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Research Report TM/87/18
1987

Assessment of airborne mineral wool fibres in domestic houses

Dodgson J, Harrison GE, Cherrie JW, Sneddon E

World Health Organisation
Collaborating Centre
For Occupational Health

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Report No. TM/87/18
UDC 677.51:622.411.512

ASSESSMENT OF AIRBORNE MINERAL WOOL FIBRES IN DOMESTIC HOUSES

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December 1987

Price : Price:
£40.00 (UK)
£45.00 (Overseas)

INSTITUTE OF OCCUPATIONAL MEDICINE

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by

J Dodgson, GE Harrison, JW Cherrie E Sneddon

Research Work carried out with financial aid
from Eurisol, UK.

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December 1987

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SUMMARY

This report describes a series of measurements made to assess the concentration of airborne mineral wool fibres (denoted as MMMF in this report) in domestic houses. Ten houses were selected for monitoring, five where new insulation was being installed and five where existing insulation was being disturbed. In the houses with new insulation samples were collected prior to installation, on the day of insulation and on two occasions afterwards. The samples were analysed by either phase contrast optical microscopy (PCOM) or by scanning electron microscopy (SEM). On each day a sample was collected to assess the airborne inspirable mass concentration. In addition, measurements of the bulk fibre characteristics and settled dust were made. A similar programme was used to obtain samples from houses with existing insulation, where monitoring was carried out prior to disturbance of the mineral wool and during major and minor disturbance.

Within the lofts the personal airborne fibre concentrations were approximately 1 fibre/ml during insulation and generally less than 0.1 fibres/ml when existing insulation was disturbed. The levels inside the houses were much lower, and in these situations only the SEM measurements are a reliable indication of airborne mineral wool concentrations. In new houses the levels of mineral wool were approximately 0.01 fibres/ml and in the old houses the levels were generally not detectable, i.e. less than 0.005 fibres/ml.

Comparison of the results from a small number of samples analysed by SEM and transmission electron microscopy (TEM) showed that both techniques produced comparable results.

Within 24 hours of insulation or disturbance of mineral wool the concentration of airborne MMMF was at or below the detection limit of 0.005 fibres/ml. Background levels from pooled data or high volume samples indicated that actual levels were about 0.0002 fibres/ml or less.

1. INTRODUCTION

Man-made mineral fibres (MMMF) comprise a group of synthetic inorganic materials made from a variety of raw materials: basaltic rock; metal slags; glass or refractory materials. The majority of MMMF produced are used in the construction industry for thermal or acoustic insulation, much of it in domestic houses. Refractory fibres are not used for insulation in domestic properties. In the UK the most common types of MMMF insulation materials are rockwool and glasswool. These fibrous materials, together with slagwool, are categorised as 'mineral wool fibres' to avoid confusion with the ceramic or refractory fibres. In this report the abbreviation 'MMMF' specifically refers to mineral wool fibres only.

There have been several epidemiological studies designed to investigate the mortality of workers employed in the MMMF production industry; the most extensive being carried out in the USA by ENTERLINE and MARSH (in press) and in Europe by SIMONATO *et al*, (in press). These and other experimental studies have been reviewed by the International Agency for Research on Cancer who have concluded that MMMF should be categorised as being possibly carcinogenic in humans (IARC, 1987).

The epidemiological studies have been carried out in conjunction with extensive measurement of airborne fibre concentrations in the factories. However, there are few published data to provide an assessment of the exposure in other situations. One of the most widespread uses of MMMF is for thermal insulation in domestic houses where a potentially large population could be exposed to airborne MMMF.

This report summarises a series of measurements of airborne MMMF made in houses associated with the installation of new MMMF and with the disturbance of existing MMMF insulation in houses.

2. METHODS

2.1 Airborne dust measurements

A total of ten houses was selected for study. Care was taken to ensure that the types of houses, insulation methods and materials used covered a wide range of conditions. Arrangements for the surveys were made directly with contractors or owners and no special precautions were taken during the work to minimise dust emission.

Measurements were made in five houses where new insulation was being installed and in a further five houses with existing MMMF insulation. The house characteristics and insulation type are summarised in Table 2.1. Further details for each house are given in the Appendix. Both old and new houses with a range of heating systems were included together with a range of glass and rockwool insulation in the form of blanket, loose wool or slabs.

All of the samples to assess airborne fibre concentration were collected using methods based on the WHO/EURO reference methods for sampling and evaluation of MMMF (WHO/EURO MMMF Technical Committee, 1985). Samples were collected on both membrane filters, 0.8 μm pore, and polycarbonate filters, 0.4 μm pore, at various locations throughout the houses. In the new houses measurements were made on four separate days: prior to insulation; on the day of insulation; 24 hours later; and seven days after. In the old houses measurements were made prior to disturbance of MMMF, with minor disturbance, for example inspection or movement of objects in the loft, and during more extensive disturbance, i.e. lifting or disturbing sections of the insulation. These disturbance operations were fairly typical of do-it-yourself work.

On each occasion four fixed point locations were chosen for sampling. These were distributed throughout the house but generally comprised the livingroom, two bedrooms and the hall under the entry to the loft. These samples were collected onto 25 mm diameter filters held inside conducting cowl sample holders. The sampling times and flowrates were varied for the different measurement operations to achieve adequate sensitivity for the fibre concentration assessments. Sampling took place throughout the insulation work which usually lasted about 30 minutes during installation of new material and for one or two hours in the case of the disturbance operations. The flowrate through the filter was initially set to between 2 and 5 l/min; subsequent flowrate measurements were made midway through the sampling and at the end. The total volume of air sampled ranged from 0.5 to 2 m^3.

On each day where MMMF was being installed or disturbed personal airborne dust samples were collected on the insulation workers. These samples were collected at 2 l/min on membrane filters using the same methods used for the static samples.

The membrane filters were prepared for evaluation by phase contrast optical microscope (PCOM) using the acetone/triacetin technique, (WHO/EURO Technical Committee 1985). All of the fibres longer than 5 μm with an aspect ratio (L/D) greater than 3:1 were counted; they were categorised as either respirable fibres, when the diameter was less than 3 μm, or non-respirable for those fibres thicker than 3 μm.

The scanning electron microscope (SEM) was used to measure both the concentration and composition of fibres on the polycarbonate membranes (WHO/EURO Technical Committee, 1985). In these assessments all particles with aspect ratio (i.e. ratio of length to diameter) of greater than 3:1 were counted and sized irrespective of diameter and length. Each fibre was then categorised on the length and diameter measurements and chemical composition; the latter data being collected by energy dispersive X-ray analysis (EDXA).

In addition, two high volume background samples of c. 10 m^3 were taken in old houses several weeks after the disturbance measurements to check the precision of the concentrations estimated by the above techniques. These samples were ashed by low-temperature techniques to remove organic matter and analysed by SEM.

A selection of polycarbonate samples taken during insulation or major disturbance were re-analysed by transmission electron microscopy for comparison with the SEM results.

In addition to samples for airborne fibre number assessment on each day a single sample was collected to assess the mass concentration of inspirable dust (VINCENT & ARMBRUSTER, 1981) in the house. These samples were collected in the hall at the entry to the loft using a specially designed static sampler (AITKEN *et al*, 1987), operating at 2 l/min.

2.2 Other measurements

Samples of settled dust were taken in a proportion of the houses, using adhesive tape, from a number of horizontal surfaces close to the fixed point sampling locations. These samples were subsequently assessed by polarised light microscopy to provide a semi-quantitative estimate of density of MMMF on these surfaces.

The ventilation conditions in the loft and the air transfer rate between the loft and the adjoining rooms was assessed using a nitrous oxide tracer gas in one old and one new house. The gas was first introduced into the loft and uniformly mixed. The concentration was then continuously monitored inside the loft using a MIRAN infrared gas analyser to determine the decay rate. The process was repeated with the measurements being undertaken in one of the bedrooms to assess the air transfer rate from the loft to the room.

All of the bulk MMMF materials were characterised to assess their nominal fibre size by SEM (OGDEN *et al*, 1985) and then oil content by UV spectrophotometry.

3. RESULTS

The detailed results from each sample, by house, are given in the Appendix.

3.1 Measurements made during insulation or disturbance of MMMF

3.1.1 New Houses

Table 3.1 summarises the respirable fibre concentrations obtained during the insulation of new houses in terms of the means and 95% confidence intervals. The 95% confidence interval based on the Poisson distribution provides an indication of the precision of the estimated mean, such that the probability that the true mean lies outwith this range would be less than 5%. Where no fibres were observed the concentrations reported are based on the upper bound of the 95% confidence limit (corresponding to 3.6 fibres). Such tabulated values are shown with a less than (<) sign. The individual mean personal concentrations assessed by PCOM ranged from 0.30 to 1.25 fibres/ml. The concentration from the static samples were all considerably lower than the personal data. They ranged from 0.0016 fibres/ml in house 0004, bedroom 1 to 0.1746 fibres/ml in the livingroom of house 0005. There is no discernable pattern in these data, either in relation to the personal concentration measurements or the location within the house. The results from the SEM evaluations are also shown in Table 3.1. These data give the respirable MMMF concentrations at two locations. The mean concentration ranged from 0.0034 to 0.0232 fibres/ml in the hall and from <0.0037 to 0.0202 fibres/ml in the livingroom. As expected, the MMMF concentrations measured by SEM were less than the corresponding PCOM concentrations which include all fibre types. In the four houses (0001 – 0004) where the livingroom was on the ground floor and the hall sampling point was on the first floor, the hall concentration was greater than that found in the livingroom.

Respirators were supplied and used to some extent by the insulation workers involved with blown wool (houses 0001 and 0002) and also house 0003.

3.1.2 Old Houses

The mean respirable fibre concentrations and confidence intervals for the samples collected in the old houses are shown in Table 3.2. These data are subdivided, for each house, into samples collected during major and minor disturbance. For the personal samples the concentrations ranged from <0.01 to 0.36 fibres/ml for major disturbance and 0.01 to 0.2 fibres/ml for minor disturbance. There were no substantial differences in concentration measurements between major and minor disturbances. In one instance the respirable fibre concentration during the minor disturbance exceeded that obtained during major work. The concentrations were much less than the personal measurements made during the installation of MMMF in the new houses, cf Table 3.1

The mean concentrations from the static samples evaluated by PCOM again showed little pattern either between major or minor or between the various locations. On the days when major disturbance was carried out the levels ranged from 0.0006 to 0.0874 fibres/ml and during minor disturbance they ranged from 0.0020 to 0.0089 fibres/ml.

The SEM analysis from the hall and livingroom samples showed that the vast majority of the airborne fibres were not MMMF. In seventeen of the twenty locations no MMMF's were detected; this corresponds to between <0.0007 and <0.006 fibres/ml depending on the volume of air sampled. The measurable concentrations of MMMF were found in house 1001, which had the highest personal fibre concentrations during disturbance. In this house the respirable MMMF concentrations ranged from 0.0008 to 0.0104 fibres/ml; the highest result being in the hall during major disturbance.

3.1.3 Inspirable Mass Concentrations

The results from the measurement of inspirable mass concentration made in the hall of the houses are shown in Table 3.3. In the new houses the concentrations ranged from <0.1 to 9.8 mg/m^3. Except for house 0001 the highest concentrations were always recorded on the day of insulation. The results from the old houses were generally lower, concentrations ranging from <0.1 to 1.0 mg/m^3. The difference between the two situations probably reflects other building work being carried out on the new houses.

In some instances the high concentration of non-fibrous dust has made the microscopic evaluation of the membrane filter samples difficult. Additional chemical pretreatment of the samples was necessary before evaluation. Where this was not possible the samples are denoted as 'TD' (too dense) in the tables of fibre concentration results.

3.2 Background levels

3.2.1 New Houses

Tables 3.4 and 3.5 show the results from the new houses, before insulation, during insulation, and the two sampling days after insulation. The data for the samples collected in the hall are shown in Table 3.4 and the data from the livingroom are shown in Table 3.5. In general the concentrations before and after insulation were lower than those obtained on the day of insulation. Before insulation the PCOM concentrations ranged from 0.0016 to 0.0370 fibres/ml. The SEM concentrations of respirable MMMF before insulation were considerably lower. MMMF was found in the halls of four of the houses (houses 0001, 0002, 0004 and 0005).

The PCOM concentrations found after insulation were not dissimilar to the initial measurements before insulation, the range being 0.0004 - 0.0279 fibres/ml. The MMMF concentrations measured by SEM were again lower, but fibres were found more frequently on the samples taken after insulation when compared with the measurements prior to insulation.

Respirable MMMF's were found at ten of the 20 locations where samples were analysed, concentrations ranging from 0.0002 to 0.0029 fibres/ml. The differences between the 24 hr and 7 day samples were not statistically significant.

3.2.2 Old Houses

The data from the samples collected in the old houses prior to disturbance are shown in Table 3.6. The mean fibre concentrations from the PCOM assessments ranged from 0.0011 to 0.1148 fibres/ml. The highest levels were found in house 1001 where there were large numbers of organic fibres present. The SEM evaluations showed that in the majority of instances the concentration of respirable MMMF was below the detection limit, <0.0012 to <0.0028 fibres/ml, depending on the sample. Only a single MMMF was found on one sample obtained from house 1005.

The results of the high volume dust measurements are shown in Table 3.7. Mean respirable MMMF concentrations varied from 0.00006 to 0.00012 fibres/ml.

3.2.3 Pooled data from Old and New Houses

The results from all of the samples collected prior to insulation and those from new houses after insulation are pooled in Table 3.8. One exceptional new house (0001) where relatively high concentrations, c. 0.003 fibres/ml, persisted for 24 hours after insulation was excluded from this tabulation. The mean PCOM concentrations ranged from 0.0046 to 0.0134 fibres/ml the highest level being found in old houses, prior to insulation. The corresponding data for respirable MMMF from the SEM analysis showed very much lower levels, mean concentrations ranged from 0.00005 to 0.00030 fibres/ml. From these data it would appear that the MMMF contribute between 0.4 and 3% of the airborne respirable fibres. The differences between MMMF concentrations found in the four conditions were not statistically significant.

3.3 Comparative measurements by transmission electron microscopy

Six samples were chosen at random for evaluation of MMMF concentration by transmission electron microscopy. These results are compared with the corresponding SEM data in Table 3.9. Overall there was no significant difference between the estimates of fibre concentration by the two electron microscope methods.

3.4 Miscellaneous Measurements

The results from the wipe samples collected in the new houses demonstrated that MMMF was present in all but one of the samples. Densities ranged from <0.1 to 1.5 f/mm^2; the highest level being found in the bedroom of one of the houses on the day of insulation. A limited number of wipe samples were collected in the old houses; the fibre densities found were all less than 0.1 f/mm^2.

Tracer gas measurements were undertaken in two houses, one old house (1001) and one new house (0002). The measured rate of air change was 0.9 per hr and 12 per hr in the old and new house respectively.

Table 3.10 shows the results from the assessment of nominal fibre size and oil content of the bulk MMMF. The nominal fibre size ranged from 2.0 to 5.7 μm while the oil contents ranged from 0.1 to 1.0%.

4. DISCUSSION

Ten houses were selected to cover a range of conditions. Five houses had new insulation being installed and five older houses were selected for disturbance tests of existing insulation. The distribution of insulation type between the houses was good, with two houses containing rockwool only, four with glasswool and four with a mixture of rock and glasswool. The material was predominantly in roll form, although three houses had loose wool and in one medium density slabs were used. Overall the houses cover a wide selection of the situations which could be encountered within domestic properties.

The measurements within the lofts during insulation showed fibre concentrations of about 1 fibre/ml despite indications of relatively high air exchange within lofts. Similar airborne fibre levels during loft insulation have been reported previously (SCHNEIDER, 1984) and arise from the high rate of fibre release within the confined volume of the loft. It is notable that there was little difference between the levels found during blowing fibre and those found when rolls were laid. The insulation workers involved did not always wear suitable respiratory protection.

The levels in the loft with existing insulation were lower on average, in most instances about one tenth of the levels found during insulation. Clearly working in a loft with existing insulation, for example, do it yourself work, presents far less opportunity for fibres to be liberated into the air.

The comparison of PCOM and SEM in situations other than during work with MMMF (see Table 3.8) showed that PCOM overestimates the levels of MMMF in air. In this type of situation the MMMF contributed less than 3% of the respirable fibres counted by PCOM. The other respirable fibres present were mainly other minerals (e.g. gypsum, mullite) or organic - from carpets, curtains, clothing, flora etc. Only the SEM data can therefore be used to assess reliably the contribution of MMMF to the airborne dust within the houses. In the remainder of this report we have restricted the discussion to respirable MMMF concentrations assessed by SEM.

On the day of insulation the levels of respirable fibres in the houses were much lower than in the lofts, typical concentrations in the hall being c. 0.01 fibres/ml or approximately one hundred times lower than in the loft. There was, therefore, little transfer of the MMMF from the lofts into the houses. The levels away from the vicinity of the entry to the lofts, i.e. in the ground floor livingrooms, were further lowered in comparison with the halls. This airborne fibre was observed to contaminate most areas within the new houses. There was residual low levels of MMMFs found on the horizontal surfaces.

During the disturbance of MMMF insulation in the old houses the concentration in the lofts were lower than during insulation. At this time the levels within the houses were generally not detectable, concentrations being less than 0.005 fibres/ml. If there was a similar level of reduction in fibre concentrations from the loft to the house as was observed in the new houses, then the expected concentration would be approximately ten times lower than the quoted detection limit. It is therefore not surprising that MMMF fibres were not generally detected.

One method of improving the detection levels is to pool the data for similar environmental conditions. The results of the pooled data in Table 3.8 show that the background levels in the houses were very low prior to insulation and prior to

disturbance of insulation; the estimated levels were 0.00018 fibres/ml and 0.00005 fibres/ml respectively. Twenty four hours after insulation in new houses the levels were not distinguishable from the concentrations prior to the work.

On all of the background samples (prior to insulation or work and 24 hrs or 7 days after work) there were 13.5 MMMF fibres found on a total of 38 samples with over 35000 fields evaluated. A better estimate with increased sensitivity may be obtained by pooling all of these data. The mean MMMF concentration obtained is 0.00017 fibres/ml, with the actual concentration probably within the range 0.00010 and 0.00030 fibres/ml. The two high volume estimates of background conditions are given in Table 3.7 and compare with the estimates from the pooled data.

5. CONCLUSIONS

It is concluded that while levels of about 1 fibre/ml or less of MMMF are generated in lofts during insulation and appreciably lower levels during subsequent disturbance, fibre release to rooms within the houses occurs to only a minimal extent. Background levels within houses 24 hours after insulation or disturbance were at or below the detection level of 0.005 fibres/ml for the individual samples. Background levels from pooled data or high volume samples indicates that actual levels were about 0.0002 fibres/ml or less.

6. ACKNOWLEDGEMENTS

The authors are grateful to the building owners in allowing access for the sampling. They also acknowledge the assistance of Miss B. Calder, Mrs. S. Groat and Mr. A.G.McK. Nicholl in the analysis of the samples and Mr. W. Maclaren for advice on the statistical analysis of the results. This work was undertaken with the financial assistance of the MMMF industry's Joint European Medical Research Board.

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TABLE 2.1

Summary of House/Insulation information

NEW HOUSES

House number	0001	0002	0003	0004	0005
Type of House	Semi-detached 3 bedroom	Semi-detached	Semi-detached 5 bedroom	Upper Flat	2 bedroom Flat
Type of insulation	Glasswool/Rockwool mix (Pilkington/Clywd rockwool)	Glasswool/Rockwool mix (Pilkington/Clywd rockwool)	Rockwool (Bridgend)	Glasswool (Crown 75)	Rockwool (RW3)
Application method	Blown	Blown	Rolled	Rolled	Slabs
Type of Heating	Gas Central Heating	Gas Central Heating	Gas Central Heating	Electric	Solid Fuel

OLD HOUSES

House number	1001	1002	1003	1004	1005
Type of House	Semi-detached 3 bedroom	End terrace 2 bedroom	Detached 4 bedroom	Terrace Upper Flat	Mid-terraced 3 bedroom
Type of insulation	Glasswool (Pilkington)	Glasswool	Glasswool	90% Glasswool 10% Rocksil	40% Glasswool 60% Rockwool
Application method	Rolled	Rolled	Blown	Rolled	Rolled
Type of Heating	Gas Central Heating	Gas Central Heating	Gas Central Heating	Solid Fuel	Solid Fuel

TABLE 3.1

Mean and 95% confidence interval of respirable fibre concentration during insulation of new houses (fibres/ml)

House	PCOM - All fibre types					SEM - MMMF only length >5μm diameter ≤3μm	
	Personal	Hall	Bedroom (1)	Bedroom (2)	Livingroom	Hall	Livingroom
0001	0.79 (0.72-0.86)	0.0326 (0.0231-0.0421)	0.0474 (0.0352-0.0596)	0.0358 (0.0242-0.0474)	0.0275 (0.0191-0.0373)	0.0034 (0.0009-0.0087)	0.0021 (0.0003-0.0075)
0002	1.25 (0.90-1.58)	0.0266 (0.0172-0.0360)	0.0381 (0.0289-0.0513)	0.0330 (0.0230-0.0426)	0.0516 (0.0402-0.0630)	0.0072 (0.0007-0.0208)	0.0025 (0.0001-0.0139)
0003	0.84 (0.70-0.97)	0.0090 (0.0053-0.0142)	0.0146 (0.0100-0.0198)	0.0201 (0.0135-0.0298)	0.0090 (0.0057-0.0141)	0.0046 (0.0012-0.0118)	0.0014 (<0.0001-0.0080)
0004	0.93 (0.76-1.10)	0.0284 (0.0191-0.0421)	0.0016 (0.0000-0.0056)	- -	0.0065 (0.0033-0.0126)	0.0232 (0.0094-0.0430)	<0.0037 (0.0000-0.0037)
0005	0.30 (0.19-0.37)	0.0615 (0.0481-0.0760)	0.0454 (0.0333-0.0634)	- -	0.1746 (0.1217-0.2059)	0.0190 (0.0056-0.0410)	0.0202 (0.0060-0.0436)

- = no samples collected

TABLE 3.2

Mean and 95% confidence interval of respirable fibre concentration in old houses during minor and major disturbance (fibres/ml)

House	PCOM - All fibre types					SEM - MMMF only length >5μm diameter ≤3μm	
	Personal	Hall	Bedroom (1)	Bedroom (2)	Livingroom	Hall	Livingroom
1001 minor	0.20 (0.15-0.24)	0.0418 (0.0303-0.0533)	0.0670 (0.0517-0.0823)	0.0550 (0.0409-0.0691)	0.0815 (0.0653-0.1007)	0.0011 (0.0000-0.0041)	<0.0058 (0.0000-0.0058)
1001 major	0.36 (0.30-0.42)	0.0874 (0.0678-0.1070)	0.0459 (0.0358-0.0560)	0.0511 (0.0400-0.0622)	0.0545 (0.0430-0.0669)	0.0104 (0.0050-0.191)	0.0008 (0.0002-0.0048)
1002 minor	0.09 (0.02-0.12)	0.0089 (0.0054-0.0145)	0.0066 (0.0039-0.104)	0.0042 (0.0023-0.0077)	0.0036 (0.0016-0.0071)	<0.0015 (0.0000-0.0015)	<0.0015 (0.0000-0.0015)
1002 major	<0.01 (<0.01-0.02)	0.0039 (0.0021-0.0067)	0.0016 (0.0005-0.0038)	0.0057 (0.0031-0.0096)	0.0034 (0.0016-0.0063)	<0.0007 (0.0000-0.0007)	<0.0015 (0.0000-0.0015)
1003 minor	0.01 (0.01-0.02)	0.0020 (0.0010-0.0038)	0.0037 (0.0021-0.0063)	- -	0.0025 (0.0013-0.0049)	<0.0007 (0.0000-0.0007)	<0.0015 (0.0000-0.0015)
1003 major	0.02 (0.01-0.03)	0.0092 (0.0068-0.0124)	0.0094 (0.0068-0.0130)	- -	0.0099 (0.0069-0.0132)	<0.0015 (0.0000-0.0015)	<0.0030 (0.0000-0.0030)
1004 minor	0.01 (<0.01-0.01)	0.0030 (0.0014-0.0063)	0.0111 (0.0082-0.0146)	0.0078 (0.0046-0.0123)	0.0073 (0.0050-0.0099)	<0.0022 (0.0000-0.0022)	<0.0015 (0.0000-0.0015)
1004 major	0.06 (0.04-0.10)	0.0006 (0.0000-0.0033)	0.0020 (0.0009-0.0042)	0.0019 (0.0008-0.0045)	0.0012 (0.0003-0.0031)	<0.0030 (0.0000-0.0030)	<0.0015 (0.0000-0.0015)
1005 minor	0.04 (0.03-0.07)	0.0003 (0.0000-0.0018)	0.0008 (0.0001-0.0023)	0.0015 (0.0003-0.0044)	0.0012 (0.0003-0.0027)	<0.0021 (0.0000-0.0021)	<0.0037 (0.0000-0.0037)
1005 major	0.07 (0.04-0.11)	0.0018 (0.0008-0.0041)	0.0023 (0.0008-0.0061)	0.0013 (0.0003-0.0047)	0.0036 (0.0014-0.0074)	<0.0018 (0.0000-0.0018)	<0.0029 (0.0000-0.0029)

- = no samples collected

TABLE 3.3

Inspirable Mass Concentrations
(mg/m^3)

NEW HOUSES

House	Pre-survey	During insulation	24 hrs later	7 days later
0001	4.2	3.8	4.5	1.9
0002	0.5	3.4	2.6	1.3
0003	<0.1	0.8	<0.1	<0.1
0004	0.1	9.8	0.5	0.3
0005	0.5	3.6	-	-

OLD HOUSES

House	Pre-survey	Minor disturbance	Major disturbance
1001	0.3	0.2	0.6
1002	0.2	0.7	0.6
1003	<0.1	<0.1	<0.1
1004	0.2	0.2	1.0
1005	-	-	0.3

TABLE 3.4

Mean and 95% confidence interval of respirable fibre concentration in the hall of new houses (fibres/ml)

House	Method of analysis	Before insulation	During insulation	24 hrs afterwards	7 days afterwards
0001	PCOM - all fibre types	TD	0.0326 (0.0231-0.0421)	TD	0.0084 (0.0060 - 0.0114)
0001	SEM-MMMF	0.0008 (<0.0001-0.0047)	0.0034 (0.0009-0.0087)	0.0008 (0.0002-0.0025)	0.0002 (<0.0001-0.0012)
0002	PCOM - all fibre types	0.0123 (0.0092 - 0.0164)	0.0266 (0.1712 - 0.0360)	TD	0.0113 (0.0081 - 0.0160)
0002	SEM-MMMF	0.0006 (0.0000 - 0.0024)	0.0072 (0.0007 -0.0208)	<0.0009 (0.0000-0.0009)	0.0009 (0.0001-0.0034)
0003	PCOM - all fibre types	0.0016 (0.0007 - 0.0036)	0.0090 (0.0053 - 0.0142)	0.0043 (0.0027 - 0.0067)	0.0081 (0.0062 - 0.0118)
0003	SEM-MMMF	<0.0030 (0.0000 - 0.0030)	0.0046 (0.0012 - 0.0118)	0.0005 (0.0000 - 0.0030)	0.0002 (0.0000 - 0.0015)
0004	PCOM - all fibre types	TD	0.0284 (0.0191 - 0.0421)	0.0042 (0.0023 - 0.0070)	0.0078 (0.0052 - 0.0113)
0004	SEM-MMMF	0.0005 (<0.0001-0.0029)	0.0232 (0.0094 - 0.0430)	<0.0044 (0.0000 - 0.0044)	<0.0022 (0.0000 - 0.0022)
0005	PCOM - all fibre types	0.0091 (0.0061 - 0.0131)	0.0615 (0.0481 - 0.0760)	0.0068 (0.0044 - 0.0101)	0.0099 (0.0065 - 0.0150)
0005	SEM-MMMF	0.0003 (0.0000 - 0.0022)	0.0190 (0.0560 - 0.0403)	<0.0030 (0.0000 - 0.0030)	0.0003 (0.0000 - 0.0022)

TD - samples too dense to allow evaluation

TABLE 3.5

Mean and 95% confidence interval of respirable fibre concentration in the livingroom of new houses (fibres/ml)

House	Method of analysis	Before insulation	During insulation	24 hrs afterwards	7 days afterwards
0001	PCOM - all fibre types	0.0116 (0.0073 - 0.0154)	0.0275 (0.0191 - 0.0373)	0.0083 (0.0053 - 0.113)	0.0085 (0.0061 - 0.0111)
0001	SEM-MMMF	<0.0022 (0.0000-0.0022)	0.0021 (0.003-0.0075)	0.0029 (0.0013-0.0056)	<0.0009 (0.0000-0.0009)
0002	PCOM - all fibre types	0.0203 (0.0138 - 0.0271)	0.0516 (0.0402 - 0.0630)	TD	0.0123 (0.0092 - 0.0164)
0002	SEM-MMMF	<0.0044 (0.0000 - 0.0044)	0.0025 (0.0001 - 0.0149)	0.0010 (0.0001-0.0036)	0.0004 (0.0001-0.0020)
0003	PCOM - all fibre types	<0.0023 (0.0010 - 0.0051)	0.0090 (0.0057 - 0.0141)	0.0028 (0.0012 - 0.0055)	0.0033 (0.0013 - 0.0068)
0003	SEM-MMMF	<0.0030 (0.0000 - 0.0030)		<0.0015 (0.0000 - 0.0015)	0.0007 (0.0001 - 0.0028)
0004	PCOM - all fibre types	0.0077 (0.0049 - 0.0115)	0.0065 (0.0033 - 0.0126)	0.0049 (0.0025 - 0.0095)	0.0061 (0.0031 - 0.0118)
0004	SEM-MMMF	<0.0030 (0.0000 - 0.0030)	<0.0037 (0.0000 - 0.0037)	<0.0052 (0.0000 - 0.0052)	<0.0044 (0.0000 - 0.0044)
0005	PCOM - all fibre types	0.0370 (0.0243 - 0.0474)	0.1746 (0.1217 - 0.2059)	0.0121 (0.0080 - 0.0182)	0.0279 (0.0185 - 0.0343)
0005	SEM-MMMF	<0.0037 (0.0000 - 0.0037)	0.0202 (0.0060 - 0.0429)	<0.0015* (0.0000 - 0.0015)	0.0006 (0.0000 - 0.0044)

TD - samples too dense to allow evaluation

* Livingroom sample rejected - bedroom used instead

TABLE 3.6

Mean and 95% confidence interval of respirable fibre concentration in old houses prior to disturbance (fibres/ml)

House	PCOM - all fibre types				SEM - MMMF only length >5μm diameter ≤3μm	
	Hall	Bedroom 1	Bedroom 2	Livingroom	Hall	Livingroom
1001	0.1148 (0.0981 - 0.1315)	0.0710 (0.0600 - 0.0820)	0.0991 (0.0899 - 0.1083)	0.0344 (0.0266 - 0.0422)	<0.0024 (0.0000 - 0.0024)	<0.0024 (0.0000 - 0.0024)
1002	0.0029 (0.0012 - 0.0060)	0.0067 (0.0036 - 0.0114)	0.0078 (0.0043 - 0.0131)	0.0087 (0.0049 - 0.0143)	0<0.0012 (0.0000 - 0.0029)	<0.0029 (0.0000 - 0.0029)
1003	0.0044 (0.0022 - 0.0085)	0.0015 (0.0004 - 0.0034)	0.0037 (0.0015 - 0.0059)	0.0027 (0.0013 - 0.0050)	<0.0027 (0.0000 - 0.0027)	<0.0014 (0.0000 - 0.0014)
1004	0.0013 (0.0004 - 0.0033)	0.0048 (0.0025 - 0.0079)	0.0043 (0.0027 - 0.0065)	0.0069 (0.0045 - 0.0090)	<0.0019 (0.0000 - 0.0019)	<0.0014 (0.0000 - 0.0014)
1005	0.0015 (0.0006 - 0.0031)	0.0026 (0.0013 - 0.0045)	0.0011 (0.0001 - 0.0040)	0.0011 (0.0003 - 0.0023)	0.0005 (0.0000 - 0.0028)	<0.0028 (0.0000 - 0.0028)

TABLE 3.7

Mean respirable MMMF concentrations with 95% confidence limits for high volume samples

(fibres/ml)

House	Room	Conditions	Volume (m^3)	n	Respirable MMMF
1001	Hall	Background	8.6	3	0.00012 (0.00002 - 0.00030) 3½
1003	Livingroom	Background	11.1	2	0.00006 (0.00001 - 0.00021) 2

n = number of respirable MMMF counted

TABLE 3.8

Mean and 95% confidence interval of respirable fibre concentrations prior to work and after insulation with MMMF for all samples (fibres/ml)

SEM-MMMF House type	n	fibres/ml	n	fibres/ml
Old houses - prior to disturbance	816	0.0134 (0.0124 - 0.0144)	1	0.00005 (0.0000-0.00025)
New houses - prior to insulation	615	0.0116 (0.0106 - 0.0126)	2.5	0.00015 (0.0004-0.00055)
New houses - after 24 hrs	241	0.0046 (0.0039 - 0.0053)	3	0.00013+ (0.0000-0.00038)
New houses - after 7 days	649	0.0091 (0.0083 - 0.0099)	7	0.00030 (0.00019-0.00061)

n = number of fibres counted

+ house 0001 excluded from this group

TABLE 3.9

Comparison of SEM and TEM Evaluations
of selected samples

- mean and 95% confidence limits

(fibres/ml)

	S E M		T E M	
Sample Number	n	Respirable fibre concentration	n	Respirable fibre concentration
0003/0055	4	0.005 (0.001 - 0.013)	3.5	0.010 (0.002 - 0.027)
0004/0105	8.5	0.023 (0.009 - 0.043)	2	0.017 (0.002 - 0.061)
0005/0134	5.5	0.020 (0.006 - 0.042)	3	0.029 (0.006 - 0.085)
1001/0022	10	0.010 (0.005 - 0.019)	9	0.010 (0.005 - 0.019)
1001/0031	23	0.344 (0.218 - 0.516)	11.5	0.097 (0.049 0 0.171)
1003/0076	0	<0.002 (0.000 - 0.002)	3	0.002 (<0.001 - 0.006)

n = number of respirable man-made mineral fibres counted

TABLE 3.10

Nominal fibre size and oil content of bulk samples

House	Fibre type	*Nominal fibre size (μm)				Oil (%)
		Min.	Mean	Geometric standard deviation	Max.	
New Houses						
0001	Mixed Glass/Rockwool (Pilkington/Clywd)	0.3	4.9	2.5	18	0.3
0002	Mixed Glass/Rockwool (Pilkington/Clywd)	0.8	4.1	2.1	15	0.4
0003	Existing Rockwool	0.6	5.1	2.0	16	0.1
	Rockwool (Bridgend)	0.2	2.9	2.7	13	0.1
0004	Glasswool (Crown 75)	0.4	5.2	2.6	21	0.4
0005	Rockwool (RW3)	0.3	4.6	2.1	18	0.2
Old Houses						
1001	Glasswool (Pilkington)	0.2	2.0	3.2	18	0.1
1002	Glasswool (?)	0.2	3.1	2.8	15	1.0
1003	Glasswool (?)	0.5	5.1	2.1	16	0.1
1004	Rocksil	0.5	3.4	2.2	11	1.0
	Glasswool (?)	0.5	3.7	2.4	11	0.4
1005	Rocksil	0.5	5.7	2.3	24	0.2
	Glasswool (?)	0.3	4.4	3.0	18	0.4

* The arithmetic mean methods commonly used in industry and elsewhere may be expected to give different values

APPENDIX

SUMMARY (0001)

1. **Address:** Murrayfield Estate, Balgreen, Edinburgh

2. **Type of House** Sem-detached - 3 bedroom

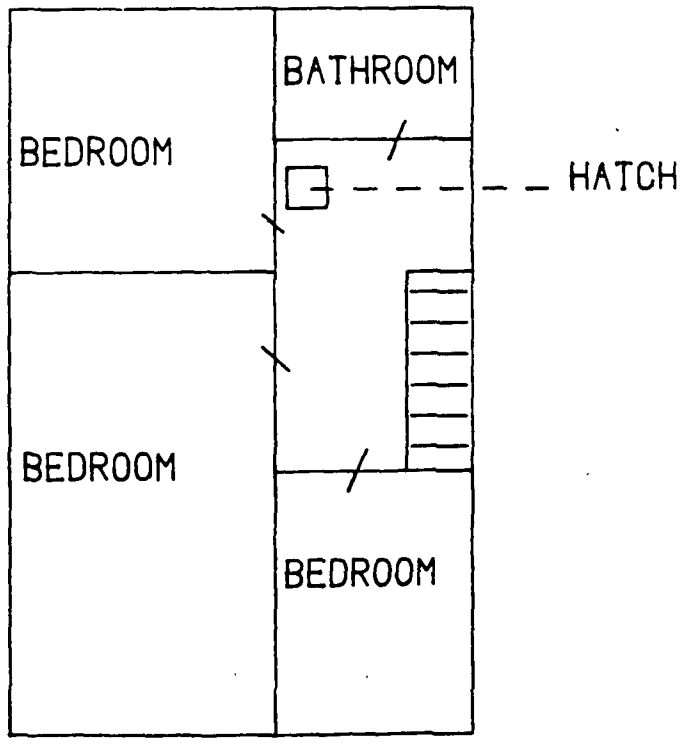
3. **Type of insulation** Blown Glasswool/Rockwool Mix (Pilkington/Clywd Rockwool)

4. **Type of Heaters** Gas Central heating

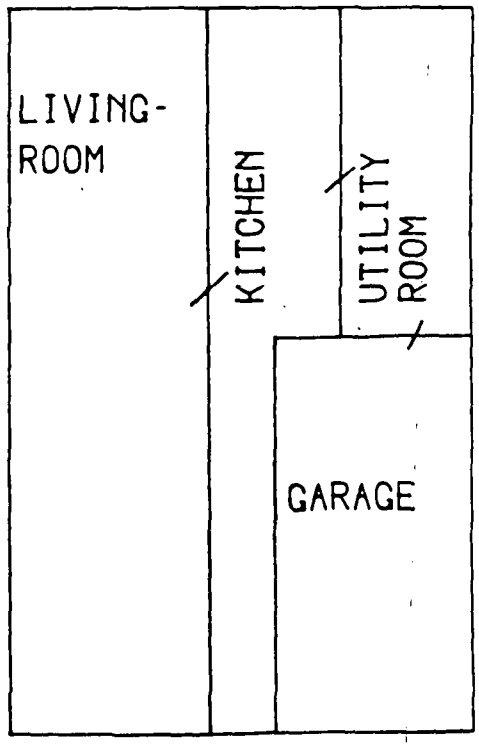
5. **Age of House** New

6. **Survey Details**

		Weather	Other activities
(a)	**Pre-survey**	Wet - light wind	Sanding plaster
(b)	**Laying Insulation**	Fair after over-night rain	Joiner working
(c)	**24 Hours After Laying**	SW wind light showers	General work and clean up
(d)	**7 Days After Laying**	Fine and warm	do.



UPPER FLOOR



GROUND FLOOR

House	Survey	Location	PCOM Filter No.	PCOM 1st Count Resp	PCOM 1st Count Non-resp	PCOM 2nd Count Resp	PCOM 2nd Count Non-resp	SEM Filter No.	MMMF fibres All	MMMF fibres >5 µm ≤3 µm	MMMF fibres >5 µm >3 µm	Other mineral fibres All	Other mineral fibres >5 µm ≤3 µm	Other mineral fibres >5 µm >3 µm	Organic fibres All	Organic fibres >5 µm ≤3 µm	Organic fibres >5 µm >3 µm	All fibres All	All fibres >5 µm ≤3 µm	All fibres >5 µm >3 µm
0001	Pre	Hall	ES009	TD		TD		ES010	<0.001	<0.001	-	0.007	0.004	-	0.008	0.005	<0.001	0.015	0.010	<0.001
		Loft	ES011	0.006	<0.001	0.025	<0.001	ES012	-	-	-	0.002	0.002	-	0.002	0.002	-	0.004	0.004	-
		L/room	ES013	0.007	0.001	0.016	0.002	ES014	-	-	-	0.001	0.001	-	0.002	0.002	-	0.003	0.003	-
		Bedroom	ES016	0.002	<0.001	0.011	0.001													
	During Insulation	Hall	ES026	0.029	0.006	0.031	0.015	ES027		0.003			0.015			0.001			0.019	
		Loft	ES030	TD				ES031												
		L/room	ES028	0.017	<0.001	0.038	0.002	ES029		0.002			0.011			0.002			0.016	
		Bedroom	ES032	0.019	0.006	0.075	0.014													
		Bedroom	ES034	0.025	0.005	0.048	0.004	ES035												
		Personal	ES040	0.56	0.138	0.655	0.309													
		Personal	ES041	0.42	0.135	0.677	0.338													
		Personal	SG001	0.769	0.367	0.749	0.606													
	24 hrs after	Hall	ES048	TD		TD		ES049		0.001			0.006			0.002			0.009	
		Loft																		
		L/room	ES046	0.005	0.001	0.012	0.007	ES047		0.003			0.009			0.001			0.013	
		Bedroom	ES050	0.003	<0.001	0.015	<0.001	ES051												
		Bedroom	ES052	TD		TD		ES053												
	7 days after	Hall	0007	0.011	0.001	0.006	0.003	0008		<0.001			0.002			0.004			0.007	
		Loft																		
		L/room	0003	0.009	0.003	0.008	<0.001	0004		<0.001			<0.001			0.002			0.002	
		Bedroom	0001	0.013	0.002	0.011	<0.001	0002												
		Bedroom	0005	0.010	0.003	0.019	0.003	0006												

SUMMARY (0002)

1. **Address:** Millers Trinity Estate, Warriston, Edinburgh

2. **Type of House** Semi-detached

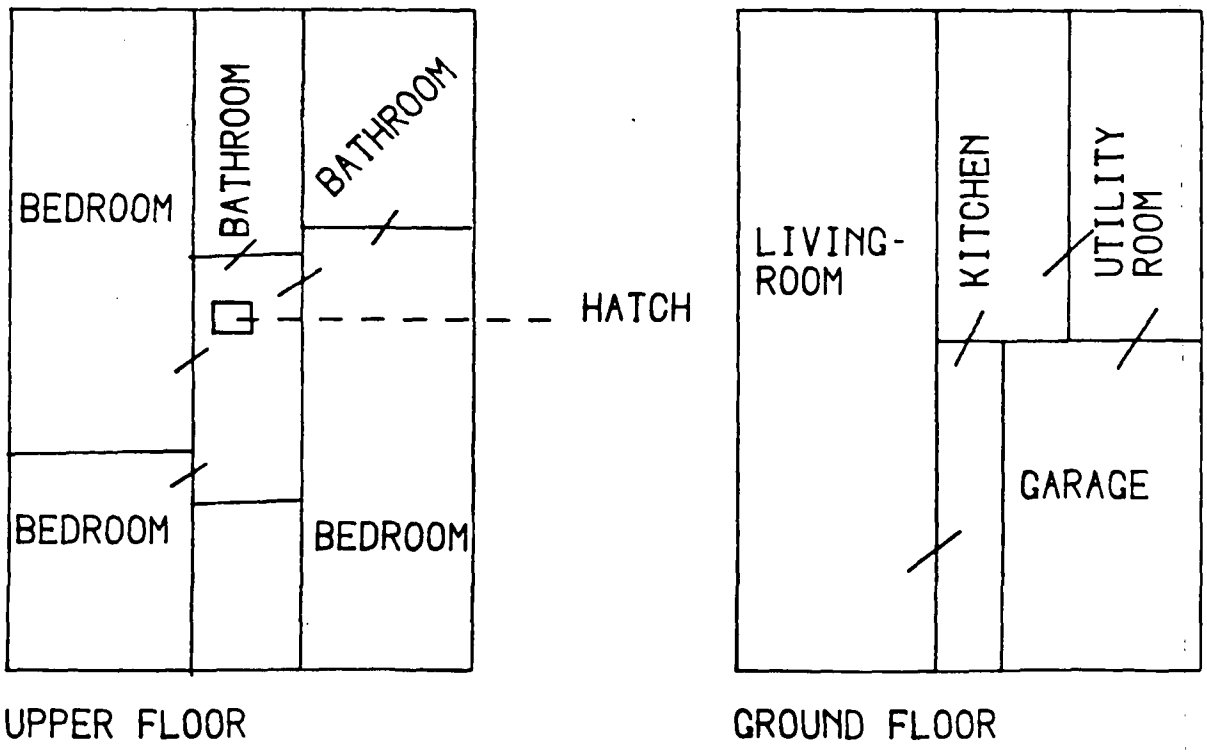
3. **Type of insulation** Blown Glass/Rockwool Mix

4. **Type of Heaters** Gas Central heating

5. **Age of House** New

6. **Survey Details**

		Weather	Other activities
(a)	**Pre-survey**	Wet and windy	Carpenters working
(b)	**Laying Insulation**	Wet - sw wind	Carpenters and painter working
(c)	**24 Hours After Laying**	Dry and sunny	Sweeping up
(d)	**7 Days After Laying**	Dry - light wind	Painting



House	Survey	Location	PCOM 1st Count Filter No.	PCOM 1st Count Resp	PCOM 1st Count Non-resp	PCOM 2nd Count Resp	PCOM 2nd Count Non-resp	SEM Filter No.	SEM MMMF fibres All	SEM MMMF fibres >5 µm ≤3 µm	SEM MMMF fibres >5 µm >3 µm	SEM Other mineral fibres All	SEM Other mineral fibres >5 µm ≤3 µm	SEM Other mineral fibres >5 µm >3 µm	SEM Organic fibres All	SEM Organic fibres >5 µm ≤3 µm	SEM Organic fibres >5 µm >3 µm	SEM All fibres All	SEM All fibres >5 µm ≤3 µm	SEM All fibres >5 µm >3 µm
0002	Pre	Hall	0011	0.009	0.002	0.016	0.002	0014	0.002	<0.001	<0.001	0.009	0.004	<0.001	0.008	0.005	0.001	0.019	0.010	0.002
		L/room	0010	0.007	0.002	0.033	0.002	0016	<0.001	<0.001	<0.001	0.026	0.012	0.002	0.026	0.018	0.001	0.052	0.030	0.003
		Bedroom	0012	0.010	0.001	0.024	0.002	0015												
		Bedroom	0013	0.005	<0.001	0.013	<0.001	0017												
	During Insulation	Hall	0024	0.021	0.005	0.032	0.016	0020	0.007	0.007	<0.001	0.072	0.047	0.003	0.043	0.029	0.001	0.122	0.083	0.004
		L/room	0023	0.020	0.003	0.081	0.033	0021	0.004	0.003	<0.001	0.089	0.039	0.003	0.018	0.008	<0.001	0.110	0.049	0.003
		Bedroom	0025	0.021	<0.001	0.055	0.020	0019												
		Bedroom	0022	0.016	0.004	0.049	0.008	0018												
		Personal	0026	1.429	0.476	1.262	0.612													
		Personal	0027	1.547	0.619	1.083	0.379													
	24 hrs after	Hall	0035	0.007	0.006	0.008	0.005	0031		<0.001			0.001			0.002			0.003	
		L/room	0032	TD		TD		0028		0.001			0.003			0.004			0.007	
		Bedroom	0033	0.009	0.001	0.005	0.001	0030												
		Bedroom	0034	0.010	0.007	0.005	0.006	0029												
	7 days after	Hall	0039	0.010	0.010	0.013	0.003	0043		0.001			0.001			0.002			0.004	
		L/room	0036	0.008	0.005	0.017	0.002	0040		<0.001			0.001			0.007			0.009	
		Bedroom	0038	0.007	0.003	0.023	0.006	0042												
		Bedroom	0037	0.006	0.002	0.008	0.003	0041												

SUMMARY (0003)

1. Address: Beauly Crescent, Dundee

2. Type of House 5 Bedroom semi-detached

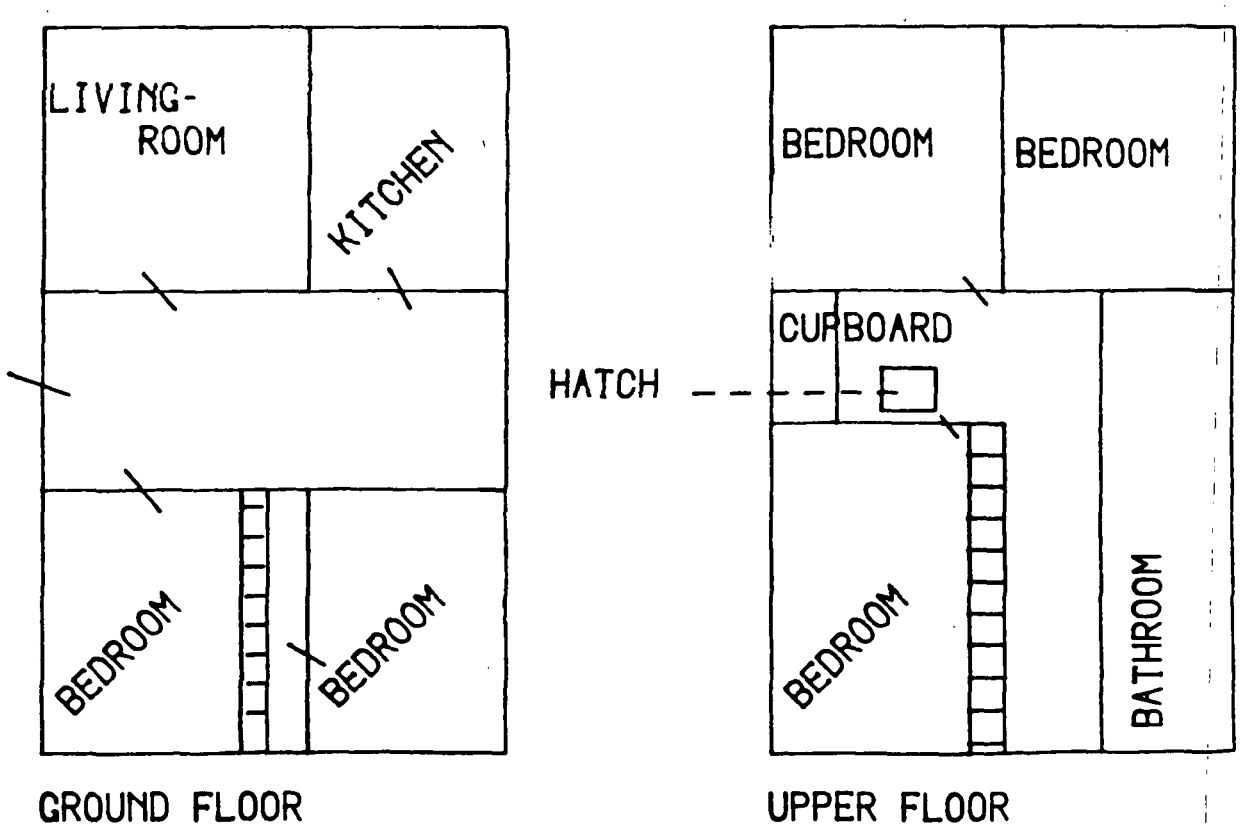
3. Type of insulation Rolled Rockwool

4. Type of Heaters Gas fire

5. Age of House Old

6. Survey Details

		Weather	Other activities
(a)	Pre-survey	Rain - sw wind	None
(b)	Laying Insulation	Rain - sw wind	None
(c)	24 Hours After Laying	Dry and sunny	None
(d)	7 Days After Laying	Dry and sunny	None



			PCOM					SEM											
				1st Count		2nd Count			MMMF fibres			Other mineral fibres			Organic fibres			All fibres		
House	Survey	Location	Filter No.	Resp	Non-resp	Resp	Non-resp	Filter No.	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm
0003	Pre	Hall	0046	0.001	<0.001	0.003	<0.001	0047	<0.001	<0.001	<0.001	0.001	0.001	<0.001	0.005	0.003	<0.001	0.006	0.004	0.001
		L/room	0044	0.002	<0.001	0.002	<0.001	0045	<0.001	<0.001	<0.001	0.004	0.002	<0.001	0.009	0.005	0.002	0.014	0.007	0.002
		Bedroom	0048	0.001	<0.001	0.004	<0.001	0049												
		Bedroom	0050	0.001	<0.001	0.002	<0.001	0051												
	During insulation	Hall	0054	0.010	0.002	0.006	0.001	0055	0.005	0.005	<0.001	0.005	0.002	0.001	0.017	0.010	0.003	0.026	0.017	0.004
		L/room	0052	0.009	0.001	0.007	<0.001	0053		0.001			0.006			0.003			0.010	
		Bedroom	0056	0.014	0.005	0.012	0.002	0057												
		Bedroom	0058	0.027	<0.001	0.006	0.002	0059												
		Personal	0061	1.086	0.308	0.700	0.183													
		Personal	0062	0.595	0.328	0.586	0.036													
	24 hrs after	Hall	0065	0.007	0.001	0.002	<0.001	0066	<0.001	<0.001	<0.001	0.006	0.002	0.001	0.009	0.004	0.001	0.015	0.006	0.002
		L/room	0063	0.003	0.002	0.002	<0.001	0064	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.005	0.005	<0.001	0.006	0.005	0.001
		Bedroom	0067	0.006	<0.001	0.002	<0.001	0068												
		Bedroom	0069	0.005	0.002	0.002	<0.001	0070												
	7 days after	Hall	0086	0.007	0.003	0.009	<0.001	0087	<0.001	<0.001	<0.001	0.002	0.001	<0.001	0.007	0.006	<0.001	0.010	0.007	0.001
		L/room	0084	0.005	0.002	0.002	<0.001	0085	0.001	0.001	<0.001	0.002	0.001	<0.001	0.004	0.004	<0.001	0.006	0.005	<0.001
		Bedroom	0088	0.005	<0.001	0.005	<0.001	0089												
		Bedroom	0090	0.006	0.002	0.007	<0.001	0091												

SUMMARY (0004)

1. **Address:** Gray Sheltered Housing, The Pleasance, Edinburgh

2. **Type of House** Upper Flat

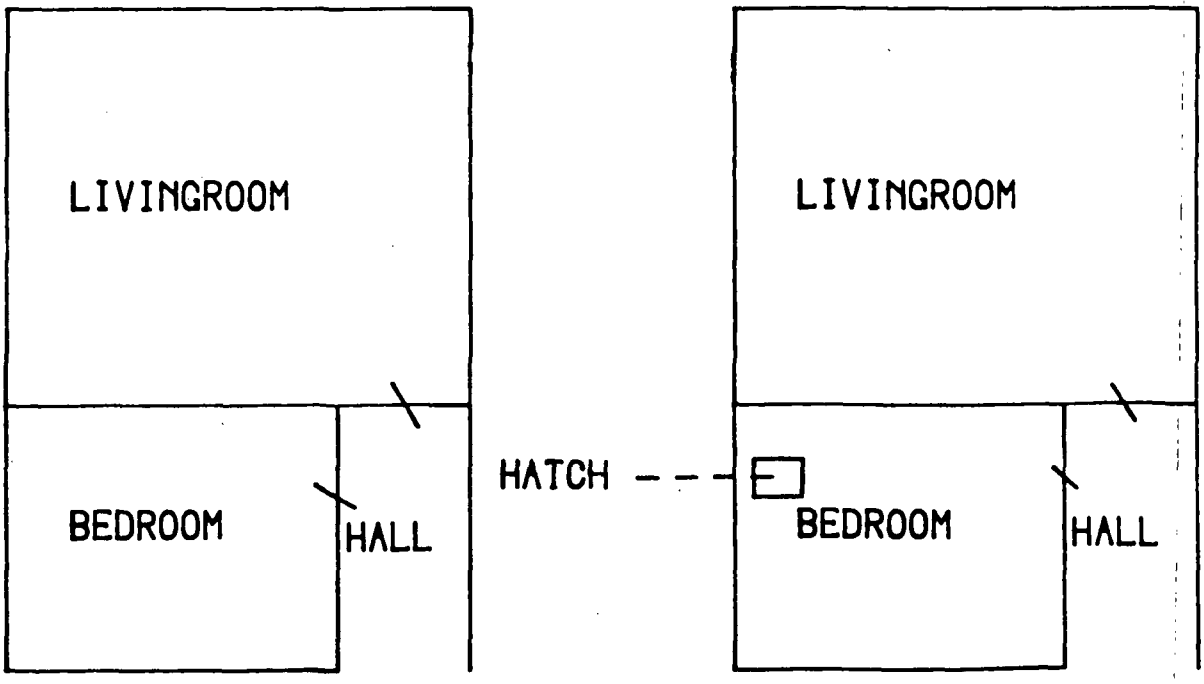
3. **Type of insulation** Crown 75 rolled Glasswool

4. **Type of Heaters** Electric

5. **Age of House** New

6. **Survey Details**

		Weather	Other activities
(a)	**Pre-survey**	Dry-westerly wind	None inside but laying paths and road outside
(b)	**Laying Insulation**	Dry-westerly wind	do.
(c)	**24 Hours After Laying**	Showers-westerly wind	do.
(d)	**7 Days After Laying**	Dry-light wind	do.



1st FLOOR No. 4 2nd FLOOR No.6

ACCESS TO AREA ONLY VIA No. 6

			PCOM					SEM											
				1st Count		2nd Count			MMMF fibres			Other mineral fibres			Organic fibres			All fibres		
House	Survey	Location	Filter No.	Resp	Non-resp	Resp	Non-resp	Filter No.	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm
0004	Pre	No.4 Bdrm	0092	0.009	<0.001	0.003	<0.001	0093											
		" L/room	0094	0.013	<0.001	0.002	<0.001	0095	<0.001	<0.001	<0.001	0.010	0.005	<0.001	0.003	0.002	<0.001	0.014	0.007	<0.001
		* No.6 Bdrm	0098	TD		TD		0099		<0.001			0.003			0.004			0.008	
		" L/room	0096	0.020	0.003	0.008	<0.001	0097											
	During insulation	No.4 Bdrm	0100	0.001	0.001	0.002	<0.001	0101											
		" L/room	0102	0.010	<0.001	0.003	<0.001	0103	<0.001	<0.001	<0.001	0.032	0.011	0.001	0.012	0.006	0.001	0.044	0.018	0.001
		* No.6 Bdrm	0104	0.035	0.002	0.021	<0.001	0105	0.027	0.023	<0.001	0.038	0.014	<0.001	0.049	0.029	0.001	0.115	0.066	0.001
		" L/room	0106	0.080	0.034	0.122	0.019	0107											
		Personal	0111	1.205	0.264	0.848	0.126												
		Personal	0112	1.147	0.161	0.527	0.046												
	24 hrs after	No.4 Bdrm	0119	0.003	<0.001	0.003	<0.001	0120											
		" L/room	0117	0.006	<0.001	0.001	<0.001	0118	<0.001	<0.001	<0.001	0.054	0.021	<0.001	0.012	0.003	<0.001	0.067	0.024	<0.001
		* No.6 Bdrm	0113	0.005	<0.001	0.004	<0.001	0114	<0.001	<0.001	<0.001	0.048	0.020	<0.001	0.033	0.002	<0.001	0.051	0.022	<0.001
		" L/room	0115	0.004	<0.001	0.001	<0.001	0116											
	7 days after	No.4 Bdrm	0141	0.013	0.002	0.004	<0.001	0142											
		" L/room	0143	0.031	0.001	0.001	<0.001	0144	<0.001	<0.001	<0.001	0.008	0.002	<0.001	0.012	0.008	<0.001	0.021	0.010	<0.001
		* No.6 Bdrm	0137	0.011	0.001	0.001	<0.001	0138	<0.001	<0.001	<0.001	0.005	0.003	<0.001	0.005	0.005	<0.001	0.010	0.008	<0.001
		" L/room	0139	0.010	<0.001	0.004	<0.001	0140											

* Hatch at floor level in this room

SUMMARY (0005)

1. Address: Thirlestane Lane, Edinburgh

2. Type of House 2 Bedroom Flat

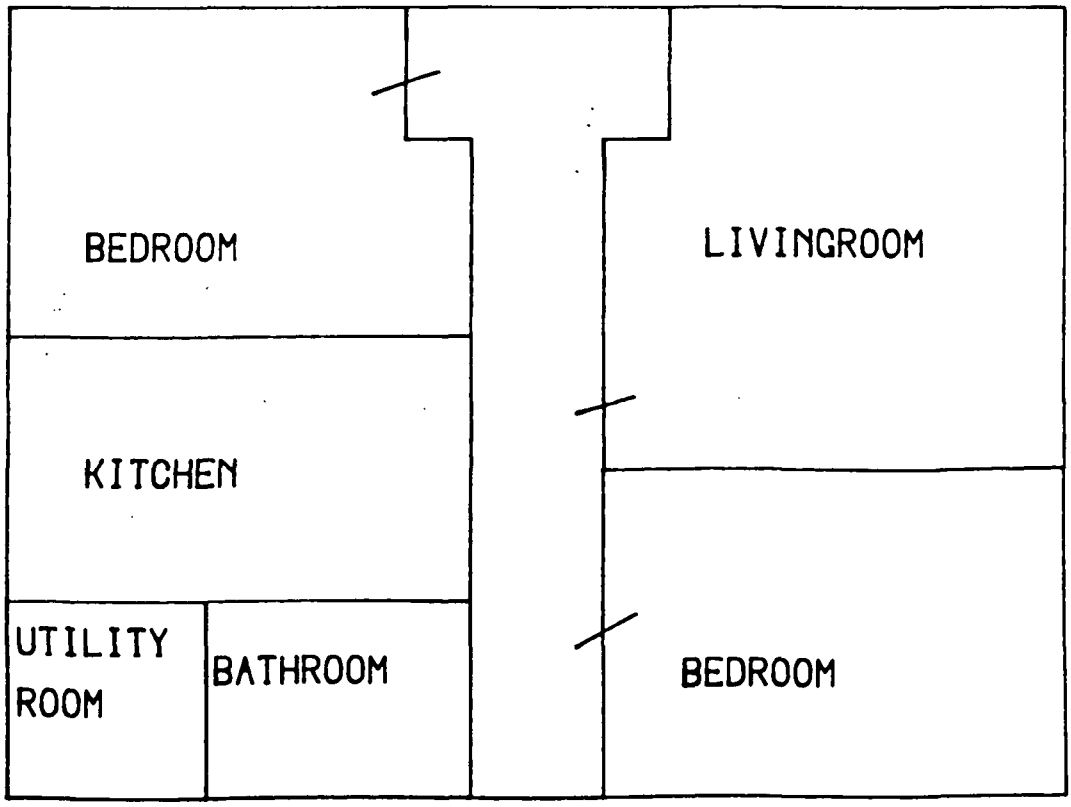
3. Type of insulation Rockwool RW3 50 mm Slabs

4. Type of Heaters Solid fuel central heating

5. Age of House 90 yrs

6. Survey Details

		Weather	Other activities
(a)	Pre-survey	Dry, 19°C, Light W wind	None
(b)	Laying Insulation	Dry 18°C Light N/E wind	None
(c)	24 Hours After Laying	Rain, 17°C Light S/W wind	None
(d)	7 Days After Laying	Dry, cloudy 19°C Light N/E wind	None



			PCOM					SEM										
				1st Count		2nd Count			MMF fibres			Other mineral fibres			Organic fibres			All fibres		
House	Survey	Location	Filter No.	Resp	Non-resp	Resp	Non-resp	Filter No.	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm
0005	Pre	Kitchen	0021	0.023	0.005	0.016	<0.001	0122												
		Hall	0123	0.013	0.006	0.005	<0.001	0124	0.001	<0.001	<0.001	0.004	0.001	0.001	0.008	0.004	<0.001	0.012	0.005	0.001
		Livingroom	0125	0.040	0.013	0.034	<0.001	0126	<0.001	<0.001	<0.001	0.008	0.004	<0.001	0.016	0.012	0.002	0.024	0.016	0.002
		Bedroom	0127	0.055	0.006	0.037	0.005	0128												
	During insulation	Personal	0129	0.357	0.071	0.243	0.028	0130												
		Hall	0131	0.091	0.015	0.031	0.006	0132	0.024	0.019	0.005	0.090	0.021	<0.002	0.028	0.005	<0.002	0.142	0.045	0.005
		Livingroom	0133	0.247	0.028	0.099	0.007	0134	0.022	0.020	0.002	0.033	0.004	<0.002	0.016	0.016	<0.002	0.072	0.040	0.002
		Bedroom	0135	0.078	0.009	0.019	<0.001	0136												
	24 hrs after	Kitchen	0145	0.007	<0.001	0.001	<0.001	0146												
		Hall	0147	0.011	0.001	0.003	0.001	0148	<0.001	<0.001	<0.001	0.006	0.004	0.001	0.008	0.007	<0.001	0.014	0.011	0.001
		Livingroom	0149	0.019	0.006	0.005	<0.001	0150	R											
		Bedroom	0151	0.008	<0.001	0.002	<0.001	0152	<0.001	<0.001	<0.001	0.003	0.001	<0.001	0.011	0.009	0.001	0.014	0.010	0.001
	7 days after	Kitchen	0153	0.012	<0.001	0.018	<0.001	0154												
		Hall	0155	0.011	<0.001	0.015	<0.001	0156	<0.001	<0.001	<0.001	0.006	0.004	<0.001	0.019	0.015	0.001	0.025	0.019	0.002
		Livingroom	0157	0.047	0.003	0.044	0.002	0158	0.001	0.001	<0.001	0.002	0.001	0.001	0.042	0.035	0.001	0.045	0.037	0.002
		Bedroom	0159	0.008	<0.001	0.012	<0.001	0160												

SUMMARY (1001)

1. **Address:** Park Court, Musselburgh

2. **Type of House** Semi-detached, 3 Bedroom

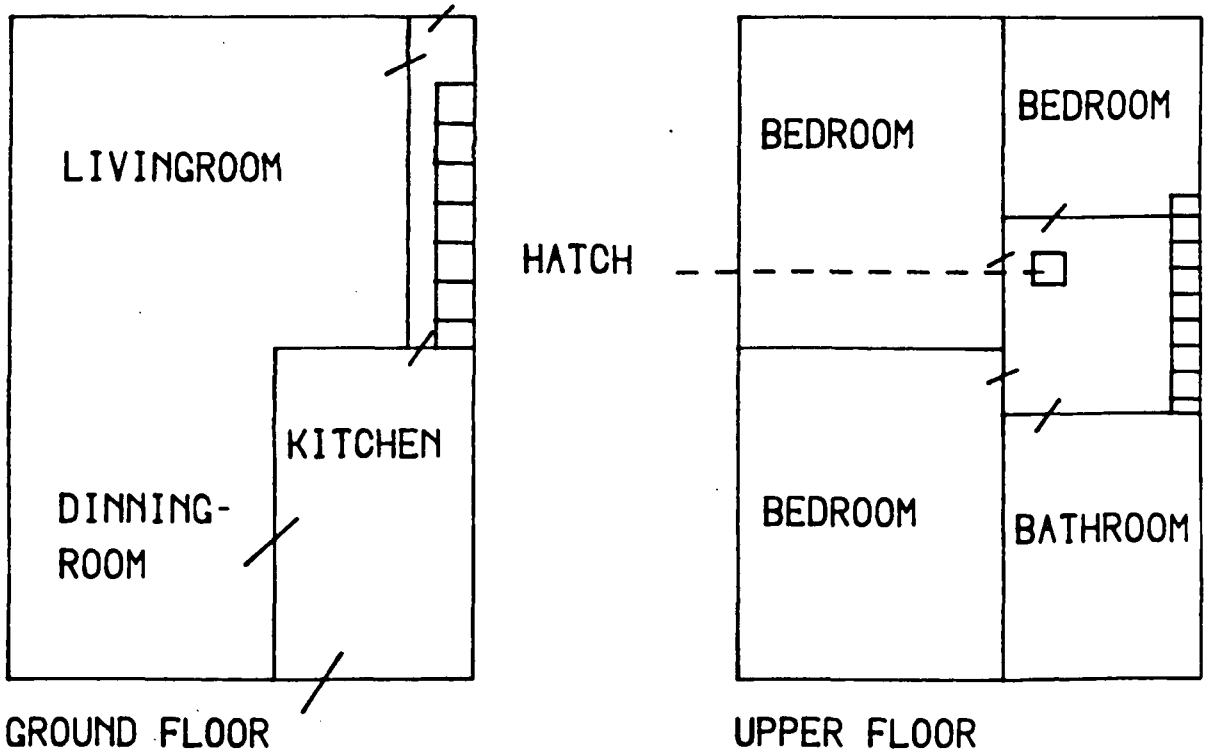
3. **Type of insulation** Rolled Glasswool (Pilkington)

4. **Type of Heaters** Gas central heating

5. **Age of House** 20 years

6. Survey Details

	Weather	Other activities
(a) **Pre-survey** No disturbance	NW'ly wind - dry	None
(b) **Minimum Disturbance** Check ballcock and domestic and CH tanks	NW'ly wind - dry	None
(c) **Major Disturbance** Moving insulation to tighten joints in cold water feed	SW wind light rain	None



House	Survey	Location	PCOM Filter No.	PCOM 1st Count Resp	PCOM 1st Count Non-resp	PCOM 2nd Count Resp	PCOM 2nd Count Non-resp	SEM Filter No.	SEM MMMF fibres All	SEM MMMF fibres >5 µm ≤3 µm	SEM MMMF fibres >5 µm >3 µm	SEM Other mineral fibres All	SEM Other mineral fibres >5 µm ≤3 µm	SEM Other mineral fibres >5 µm >3 µm	SEM Organic fibres All	SEM Organic fibres >5 µm ≤3 µm	SEM Organic fibres >5 µm >3 µm	SEM All fibres All	SEM All fibres >5 µm ≤3 µm	SEM All fibres >5 µm >3 µm
1001	Pre	Below Hatch	0001	0.095	0.005	0.143	<0.001	0002	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.026	0.016	0.001	0.028	0.017	0.001
		Bedroom	0004	0.065	0.004	0.077	<0.001	0005												
		Bedroom	0006	0.034	0.003	0.083	<0.001	0007												
		L/room	0008	0.013	0.002	0.055	<0.001	0009	<0.001	<0.001	<0.001	0.003	0.001	<0.001	0.025	0.019	<0.001	0.028	0.021	<0.001
	Minor	Below Hatch	0010	0.046	0.007	0.037	<0.001	0011	0.002	0.001	<0.001	<0.001	<0.001	<0.001	0.028	0.016	0.002	0.030	0.017	0.002
		Bedroom	0013	0.051	0.011	0.084	<0.001	0014												
		Bedroom	0015	0.055	0.007	0.056	0.001	0016												
		L/room	0017	0.094	0.010	0.069	0.003	0018	<0.001	<0.001	<0.001	0.006	0.001	<0.001	0.063	0.049	<0.001	0.069	0.051	<0.001
		In loft	0019	0.197	0.040	0.183	0.025	0020	0.081	0.059	0.009	0.019	0.006	<0.001	0.141	0.106	0.003	0.241	0.172	0.013
	Major	Below Hatch	0021	0.014	<0.001	0.256	0.023	0022	0.013	0.010	<0.001	0.003	0.002	<0.001	0.026	0.019	<0.001	0.042	0.031	0.001
		Bedroom	0024	0.017	0.002	0.066	0.009	0025												
		Bedroom	0026	0.021	<0.001	0.070	0.009	0027												
		L/room	0028	0.018	<0.001	0.087	0.003	0029	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.036	0.021	<0.001	0.037	0.023	<0.001
		In loft	0030	0.386	0.017	0.345	0.102	0031	0.456	0.344	0.045	0.037	0.015	<0.001	0.075	0.045	<0.001	0.568	0.403	0.045

SUMMARY (1002)

1. **Address:** Waugh Path, Bonnyrigg

2. **Type of House** End Terrace - 2 Bedroom

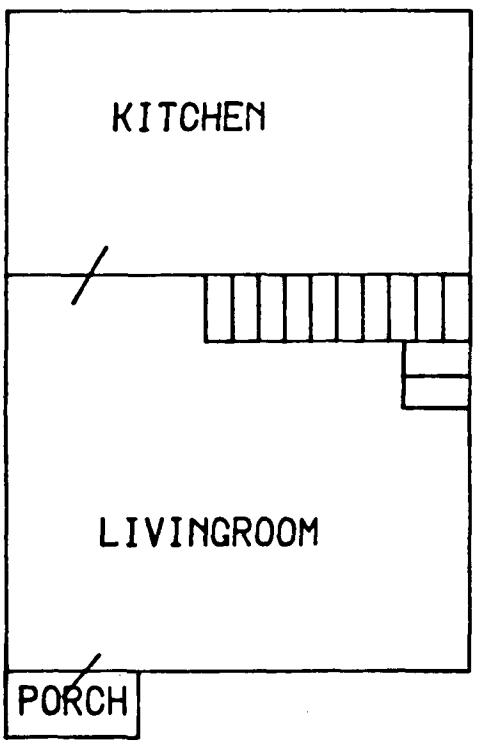
3. **Type of insulation** Rolled Glasswool

4. **Type of Heaters** Gas central heating

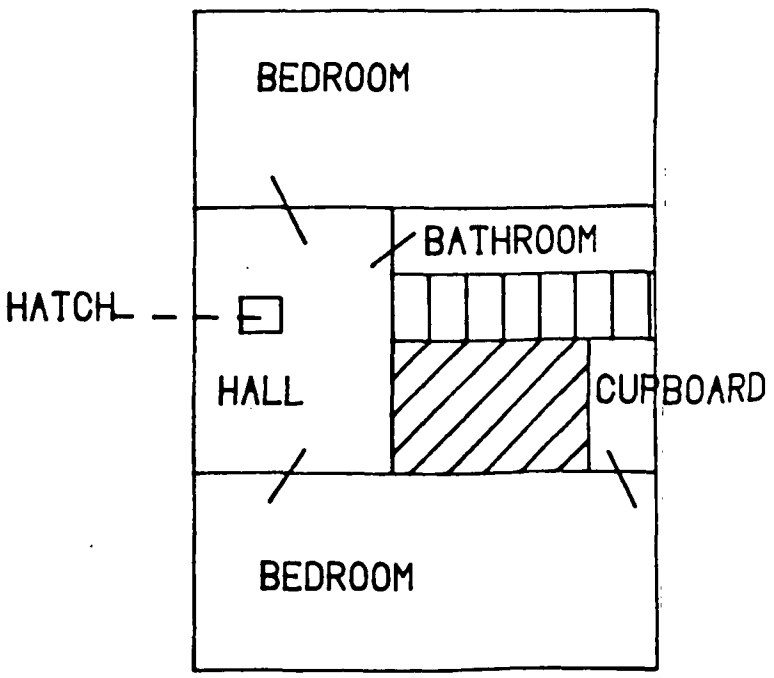
5. **Age of House** 10 years

6. **Survey Details**

	Weather	Other activities
(a) **Pre-survey** No disturbance	Dry ne'ly wind	None
(b) **Minimum Disturbance** Tidy attic	SW wind - showers	None
(c) **Major Disturbance** Packing insulation between rafters	Light sw wind - fine	None



GROUND FLOOR



UPPER FLOOR

House	Survey	Location	PCOM 1st Count Filter No.	PCOM 1st Count Resp	PCOM 1st Count Non-resp	PCOM 2nd Count Resp	PCOM 2nd Count Non-resp	SEM Filter No.	SEM MMMF fibres All	SEM MMMF fibres >5 µm ≤3 µm	SEM MMMF fibres >5 µm >3 µm	SEM Other mineral fibres All	SEM Other mineral fibres >5 µm ≤3 µm	SEM Other mineral fibres >5 µm >3 µm	SEM Organic fibres All	SEM Organic fibres >5 µm ≤3 µm	SEM Organic fibres >5 µm >3 µm	SEM All fibres All	SEM All fibres >5 µm ≤3 µm	SEM All fibres >5 µm >3 µm
1002	Pre	Below Hatch	0032	0.002	<0.001	0.004	0.004	0033	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	0.006	0.005	<0.001	0.009	0.005	<0.001
		Bedroom	0035	0.007	0.002	0.006	0.006	0036												
		Bedroom	0037	0.006	<0.001	0.010	0.004	0038												
		L/room	0039	0.005	<0.001	0.013	0.003	0040	<0.001	<0.001	<0.001	0.007	0.002	<0.001	0.012	0.007	0.002	0.018	0.009	0.002
	Minor	Below Hatch	0041	0.005	<0.001	0.013	0.003	0042	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.009	0.007	0.001	0.010	0.007	0.001
		Bedroom	0044	0.005	<0.001	0.008	<0.001	0043												
		Bedroom	0046	0.005	<0.001	0.003	0.003	0045												
		L/room	0048	0.005	<0.001	0.002	<0.001	0047	<0.001	<0.001	<0.001	0.004	0.002	<0.001	0.012	0.009	<0.001	0.016	0.011	<0.001
		Loft	0049	0.034	0.015	0.150	0.006													
	Major	Below Hatch	0050	0.004	<0.001	0.044	0.001	0051	<0.001	<0.001	<0.001	0.001	0.001	<0.001	0.008	0.005	<0.001	0.009	0.006	0.001
		Bedroom	0052	0.002	<0.001	0.002	<0.001	0053												
		Bedroom	0054	0.004	0.001	0.008	<0.001	0055												
		L/room	0056	0.004	<0.001	0.003	0.001	0057	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.001	<0.001	0.002	0.001	<0.001
		Loft	0057A	0.007	0.009	0.002	<0.001													

SUMMARY (1003)

1. **Address:** Forth Street, Port Seton

2. **Type of House** 4 Bedroom - Detached

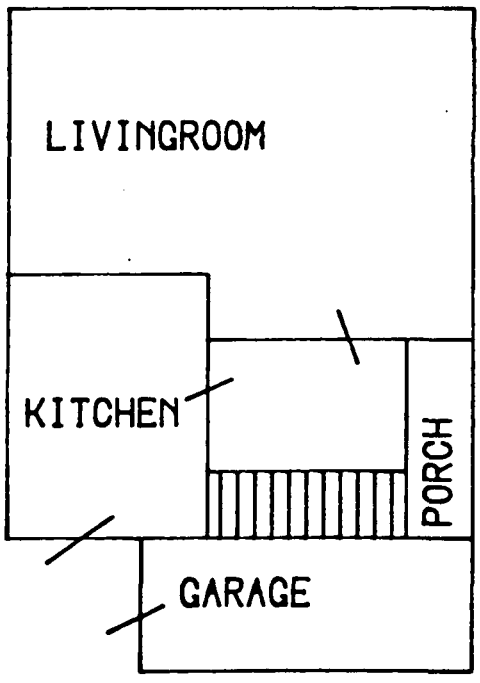
3. **Type of insulation** Blown glass

4. **Type of Heaters** Gas central heating

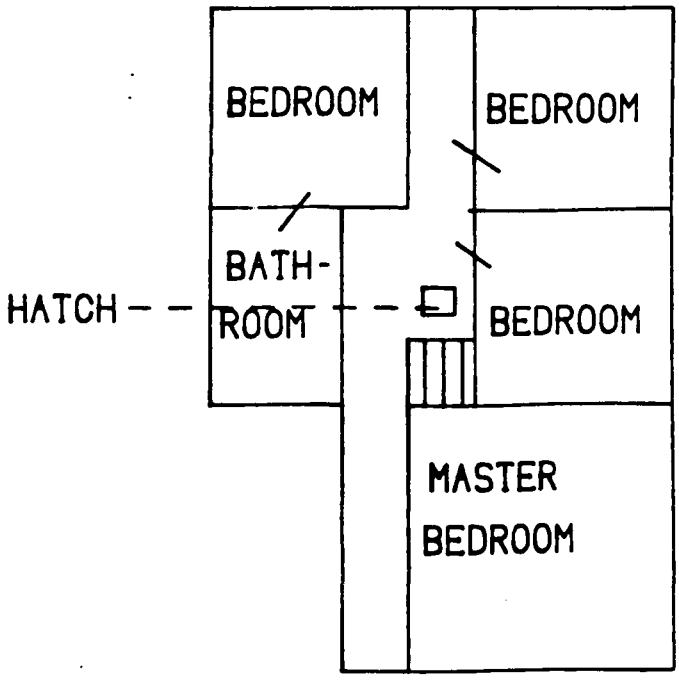
5. **Age of House** 5 years

6. **Survey Details**

	Weather	Other activities
(a) **Pre-survey** No disturbance	Dry, northerly wind	None
(b) **Minimum Disturbance** Check ballcock and domestic water system	Dry, northerly wind	None
(c) **Major Disturbance** Raking and levelling insulation	Showers - sw wind	None



GROUND FLOOR



UPPER FLOOR

House	Survey	Location	PCOM 1st Count Filter No.	PCOM 1st Count Resp	PCOM 1st Count Non-resp	PCOM 2nd Count Resp	PCOM 2nd Count Non-resp	SEM Filter No.	MMMF fibres All	MMMF fibres >5 µm ≤3 µm	MMMF fibres >5 µm >3 µm	Other mineral fibres All	Other mineral fibres >5 µm ≤3 µm	Other mineral fibres >5 µm >3 µm	Organic fibres All	Organic fibres >5 µm ≤3 µm	Organic fibres >5 µm >3 µm	All fibres All	All fibres >5 µm ≤3 µm	All fibres >5 µm >3 µm
1003	Pre	Below Hatch	0061	0.003	<0.001	0.005	0.002	0060	<0.001	<0.001	<0.001	0.002	0.001	<0.001	0.013	0.006	0.003	0.014	0.007	0.003
		Bedroom	0065	0.001	<0.001	0.002	0.001	0064												
		Bedroom	0063	0.003	<0.001	0.003	0.001	0062												
		L/room	0059	0.002	<0.001	0.004	0.001	0058	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Minor	Below Hatch	0067	0.001	<0.001	0.004	0.001	0066	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	0.005	0.004	<0.001	0.006	0.004	0.001
		Bedroom						0072												
		Bedroom	0071	0.002	<0.001	0.005	<0.001	0070												
		L/room	0069	0.002	0.002	0.003	0.002	0068	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.006	0.003	<0.001	0.008	0.003	<0.001
		In loft	0075	0.014	<0.001	0.008	0.007	0074												
	Major	Below Hatch	0077	0.009	0.003	0.007	0.004	0076	<0.001	<0.001	<0.001	0.003	0.001	<0.001	0.014	0.010	0.001	0.017	0.011	0.002
		Bedroom	0081	0.009	<0.001	0.009	0.002	0080												
		Bedroom																		
		L/room	0079	0.006	0.003	0.013	0.003	0078	<0.001	<0.001	<0.001	0.002	0.001	<0.001	0.034	0.022	0.002	0.036	0.024	0.002
		In loft	0083	0.013	0.006	0.020	0.012	0082												

SUMMARY (1004)

1. **Address:** Morningside Road, Edinburgh

2. **Type of House** Terrace - Upper Flat

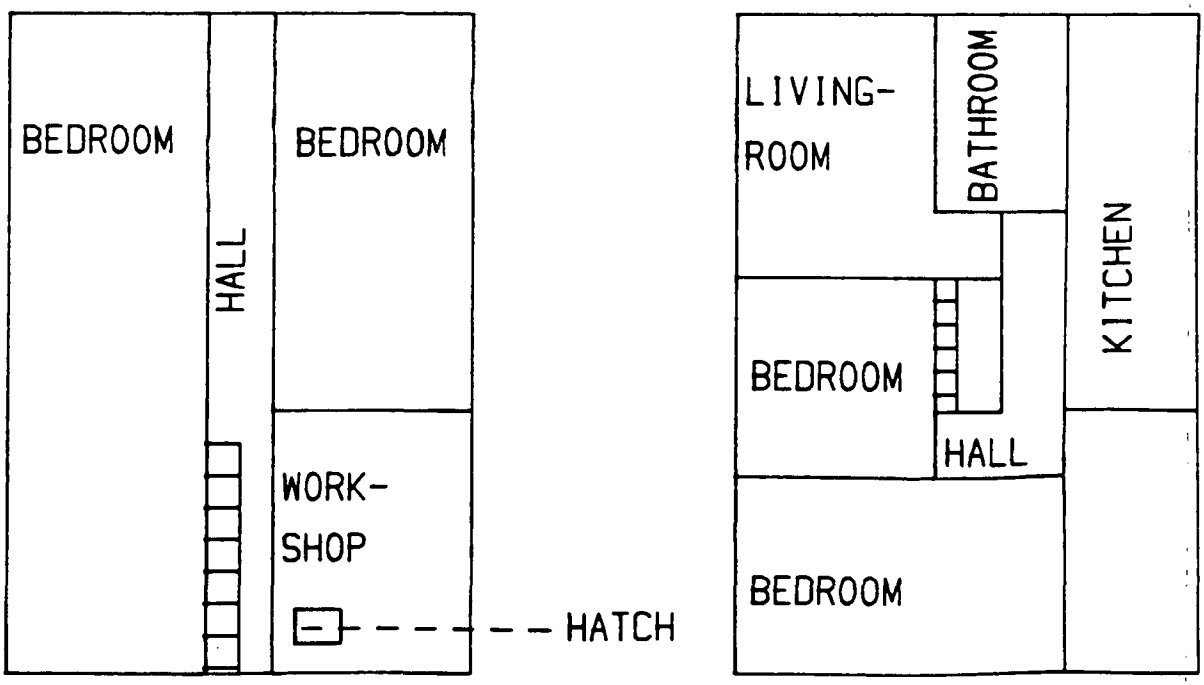
3. **Type of insulation** 90% Glasswool, 10% Rockwool

4. **Type of Heaters** Solid fueld central heating

5. **Age of House** 100 years

6. **Survey Details**

	Weather	Other activities
(a) **Pre-survey** No disturbance	Dry - no wind	None
(b) **Minimum Disturbance** Tidied up loft	Dull, but dry	None
(c) **Major Disturbance** Lifted and relaid approx 20' insulation	Wet overnight, but dry at time	None



UPPER FLOOR GROUND FLOOR

			PCOM					SEM											
				1st Count		2nd Count			MMMF fibres			Other mineral fibres			Organic fibres			All fibres		
House	Survey	Location	Filter No.	Resp	Non-resp	Resp	Non-resp	Filter No.	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm
1004	Pre	Below Hatch	0098	<0.001	<0.001	0.003	<0.001	0099	<0.001	<0.001	<0.001	0.002	0.002	<0.001	0.005	0.004	<0.001	0.007	0.006	<0.001
		Bedroom	0092	0.007	<0.001	0.003	<0.001	0093												
		Bedroom	0094	0.003	<0.001	0.005	<0.001	0095												
		L/room	0096	0.009	<0.001	0.005	<0.001	0097	<0.001	<0.001	<0.001	0.003	0.002	0.001	0.010	0.007	0.002	0.013	0.009	0.002
	Minor	Below Hatch	0108	0.002	0.001	0.003	<0.001	0109	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.004	0.001	0.006	0.004	0.001
		Bedroom	0102	0.103	0.001	0.009	0.001	0103												
		Bedroom	0104	0.006	<0.001	0.010	<0.001	0105												
		L/room	0106	0.008	0.004	0.006	0.003	0107	<0.001	<0.001	<0.001	0.003	0.001	<0.001	0.016	0.010	0.001	0.019	0.011	0.002
		In loft	0110	0.007	<0.001	0.010	0.004	0111												
	Major	Below Hatch	0118	0.001	<0.001	0.001	0.001	0119	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.003	0.002	<0.001	0.005	0.002	<0.001
		Bedroom	0114	0.002	<0.001	0.002	0.002	0115												
		Bedroom	0112	0.001	<0.001	0.002	0.001	0113												
		L/room	0116	0.001	<0.001	0.001	<0.001	0117	<0.001	<0.001	<0.001	0.002	0.001	<0.001	0.004	0.002	0.001	0.006	0.002	0.001
		In loft	0120	0.086	<0.001	0.036	0.036	0121												

SUMMARY (1005)

1. **Address:** Steel Grove, Tranent

2. **Type of House** Terraced

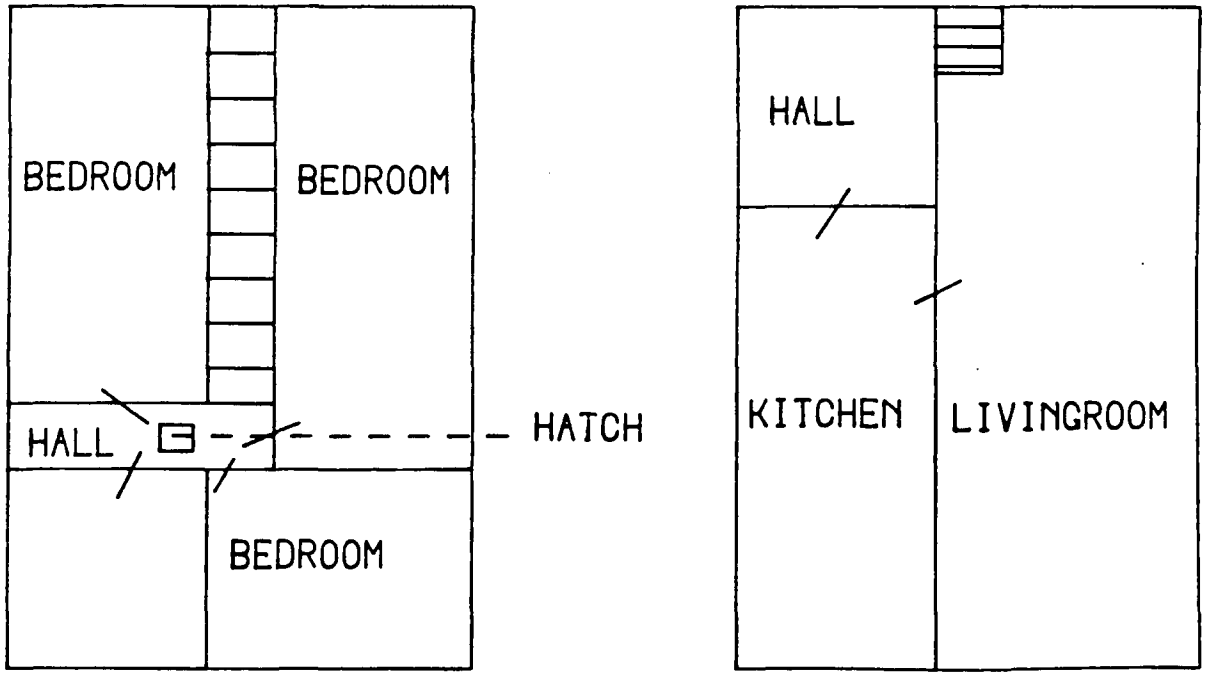
3. **Type of insulation** Glass and rockwool

4. **Type of Heaters** Solid fuel central heating

5. **Age of House** 32 years

6. **Survey Details**

	Weather	Other activities
(a) **Pre-survey** No disturbance	Dry, sunny	
(b) **Minimum Disturbance**	Heavy rain, windy	Organised search
(c) **Major Disturbance**	Dull, wet	Shifting insulation and relaying



UPPER FLOOR GROUND FLOOR

House	Survey	Location	PCOM					SEM											
				1st Count		2nd Count			MMMF fibres			Other mineral fibres			Organic fibres			All fibres		
			Filter No.	Resp	Non-resp	Resp	Non-resp	Filter No.	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm	All	>5 µm ≤3 µm	>5 µm >3 µm
1005	Pre	Below Hatch	0125	0.003	<0.001	0.005	<0.001	0126	0.001	0.001	<0.001	0.001	0.001	0.001	0.004	0.003	<0.001	0.006	0.004	0.001
		Bedroom	0127	0.005	0.002	0.006	<0.001	0128												
		Bedroom	0129	<0.001	<0.001	0.002	<0.001	0130												
		L/room	0131	0.001	<0.001	0.001	0.001	0132	<0.001	<0.001	<0.001	0.001	0.001	<0.001	0.008	0.005	0.002	0.008	0.006	0.002
	Minor	Below Hatch	0133	<0.001	<0.001	0.001	<0.001	0134	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.009	0.007	0.002	0.011	0.007	0.002
		Bedroom	0135	0.001	<0.001	0.001	<0.001	0136												
		L/room	0139	0.002	<0.001	0.001	<0.001	0140	<0.001	<0.001	<0.001	0.003	0.001	0.002	0.009	0.006	0.002	0.012	0.007	0.004
		Personal	0141	0.051	0.007	0.033	0.007	0142												
	Major	Below Hatch	0143	0.001	<0.001	0.002	<0.001	0144		<0.001			<0.001			0.002			0.002	
		Bedroom	0145	<0.001	0.001	0.004	<0.001	0146												
		Bedroom	0147	0.001	<0.001	0.001	<0.001	0148												
		L/room	0149	0.003	0.002	0.004	<0.001	0150	<0.001	<0.001	<0.001	0.001	<0.001	0.001	0.006	0.004	0.003	0.008	0.004	0.004

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