CH. = 53
27% ind. [illegible]19

(all figures percentages of sample)

D = DESIGN

A = ACTUAL

TABLE A2.14

ACTUAL FUEL USED AGAINST DESIGN FUEL

DESIGN FUEL	ACTUAL FUEL USED		TOTALS
	SAME	DIFFERENT	
NONE	0.0%	0.0%	0.0%
ELECTRIC ON	1.1	0.2	1.3
ELECTRIC OFF	6.9	7.4	14.3
SOLID	3.9	43.1	47.0
GAS	33.4	3.0	36.4
OIL	1.0	0.0	1.0
MANUFACTURED	0.0	0.0	0.0
SOLAR	0.0	0.0	0.0
TOTALS	46.3%	53.7%	100.0%

(All figures percentages of sample)

TABLE A2.15

ACTUAL FUEL USED TO HEAT WATER AGAINST DESIGN FUEL TO HEAT LIVING AREA

TUAL EL SED TO HEAT ATER	DESIGN FUEL FOR LIVING AREA								
	NONE	ELECTRIC ON	ELECTRIC OFF	SOLID	GAS	OIL	MANUFAC-TURED	SOLAR	TOTALS
ONE	0.0%	0.0%	0.0%	0.3%	0.2%	0.0%	0.0%	0.0%	0.5%
LECTRIC ON	0.0	1.2	7.7	38.6	24.4	0.1	0.0	0.0	72.0
LECTRIC OFF	0.0	0.1	6.4	1.6	0.3	0.0	0.0	0.0	8.4
OLID	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	2.5
AS	0.0	0.0	0.2	4.0	11.5	0.1	0.0	0.0	15.8
IL	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.8
OTALS	0.0%	1.3%	14.3%	47.0%	36.4%	1.0%	0.0%	0.0%	100%

All figures percentages of sample)

TABLE A2.16

INCIDENCE OF HOT WATER STORAGE AND INSULATION BY DESIGN FUEL

DESIGN FUEL	STORAGE		% WITHOUT STORAGE	TOTALS
	% INSULATED	% UNINSULATED		
NONE	0.0	0.0	0.0	0.0%
ELECTRIC ON	1.0	0.2	0.0	1.2%
ELECTRIC OFF	11.2	3.0	0.1	14.3%
SOLID	33.5	12.8	0.8	47.1%
GAS	31.4	4.7	0.3	36.4%
OIL	0.8	0.2	0.0	1.0%
MANUFACTURED	0.0	0.0	0.0	0.0%
SOLAR	0.0	0.0	0.0	0.0%
TOTALS	77.9	20.9	1.2	100%

(All figures percentage of sample)

TABLE A2.17 PRESENCE OF WINDOW WEATHERSTRIPPING

WEATHERSTRIPPING		TOTAL
YES	NO	
6.8	93.2	100%

(All figures percentages of sample)

TABLE A2.18

EXISTENCE OF FLUE
BY FUEL TYPE

DESIGN FUEL	FLUE		TOTALS
	YES	NO	
NONE	0.0%	0.0%	0.0%
ELECTRIC ON	0.5	0.7	1.2
ELECTRIC OFF	1.2	13.1	14.3
SOLID	45.6	1.5	47.1
GAS	27.7	8.7	36.4
OIL	0.1	0.9	1.0
MANUFACTURED	0.0	0.0	0.0
SOLAR	0.0	0.0	0.0
TOTALS	75.1%	24.9%	100%

(All figures percentages of sample)

TABLE A2.19 PRESENCE OF PORCH BY DWELLING TYPE

TYPE	PORCH YES	PORCH NO	TOTALS
DETACHED	0.0	0.8	0.8
SEMI DETACHED	3.3	10.6	13.9
END/TERRACE	3.5	14.3	17.8
INN/TERRACE	6.5	24.7	31.2
FLAT/M	3.5	32.8	36.3
TOTALS	16.8	83.2	100.0%

(All figures percentages of sample)

TABLE A2.20

OCCURRENCE OF OUTSIDE W.C. ONLY
BY DWELLING AGE

AGE	OUTSIDE W.C. YES	OUTSIDE W.C. NO	TOTAL
PRE-1919	1.1%	3.6%	4.7%
1919-39	6.3	22.0	28.3
1940-63	0.9	27.4	28.3
1964-69	0.0	21.7	21.7
1970+	0.0	17.0	17.0
TOTAL	8.3%	91.7%	100.0%

(All figures percentages of sample)

TABLE A2.21 ROOF PITCHES BY DWELLING TYPE

TYPE	ROOF TYPE PARTY	FLAT	PITCHED	TOTALS
DETACHED	0.0	0.1	0.7	0.8
SEMI DETACHED	0.0	0.1	13.8	13.9
END/TERRACE	0.0	0.4	17.4	17.8
INN/TERRACE	0.0	1.1	30.1	31.2
FLAT/M	26.0	0.6	9.7	36.3
TOTALS	26.0	2.3	71.7	100.0%

(All figures percentages of sample)

TABLE A2.22 AVERAGE AREAS OF MAJOR BUILDING ELEMENTS BY DWELLING TYPE

TYPE	AVERAGE AREA M^2			
	EXTERNAL WALL	ROOF	GROUND FLOOR	WINDOWS
DETACHED	67.7	64.1	64.1	11.0
SEMI DETACHED	73.9	41.2	41.2	13.3
END/TERRACE	73.9	40.9	40.9	13.2
INN/TERRACE	47.8	41.1	40.9	12.9
FLAT/M	38.9	55.5	55.5	10.9

TABLE A2.23 EXTERNAL WALL TYPE BY DWELLING TYPE

TYPE	WALL TYPE SOLID	CAVITY	RENDERED SOLID	RENDERED CAVITY	OTHER	TOTALS
DETACHED	0.0	0.0	0.0	0.0	0.8	0.8
SEMI DETACHED	5.9	5.0	1.2	0.0	1.8	13.9
END/TERRACE	7.9	5.9	1.7	0.0	2.3	17.8
INN/TERRACE	13.1	10.9	2.1	0.0	5.1	31.2
FLAT/M	7.4	13.1	3.1	0.0	12.7	36.3
TOTALS	34.3	34.9	8.1	0.0	22.7	100%

(All figures percentages of sample)

TABLE A2.24 FLOOR TYPE BY DWELLING TYPE

TYPE	FLOOR TYPE				
		SUSPENDED			
	SOLID	CONCRETE	TIMBER	PARTY	TOTALS
DETACHED	0.3	0.0	0.5	0.0	0.8
SEMI DETACHED	10.5	1.2	2.2	0.0	13.9
END/TERRACE	13.4	1.2	3.2	0.0	17.8
INN/TERRACE	24.1	2.0	5.1	0.0	31.2
FLAT/M	8.6	0.7	0.8	26.2	36.3
TOTALS	56.9	5.1	11.8	26.2	100%

(All figures percentages of sample)

TABLE A2.25 FLOORSPACE BY DWELLING TYPE

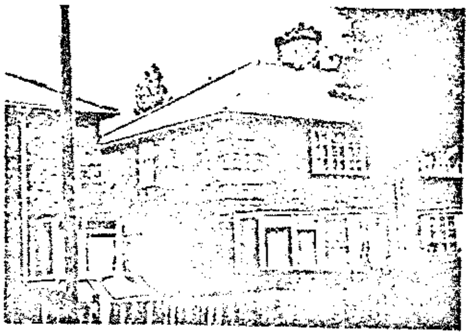
TYPE	AREA M^2 BELOW 60.0	60.0-79.9	80.0-99.9	100.0-119.9	120+	TOTAL
DETACHED	0.3	0.5	0.0	0.0	0.0	0.8
SEMI DETACHED	1.4	5.1	6.4	1.0	0.0	13.9
END/TERRACE	1.9	6.5	7.7	1.5	0.2	17.8
INN/TERRACE	2.3	11.4	13.9	3.4	0.2	31.2
FLAT/M	17.0	14.6	4.5	0.2	0.0	36.3
TOTALS	22.9	38.1	32.5	6.1	0.4	100%

(All figures percentages of sample)

APPENDIX 3

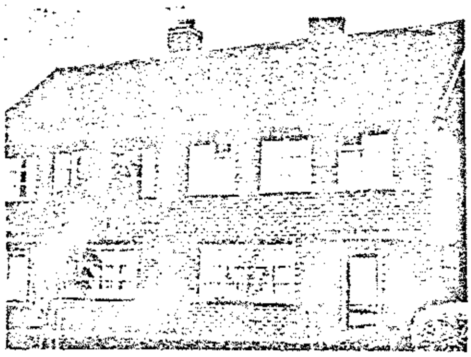
25 Energy Types, i.e. the Case Studies

A3.1



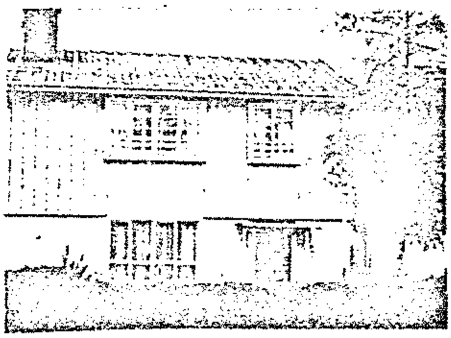
Type: Semi-detached house built 1931 (3 beds)
Construction: 9" solid brick walls; timber suspended floor in living room, concrete floor in kitchen; pitched slate roof.
Heating: Solid fuel room heater with back boiler in living room, electric fires in bedrooms.
Existing Insulation: 50 mm fibreglass quilt in loft, front porch but no inner door.
Characteristics: Draughty louvre windows in kitchen, no direct air supply to room heater.

A3.2



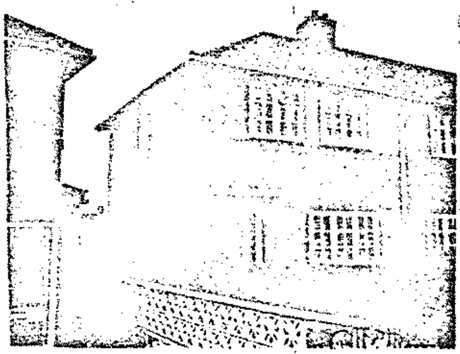
Type: Semi-detached house built 1948 (3 beds)
Construction: Cavity wall with brick outer leaf and blockwork inner leaf; concrete floor in rear living room and kitchen, boarding on battens on concrete in front living room, pitched tile roof
Heating: Gas fires in both living rooms, gas fire in main bedroom.
Existing Insulation: 100 mm glass fibre quilt in loft.
Characteristics: Air bricks in every room.

A3.3



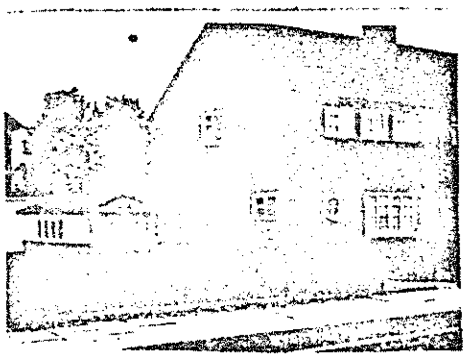
Type: Semi-detached house built 1953 (3 beds)
Construction: B.I.S.F. (British Industries Steel Federation) house, tubular steel frame with cement render on expanded metal at ground floor and steel trough sheeting at first floor, internally board lined; concrete floor, pitched steel roof.
Heating: Gas fire in living room, electric fire in bedroom.
Existing Insulation: 100 mm fibreglass quilt in loft, wall cavity filled with rockwool Feb, 1980 as part of a country wide fire stopping programme.

A3.4



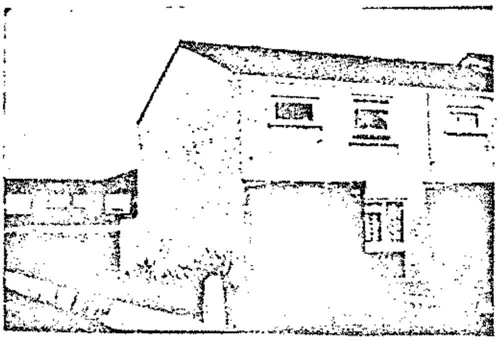
Type: Semi-detached house built 1928 (3 beds)
Construction: 9" solid brick wall, rendered on gable end, timber suspended floor in living room, concrete floor in kitchen, pitched slate roof.
Heating: Gas fire in living room, electric fire in bedroom.
Existing Insulation: Nil
Characteristics: No hall, front door in the living room; rain penetration through gable end wall; stairs lead off the kitchen.

A3.5



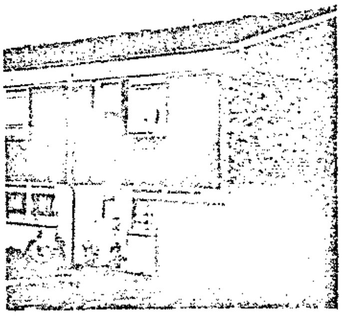
Type: End terrace house built 1951 (2 beds)
Construction: Cavity wall with brick outer leaf and blockwork inner leaf; concrete floor; pitched tile roof.
Heating: Gas fires in living room and main bedroom, flueless gas convector heater in hall.
Existing Insulation: 100 mm fibreglass quilt in loft.
Characteristics: Air bricks in all rooms; damp gable end wall.

A3.6



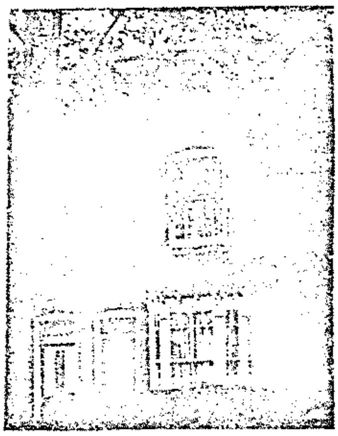
Type: End terrace house built 1970 (3 beds)
Construction: No fine concrete with pebble dash finish, board lined interior; concrete floor; pitched tile roof.
Heating: Gas warm air unit with registers in kitchen, living room and hall; electric convector heater with thermostat in main bedroom.
Existing Insulation: 25 mm fibreglass quilt in loft.

A3.7



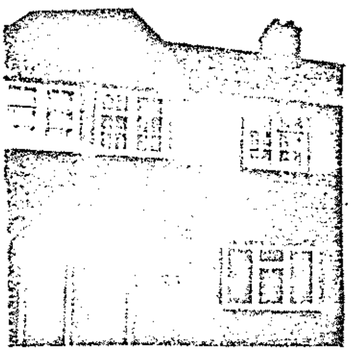
Type: End terrace house built 1969 (3 beds)
Construction: Timber frame with 'Artex' on plywood at ground floor and tile hanging at first floor, brick faced gable end, board lined interior; concrete floor; pitched tile roof.
Heating: Gas warm air unit with registers in all rooms and hall.
Existing Insulation: 25 mm quilt in loft; 25 mm in external walls.

A3.8



Type: Mid terrace house built before 1900 (2 beds)
Construction: 9" solid brick walls, 'tunnel' to rear, timber suspended floors in front and rear living rooms; concrete floor in kitchen, pitched slate roof.
Heating: Gas fire in rear living room; electric fire/paraffin heater in front living room.
Existing Insulation: 30 mm fibreglass quilt in loft.
Characteristics: Sash windows in poor condition, front door leads into front living room, stairs lead off rear living room.

A3.9

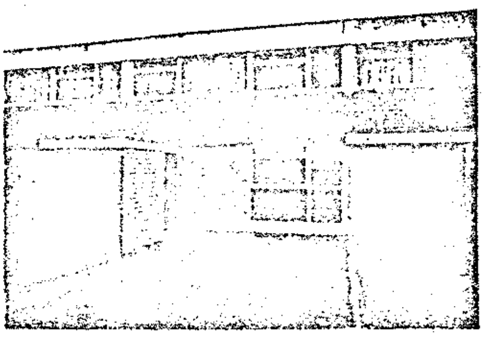


Type: Mid terrace house built 1928 (3 beds)
Construction: 9" solid brick walls; suspended timber floor in living room, concrete floor in kitchen; pitched slate roof.
Heating: Gas fire in living room; electric fire in main bedroom.
Existing Insulation: Nil.
Characteristics: Front door leads into living room, stairs lead off kitchen, air bricks in every room.

A3.10

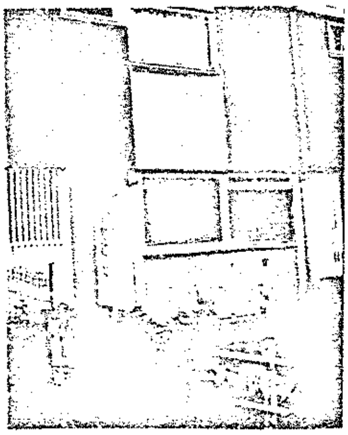
Type: Mid terrace house built 1947 (3 beds)
Construction: Cavity wall with brick outer leaf and blockwork inner leaf; boarded floor on battens on concrete sub floor; pitched tile roof
Heating: Gas fires in both living rooms; gas fire and electric fan heater in main bedroom.
Existing Insulation: 75 mm fibreglass quilt in loft; rear entry draught lobby.
Characteristics: 'Tunnel' access to rear.

A3.11



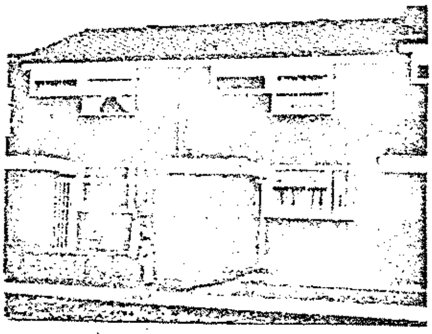
Type: Mid terrace house built 1967 (3 beds)
Construction: Heavy large panel pre-cast walls tile hung at first floor, board lined internally; concrete floor; pitched tile roof.
Heating: Gas warm air unit with registers in front living room, rear living room, kitchen and landing.
Existing Insulation: 25 mm fibreglass quilt in loft; bitumen bonded glass fibre quilt behind tile hanging.
Characteristics: 55% glazing in external walls; (access to back garden through rear living room)

A3.12



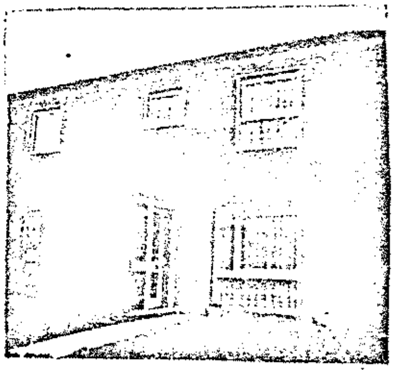
Type: Mid terrace house built 1968 (3 beds)
Construction: Heavy large panel pre-cast walls; external walls board lined internally; concrete floor; pitched tile roof.
Heating: Gas warm air unit with registers in living room, kitchen, hall, and 2 bedrooms.
Existing Insulation: 25 mm fibreglass quilt in loft; 675 x 19mm polystyrene edge insulation in slab; 19 mm polystyrene in external wall panels.
Characteristics: Access to rear garden through living room.

A3.13



Type: Mid terrace house built 1970 (3 beds)
Construction: Traditional 250 mm cavity wall with board lined interior; concrete floor; pitched tile roof.
Heating: Gas warm air unit with registers in living room, kitchen and hall.
Existing Insulation: 25 mm fibreglass quilt in loft; front draught lobby (installed by tenant).
Characteristics: Access to rear garden through living room.

A3.14

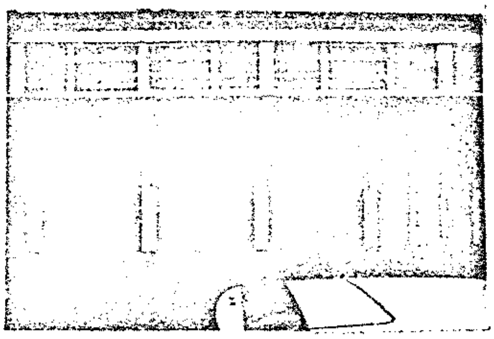


Type: Mid terrace house built 1977 (2 beds)
Construction: At ground floor cavity wall with brick outer leaf and 'thermalite' block inner leaf, at first floor tile hanging on blockwork board lined internally, concrete floor pitched tile roof.
Heating: Gas-fired boiler with radiators in living room, kitchen, hall and bathroom.
Existing Insulation: 25 mm fibreglass quilt in loft; front draught lobby (installed by tenant); integral weather stripped windows.

A3.15

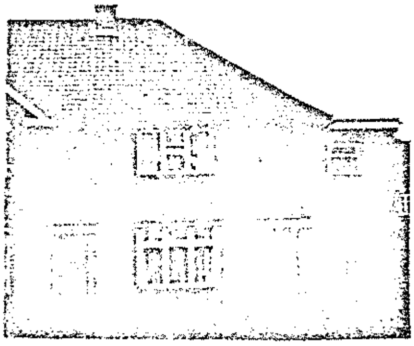
Type: Mid terrace bungalow built 1968 (1 bed)
Construction: Cavity wall with brick outer leaf and block inner leaf, board lined internally; concrete floor; pitched tile roof.
Heating: Gas warm air unit with registers in living room, kitchen and hall; electric 'heat lamp' in bathroom.
Existing Insulation: 25 mm glass fibre quilt in loft.

A3.16



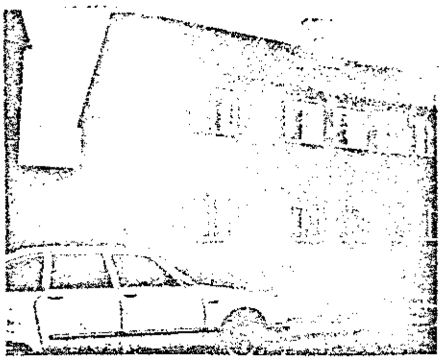
Type: First floor flat (mid terrace) in two storey block (ground floor garages) built 1968 (2 beds)
Construction: Heavy large panel pre-cast walls with tile hanging; chipboard floor on battens on pre-cast suspended concrete slab; pitched tile roof.
Heating: Gas warm air unit with registers in living room, hall and 2nd bedroom.
Existing Insulation: 25 mm fibreglass quilt in loft; 25 mm insulation in floor void; insulation behind tile hanging; enclosed communal entrance hall.

A3.17



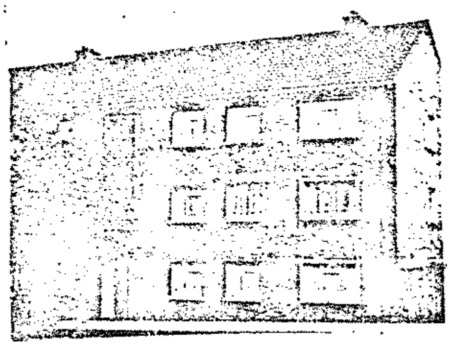
Type: First floor flat in converted house, house built 1930 converted 1970 (1 bed)
Construction: Main building 9" solid brick with pitched slate roof; kitchen 250 mm cavity wall with flat timber/board/felt roof.
Heating: Gas fire in living room, fixed electric heaters in bedroom and kitchen; paraffin heater on landing and in kitchen.
Existing Insulation: 25 mm quilt in flat roof; none in main roof.

A3.18



Type: Ground floor flat (end terrace) in two storey block built 1957 (1 bed).
Construction: Traditional cavity brick wall; concrete floor.
Heating: Gas fire in living room; calor gas heater in bedroom.
Existing Insulation: Nil.
Characteristics: Mould growth on gable end wall in bedroom and hall ceiling.

A3.19

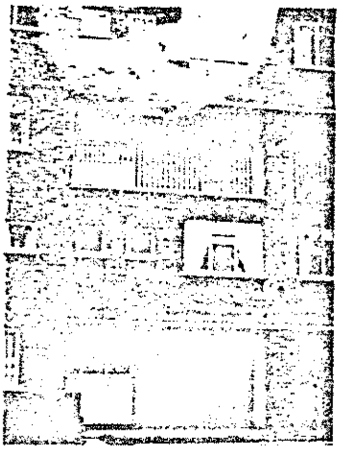


Type: Top floor flat (end terrace) in three storey block built 1954 (3 beds)
Construction: Cavity wall with brick outer leaf and block inner leaf; pitched tile roof.
Heating: Gas fire in living room.
Existing Insulation: 100 mm fibreglass quilt in loft.
Characteristics: Air bricks in every room; externally ventilated drying room adjacent to kitchen.

A3.20

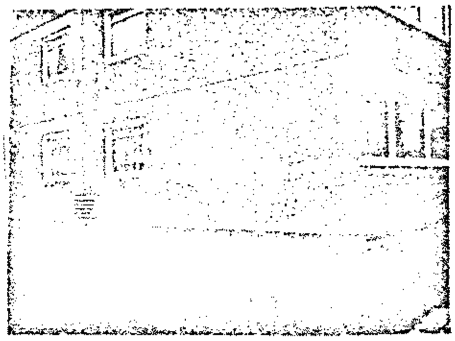
Type: Mid floor flat (mid terrace) in 3 storey block built 1952 (2 beds)
Construction: No fines concrete with pebble dash finish.
Heating: Gas fire in living room, electric radiator in hall.
Existing Insulation: Balcony glazed in by tenant.
Characteristics: Air bricks in every room.

A3.21



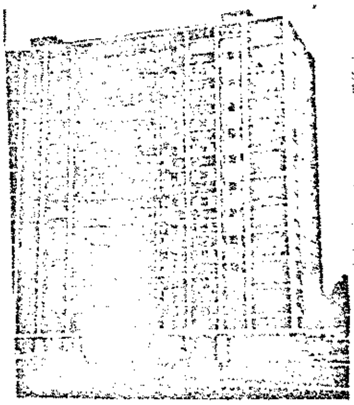
Type: Ground floor maisonette (mid terrace) in a 4 storey block built 1960 (3 beds).
Construction: Cavity wall with brick outer leaf and block inner leaf; concrete floor.
Heating: Gas fire in living room; flueless gas convector heater in hall.
Existing Insulation: Nil.
Characteristics: Deck access to 2nd floor above bedrooms 1 and 2 and bathroom; suspended concrete floor to bedroom 1 and bathroom over maisonette entrance; mould growth on bedroom ceiling.

A3.22



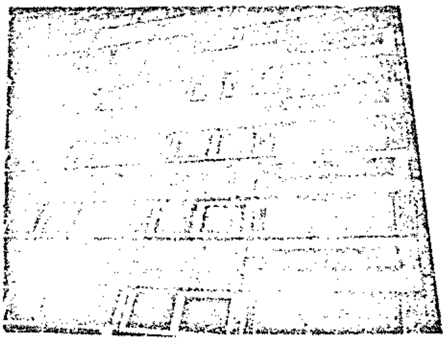
Type: Ground floor flat in 12 storey block built 1969 (1 bed)
Construction: Heavy large panel pre-cast multi storey; concrete floor.
Heating: Off peak night storage heaters in living room and bedroom, fixed electric fire in living room.
Existing Insulation: 25mm polystyrene in walls; 12 mm polystyrene in floor slab.

A3.23



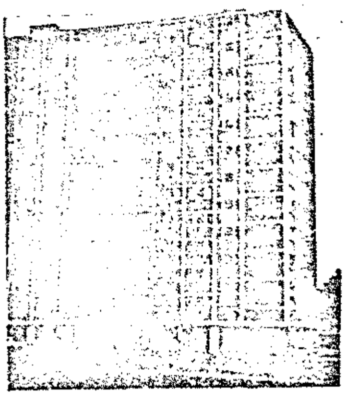
Type: 7th floor flat in 12 storey block built 1964 (1 bed)
Construction: Concrete frame with concrete infill panels with cavity and thermolite blocks internally.
Heating: Off peak electric underfloor heating in living room and hall; electric fire in living room.
Existing Insulation: 50 mm insulation in wall panels.

A3.24



Type: 3rd floor flat in 11 storey block built 1968 (1 bed)
Construction: Heavy large panel pre cast multi storey.
Heating: Off peak electric underfloor heating in living room; electric fire in living room and bedroom.
Existing Insulation: 12 mm polystyrene in external walls; 25 mm polystyrene in communal wall to ventilated fire lobby.

A3.25



Type: Top floor flat in 12 storey block built 1964 (1 bed).
Construction: Concrete frame with concrete infill panels with cavity and thermolite blocks internally; concrete roof with plasterboards on battens.
Heating: Off peak electric underfloor heating in living room and hall; electric fire in living room.
Existing Insulation: 50 mm insulation in wall panels.

APPENDIX 4

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