VENTILATION

IN

INDUSTRIAL BUILDINGS

FINAL REPORT

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Contents

1. Introduction and Objectives

1.1 Background to the study

A considerable body of knowledge exists on the natural ventilation and air infiltration of domestic buildings, and of domestic size rooms in other buildings. Experimental measurements have been carried out for many years by a number of workers, and several experimental techniques are well established. Review papers have been published by Hitchen and Wilson (1), Hunt (2), and Sherman et. al (3). There is no similar body of knowledge on natural ventilation in large single cell buildings such as factories. This may be partly due to lack of attention by research workers to this type of building, but there is also some doubt as to whether or not the measurement techniques used in domestic dwellings can be used in much larger buildings. There have been a number of model studies of air flow patterns in factory buildings, for example, by Baturin (4), and there are some published results on measured temperature distributions. However, there is hardly any published work on measured ventilation rates and air movement patterns in any large single cell buildings.

The initial impetus for this study came from a desire to model the energy consumption of factory buildings. The natural ventilation rate is an essential parameter in such a model, and typical values were needed for typical buildings in the size range 1000 m^3 to 10,000 m^3. It was realised that air movement patterns within such a building may be just as important as ventilation rate, and indeed that there may be considerable variations in the ventilation rate throughout the space. In order to fill the gap in knowledge, and to provide essential information for the modelling of energy consumption of factories, it was decided to institute an experimental programme to measure ventilation and air movement in factory buildings. The programme was conceived as being in two stages, firstly a pilot study to assess the experimental problems and to identify the most important parameters, and secondly a more substantial study to obtain data on a number of buildings. The pilot study, which was funded by SERC research grant GR/B/64604, is the subject of this report.

1.2 Objectives

The overall objective was to study the problems associated with the measurement of ventilation rates and air movement patterns in large single cell buildings. In order to contain the study within the resources and time scale of a pilot study, it was limited in two ways:

(i) it was restricted to unoccupied, unheated buildings;
(ii) it was restricted to tracer gas methods.

The restriction on occupancy and heating provided a considerable simplification, because difficulties of measurement and interpretation of results due to, for example, the random opening and closing of doors or windows, or due to the nature and location of heat emitters, were eliminated.

The restriction to tracer gas methods was made because it was considered necessary to explore in the first instance the validity and usefulness of the technique which has found widest acceptance for ventilation measurement in other types of building. Should tracer gas methods prove to be satisfactory, then the investigation of factory ventilation could commence immediately, using the knowledge and expertise which already exists for such methods. On the other hand, should they be shown to be unsatisfactory, the investigation of factory ventilation itself would have to be preceded by a programme of research on instrumentation and methodology.

The specific question to be answered is, therefore, "can a tracer gas method be used to measure air change rates in large single cell buildings?". Particular aspects of this question which the project is intended to explore are:

(i) the difficulty of adequate mixing of the tracer gas;
(ii) variability of ventilation rate throughout the space;
(iii) variation of ventilation rate with time.

2. Equipment and Experimental Technique

Two independent tracer gas systems were employed, one based on nitrous oxide and the other on sulphur hexafluoride. These were chosen because they have suitable properties and appear to be the most popular of the tracer gases in current use.

.1 Nitrous Oxide System

The detection system consisted of a model 120 Infra Red Gas Analyser (IRGA) and a six point sampling unit, purchased complete from GP Instrumentation. The IRGA was fitted with a Luft detector, and was designed to measure nitrous oxide in air over a range of concentrations from 0 to 100 $x10^{-6}$, with an accuracy of about $\pm$ 2 $x10^{-6}$. The range was checked using a calibrated gas mixture of 44 $x10^{-6}$ nitrous oxide in air. Although the instrument gives a continuous record of nitrous oxide concentration with time, its response is not instantaneous. For example, for a step change in nitrous oxide concentration of about 50 $x10^{-6}$, the instrument exhibited a time constant of about 15 secs. The six point sample unit has a single pump which draws air through each channel in turn, with a dwell time of 1 minute per channel. In normal use, this allows adequate time for the instrument to settle at the correct reading before switching to the next channel. However, in actual use, the IRGA and sample unit were often some distance from the points within a building at which it was desired to measure the tracer concentration. Consequently, there was about 20 m of small diameter tubing between the input part of the sample unit and each measurement point, as well as a filter head to remove dust particles. Thus, a significant proportion of the 1 minute dwell time was required before a stable reading was obtained. To overcome this problem without increasing the dwell time per channel, an additional pump was used to draw air continuously through the sample lines.

At first, the output of the IRGA was taken to a chart recorder via a logarithmic amplifier, the idea being that a change in ventilation rate would show up immediately as a change in the slope of the trace on the recorder. However, this did not prove to be of any great value, and the logarithmic amplifier was dispensed with.

Air was drawn through each sample line at a rate of about 1.4 litres per minute, and the flow rate through the IRGA was normally set to about 0.8 litres/minute.

2.2 Sulphur Hexafluoride System

This was based upon an AI Instruments model 505 gas chromatograph detector. This is a small portable gas chromatograph designed for leak detection using sulphur hexafluoride gas. The detector itself is an electron capture cell, and the column is 380 mm long stainless steel tubing filled with 100-120 mesh alumina. For leak detection, the instrument is operated in continuous mode, with a constant flow of air through the detector. However, used in this way, the output is insufficiently stable to be quantitative. For quantitative measurements, the instrument is operated in sample mode. The internal pump draws air continuously through a sample loop; on operating a valve on the front panel, the contents of the loop are injected into the column and detector. The output produced on the chart recorder is a typical gas chromatogram, with a large peak due to atmospheric oxygen showing first, followed approximately six seconds later by a lower peak due to sulphur hexafluoride. Using a calibrated gas mixture of 35×10^{-9} sulphur hexafluoride in air, the range and sensitivity of the instrument were checked. It was found that on the least sensitive (x50) range, full scale deflection corresponded to a concentration of 350×10^{-9}, whereas on the most sensitive (x1) range, the concentration at full scale was about 7.4×10^{-9}. In practice, because signal noise and instability were sometimes apparent on the x 1 range, the lowest range which was used was the x 5 range, for which f.s.d. was 36.8×10^{-9}.

In its original form, this instrument was found to be unsatisfactory, due mainly to interaction between the internal air circuits for the two different modes of operation. The problem was solved by dismantling the instrument and rebuilding it for operation in sample mode only, and in this form the instrument proved to be stable and consistent in its readings.

In its revised form, the instrument appeared to recover sufficiently rapidly after each chromatogram for successive readings to be taken at 1 minute intervals. It could therefore be operated in conjunction with the six point sample unit, through in practice it was found easier to operate the six point sample unit manually at intervals slightly longer than one minute.

The flow rate of air through the instrument was normally set at 0.6 litres/minute.

2.3 Injection of the Tracer Gas

Several methods of injecting the tracer gas were used, ranging from the crude and simple, to the complex. Details of the evaluation of these methods is given in Chapter 3. It was found that relatively simple methods were sufficiently effective, the preferred ones being as follows:

(i) Nitrous Oxide. Gas was taken directly from the gas cylinder through a flow meter. The flow was adjusted to a rate that would give an overall concentration of between 50×10^{-6} and 100×10^{-6} throughout the building within a maximum period of 30 minutes.

(ii) Sulphur Hexafluoride. An inverted burette was used to collect a measured volume of gas from the cylinder by displacement of water. The measured volume was chosen to give an overall concentration of about 350×10^{-9}. The burette was usually filled outside the building being tested, and was then carried to the point of release.

As experimental work progressed, it became clear that there were two starting conditions of particular interest, one with the tracer gas distributed approximately uniformly, and the other with a "plug" of unmixed tracer at a selected point in the building. The first was achieved by injecting the gas into the blades of a small fan, and the other by bleeding it into a small piece of foam or fibrous material (in order to randomise the exit velocity direction).

2.4 Experimental Difficulties

The majority of the experimental difficulties which were encountered arose from the practical problems of using sensitive laboratory type equipment on site in industrial surroundings. Nevertheless such difficulties are important, and must be overcome if good quality measurements are to be made. In addition some difficulties of a more fundamental nature were found. The main problems were as follows:

i) Leakage

In order to ensure sufficient speed of response, it was necessary to draw air through all sample lines continuously and simultaneously, by means of a single vacuum pump. The multipoint sampling unit, equipped with its own pump, switched sequentially between the sample lines, diverting a proportion of the sample line flow into the detector. It has proved very difficult to maintain the integrity of all seals, joints, junctions and valves in the system so as to prevent ingress of air other than at the entry to the sample line, and to prevent cross-leakage between sample lines. Alterations and checking of the equipment to eliminate leakage has accounted for a large part of the project time. The new system which is proposed later has been designed to be inherently less prone to this problem.

(ii) Robustness

Although the infra red gas analyser was a good laboratory instrument, it was frequently troublesome and unreliable when used for field measurements. The act of transporting it to and from factory sites often disturbed its mechanical adjustments, and when on site it required a very long warm-up period. It required frequent repair and readjustment, and it was difficult to ensure that it performed up to specification in the field.

The sulphur hexafluoride gas chromatograph, on the other hand, has been found to be highly robust, and in its final modified form, was also very reliable. It required only a short warm up time before giving consistent and repeatable readings.

(iii) Speed of response

In the early stages of the tracer decay, not only are tracer concentrations changing rapidly, but there may be large differences in concentration between adjacent channels. In these circumstances, the one minute dwell time per channel was barely sufficient to allow the IRGA to come to a recognisably stable reading. Increasing the dwell time would have widened the interval between successive readings on each channel, giving less information during the period of most rapidly varying tracer concentration.

The sulphur hexafluoride detector, because of its different operating principle, did not suffer in the same way. The transit time of air through the sample loop is of the order of 1 second, so that the instrument is effectively taking 1 second samples of air, and analysing that sample for average sulphur hexafluoride content. Even when tracer gas concentrations were varying rapidly, the gas chromatograms were clean and undistorted, and the recovery time between successive readings could be reduced to as little as one minute. A reduction below one minute did not see feasible.

(iv) Accuracy and stability

In clean, thermally stable laboratory conditions, and using calibrated gas mixtures as reference sources, both instruments could be shown to be stable and accurate to better that $\pm$ 2% full scale deflection over periods of several hours.

However, in the more rigorous environment of field measurements, both instruments exhibited some instability.

In the case of the IRGA, the instability appeared in the form of a slow, random zero drift, which in severe cases could be equivalent to as much as 20×10^{-6} parts of nitrous oxide in air over a period of about 3 hours. To monitor this drift, it was found necessary to connect one of the six sample lines to an uncontaminated source of air, usually external air. In the case of the gas chromatograph, the instability was in the form of a slow drift in sensitivity, which showed itself as a change in the oxygen peak on the chromatogram. Fortunately, calibration tests showed that the sensitivity to sulphur hexafluoride was in proportion to the magnitude of the oxygen peak.

Therefore, by measuring the oxygen peak as well as the sulphur hexafluoride peak on each chromatogram, a correction for sensitivity drift could be applied to each reading.

(v) Interference from other gases

Both instruments are susceptible to interference from atmospheric gases other than the gas for which they are designed. The IRGA is particularly sensitive to interference from carbon dioxide and water vapour, both of which have infra-red absorption bands close to those of nitrous oxide. To combat this, the IRGA is fitted with an optical carbon dioxide filter in the sample beam, and drying agents in the input gas line. However, since the output of the instrument is merely the deflection of a meter, it is impossible to know whether or not any interference due to changes in the atmospheric content of carbon dioxide or water vapour has occurred.

The gas chromatograph will detect any electron capture gas in the atmosphere, but in this case different gases will usually have different retention times in the column, and so should be separated in the resulting chromatogram. The usual procedure is to run a series of null tests before injecting sulphur hexafluoride into the atmosphere to see if any interfering gases are present. In all tests conducted so far, no interfering gases have been detected.

3. Preliminary Investigations

Some preliminary investigations were carried out to investigate different methods for mixing the tracer gas in the air, and to investigate possible variation of ventilation rate throughout a space.

3.1 Mixing of tracer gas

When measuring the ventilation rate of small rooms, it is usual to mix the tracer gas with the air with a small fan. The fan is switched off before the measurements are commenced, and it is then assumed that the tracer gas concentration is uniform throughout the space at all times. This assumption greatly simplifies both the experimental technique and the theoretical analysis. In large spaces, not only may it be more difficult to achieve an initial uniform distribution of tracer gas, but the assumption of uniform concentration at all times may no longer hold.

Investigations of this aspect of the problem were first carried out by injecting tracer gas into a sealed room and noting the time taken for uniform concentration to be achieved using a variety of mixing techniques. The Coventry Polytechnic reverberation chamber (200 m^3) has been used for this part of the project, because it can be sealed to give effectively zero infiltration. The nitrous oxide system was used for these tests, and typical results are shown in figures 1, 2 and 3. In each case, the graphs show at all six sample positions the time taken to reach uniform tracer concentration, and the period immediately before uniformity during which the concentration was within 5% of its final value. Figure 1 shows the results of bleeding in the nitrous oxide directly from the gas cylinder with no artificially induced air movement. In figure 2, the nitrous oxide was injected close to the blades of a small fan, which continued to operate throughout the test. In figure 3, air was forced into an 80 m length of 150 mm diameter polyethylene tubing, perforated along its length. The nitrous oxide was bled into the tubing at the fan position, so that it entered the

room via the perforations. These results show that even with no artificially induced air movement, uniform mixing is reached in less than an hour, and that the simplest method of mixing, as in figure 2, achieves uniformity most quickly.

Further tests were carried out in a factory building of about 3000 m^3 internal volume, again using nitrous oxide. In figure 4, nitrous oxide was introduced at a rate sufficient to reach a uniform concentration of 50 $x10^{-6}$ in about 1 hour. Mixing was by means of a small fan. It can be seen that the distribution of nitrous oxide throughout the space was approximately uniform at all times. Figure 5 shows a similar test at twice the injection rate, and it can be seen that the distribution is less uniform. However, uniformity was reached by continuation of stirring for another 15 minutes. It can be concluded, therefore, that there is little difficulty in achieving a reasonably uniform distribution of tracer gas throughout spaces of volume up to at least 3000 m^3. This conclusion has been confirmed by the experience gained in other measurements in this study.

3.2 Variation of ventilation rate throughout a space.

This was investigated in a room measuring approximately 4.4 m x 4.8 m x 2.7 m high. The room was on the corner of a building with two glazed external walls. The six sample points were arranged on a grid on a horizontal plane, and measurements were repeated with the grid at different heights, thus enabling tracer decay rate contours to be constructed. It was assumed that these decay rates could be converted directly into air change rates, and typical results for three different conditions are shown in figures 6, 7 and 8. These results indicate that the ventilation rate (that is, the rate of exchange between room air and external air) can vary with position by as much as $\pm$ 20% of its mean value. Two conclusions may be drawn from this result. The first is that although the initial distribution of tracer gas was uniform, a ventilation rate derived from measurements of tracer decay at only one point in the room could be misleading. The second is that the decay rate may no longer represent the ventilation rate in a simple fashion. The reason for the second of these conclusions is that although the tracer gas distribution was initially uniform, it gradually becomes non-uniform as the decay procedes, because the decay rates throughout the room vary. Thus with a non-uniform tracer gas distribution, the decay rate at any point may be influenced by air exchange to other internal points as well as by air exchange to the outside.

3.3 Implications of the preliminary investigations

At the start of the project, the problem of achieving an initial uniform distribution of tracer gas was seen as a possible major obstacle to the viability of tracer decay methods. The results of the preliminary investigation show that this is not the case, and that simple methods of injecting and stirring the tracer gas will achieve acceptable uniformity in buildings up to at least 4000 m^3 in volume. In any case, a uniform distribution cannot be sustained after stirring has ceased if there is a spatial variation in decay rate.

The variation in decay rate throughout the space has implications for both the experimental technique and for the analysis and interpretation of results. Clearly it was first necessary to establish whether or not the variations in decay rate observed in the small room used for this preliminary study were present to a greater or lesser

degree in large spaces such as factories. Therefore, considerable care was taken to ensure that the construction, calibration, and operation of the apparatus was sufficiently good to record such differences. For example, it was found that differences in the lengths of the sample lines could cause differential time lags between channels, and hence cause uncertainty in the timing of each individual measurement.

The method of analysing the results must take account of both findings of the preliminary investigation. On the one hand, there appears to be no difficulty in generating sufficient internal circulation to generate an initial uniform concentration. On the other, once stirring has ceased, the tendency to a non-uniform distribution suggests that internal circulation is itself non-uniform, or that exchange from each part of the space to the outside is dominant. In order to create additional experimental evidence on this problem, several tests were carried out with the tracer gas initially unmixed, that is with the gas concentrated in one small part of the building rather than distributed uniformly throughout. It was thought that this technique would be particularly useful in demonstrating the pattern of internal air movements.

4. Theoretical Considerations

As the main purpose of the pilot study is an examination of experimental technique, no attempt has been made to develop a new approach to the analysis of the results. All the results have been analysed using the usual single cell ventilation model, even though this model may be inadequate for describing large spaces. However, in preparation for the development of a more realistic model for the next stage of the overall programme, some preliminary work has been done using a multi-cell model.

4.1 Single Cell Ventilation Model

Figure 9 represents on enclosed space which is being ventilated by a supply of fresh air as well as being injected with a contaminant. It is assumed that the contaminant is at all times uniformly distributed throughout the space, so that its concentration in everywhere defined by a single value. The following symbols may be defined:

V = volume of the space
F = flow rate of fresh air into space (assumed constant)
q = flow rate of contaminant into space (assumed constant)
x_1 = concentration of contaminant in space
x_o = concentration of contaminant in the incoming fresh air

Assuming that pressure and temperature differences throughout the system are negligible, a volumetric balance may be taken on the contaminant concentration:

$$(F\,x_o + q) - (F + q)\,x_1 = V\,\frac{dx_1}{dt}$$

If the internal contaminant concentration at time t = 0 is $x_1(0)$, the solution of this equation is:

$$x_1 = \left(\frac{Fx_o + q}{F + q}\right)\left(1 - \exp\left(-\frac{(F + q)\ t}{V}\right)\right) + x_1(0)\ \exp\left(-\frac{(F+q)t}{V}\right)$$

A tracer decay measurement corresponds to the case q = 0, and $x_1(0) \neq x_o$, which yields:

$$x_1 = x_o + (x_1(0) - x_o)\ \exp\left(-\frac{Ft}{V}\right)$$

This is a simple exponential decay with a time constant, t_c, given by:

$$t_c = \frac{V}{F}$$

It is conventional to express ventilation rates as the flow rate of fresh air per unit volume, with units of reciprocal time. The ventilation rate, N, is thus:

$$N = \frac{F}{V} = \frac{1}{t_c}$$

Clearly, a plot of the natural logarithm of the concentration versus time should yield a straight line, the gradient of which is the negative of the ventilation rate.

4.2 Analysis of Results

In practice, for each ventilation rate measurement, both the nitrous oxide system and the sulphur hexafluoride system yielded a set of pairs of values of time and tracer gas concentration. By first converting the values of concentration to their natural logarithm, a straight line could be fitted to each set of results using the method of least squares. The gradient of the best fit line was taken as the ventilation rate. As an indication of the reliability of each ventilation rate result, the goodness of fit of the data was investigated statistically. A correlation coefficient, R, was evaluated, where R is defined by:

$$R = \sqrt{\frac{\text{Regression Sum of Squares}}{\text{Total Sum of Squares}}}$$

or

$$R = \sqrt{\left(\frac{\Sigma\ (Y_e - \bar{Y})^2}{\Sigma\ (Y_i - \bar{Y})^2}\right)}$$

where $\bar{Y}$ is the mean of the Y values (Y is the natural logarithm of the concentration), Y_e is the estimated value, Y_i is the measured value, and the summations are taken over all points in the data set.

Table 1 is a summary of the results of the measurements, and shows the ventilation rate, the number of experimental points and the correlation coefficient for each data set. In most cases, the correlation coefficient is close to unity, showing that a simple exponential decay is a good description of the results. Further statistical information is given in the detailed analysis of each run, by means of a statistical analysis table. The definition of the terms in this table are:

Regression	Df	Regression degrees of freedom (always unity)
Residual	Df	Residual degrees of freedom (N-2)
Total	Df	Total degrees of freedom (N-1)
Regression	SS	Regression of sum of squares
Residual	SS	Residual sum of squares
Total	SS	Total sum of squares
Regression	MS	Regression mean squares
Residual	MS	Residual mean squares
F		The F statistic (Regression MS/Residual MS)

4.3 Multi-cell ventilation model

Despite the high correlation coefficients obtained by the application of simple single cell theory to the results, there are two reasons for suspecting that a more sophisticated theory is necessary. Firstly, the difference in the ventilation rates between channels in the same run is large enough to be significant at the levels of correlation obtained. For example, referring to run BO3R07 in table 1, for channel 1, V = 1.898 with R = 0.956, and for channel 6, V = 2.544 with R = 0.993. Secondly, in nearly all cases, the correlation coefficient for the complete set of data for a run (the final column in table 1) is less than the correlation coefficients for the individual channels. This is most obvious in runs BO1R01 and BO1R02, though the small number of data points for these runs may have exaggerated this phenomenon. Both of these reasons suggest that there are genuine differences in the ventilation properties of different parts of the same space. Thus, the central assumption of single cell theory, viz. that the tracer gas is fully mixed and uniformly distributed, is at best an approximation. Further, even if the distribution was uniform at a particular point in time, it could not remain so because the decay rate varies throughout the space.

An improvement on single cell theory can be achieved by treating the space as an assembly of small cells, or zones. Within each zone, the tracer gas may be assumed to be uniformly mixed, and each zone exchanges air, or ventilates, to its adjacent zones. Clearly, the greater the number of zones, the more closely will this arrangement approximate to the continuum which exists in practice. The resulting system of zones can be analysed using the multi-cell theory developed by Sinden (5). Figure 10 is a schematic diagram of a multi-cell system. The symbols are defined as:

V_i = volume of cell i

F_{ij} = flow rate from cell i to cell j. Note that $F_{ii} = 0$, and in general $F_{ij} \neq F_{ji}$

q_i = flow rate of contaminant in cell i

x_i = concentration of contaminant in cell i

n = number of cells

Taking a balance on the contaminant concentration in cell j;

$$q_j + \sum_i F_{ij} x_i - \sum_k F_{jk} x_j = V_j \dot{x}_j$$

Taking a balance on the total flow into and out of cell j

$$q_i + \sum_i F_{ij} = \sum_k F_{jk} = S_j$$

For tracer decay, $q_j = 0$, and the equation becomes

$$V_j \dot{x}_j = \sum_i F_{ij} x_i - x_j S_j$$

or

$$\overline{V}\,\dot{\overline{x}} = \overline{F}\,\overline{x}$$

where $\overline{V} = \begin{vmatrix} V_1 & 0 & 0 & - & - & - \\ 0 & V_2 & 0 & - & - & - \\ - & - & - & - & - & - \\ 0 & 0 & - & - & - & V_n \end{vmatrix}$ $\overline{F} = \begin{vmatrix} -S_1 & F_{21} & F_{31} & - & - & - \\ F_{12} & -S_2 & F_{32} & - & - & - \\ - & & - & - & - & - \\ F_{1n} & - & - & - & - & -S_n \end{vmatrix}$

If the F_{ij} are known, the equation may be solved to give the time evolution of the tracer gas concentration in each cell, i.e.

$$\overline{x}(t) = (x_1(t)\ , x_2(t) \ldots\ldots x_n(t))$$

A simple solution is of the form

$$\overline{x}(t) = \overline{x}(0)\ e^{\lambda t}$$

which, on substitution into the original equation, gives

$$\lambda \overline{V}\,\overline{x} = \overline{F}\,\overline{x}$$

The eigen values, λ_o, λ_1, ... λ_n for which this has a non-zero solution, and the corresponding eigen vectors $\bar{x}^o$, $\bar{x}^1$, ... $\bar{x}^n$

may be found. Further solutions, corresponding to arbitrary initial conditions may be found by linear combination

$$\bar{x}(t) = \sum_{k=0}^{n-1} a_k \bar{x}^k e^{\lambda_k t}$$

where a_k are constants determined from the initial conditions, i.e. the concentrations x_i at time t = 0.

As an example, the multi-cell theory has been applied to a rectangular building of internal volume 12,000m^3, split into 6 equal cells each of volume 2,000 m^3. An overall fresh air ventilation rate of 2 a.c.h. was assumed (corresponding to 7 $m^3 s^{-1}$). Figure 11 shows the building, and also gives the assumed values of the flow rates between cells, i.e. the values of F_{ij}. The equations were solved to give the time evolution of the tracer concentration in each cell for several different sets of initial conditions. The results are shown in table 2 and in figures 12 to 17. In each case it can be seen that after about 20 minutes, the decay curves for all cells are similar. Thus, if these curves were analysed by means of single cell theory, they would yield similar, but slightly different ventilation rates. However, it is clear from figure 11 that this would not be a true interpretation of the air movement regime in the building; in particular, cells 1, 2 and 3 are receiving no fresh air at all, the flow into them coming entirely from other parts of the building.

The reverse problem, the evaluation of the F_{ij} from the measured decay curves, is more difficult. It requires the shapes of the decay curves to be accurately known during the early part of the decay, which was not possible with the apparatus in its current form. In any case, this was outside the scope of the objectives for this project.

Results and Conclusions

The complete set of results is presented in the Results Section. There are three sections, one for each building, with a drawing of the building at the head of each section. Within each section, the individual runs are listed in sequence, the information in each run being presented in the following format:-

1) Summary of conditions prevailing at the time of the run, plus a diagram showing the position of the sample points and where relevant, the position of gas release.

2) A table of results. The tracer gas concentration is given in arbitrary units, because the fine sensitivity of the recording was usually adjusted at the start of each run to give approximately full scale deflection on the recorder.

3) A statistical analysis table.

4) Graphs of the natural logarithm of tracer gas concentration versus time for each channel.

5) A graph of the tracer gas concentration versus time for all channels.

The main conclusion which can be drawn from these results is that, experimentally, there is no particular difficulty in using a tracer gas decay method to measure ventilation rates in a large single cell building. Relatively simple methods of stirring can achieve an initial uniform distribution of tracer gas, if indeed this is considered necessary. Satisfactory decay curves have been obtained even when there has been no attempt to achieve an initial uniform distribution. The variability of ventilation rate throughout the space appears, in most of the results, to be small but significant. This variability, even though it is small, leads immediately to a conceptual difficulty in defining ventilation rate, because it is clear that, if different parts of the same cell are behaving differently, the tracer gas decay constant is not necessarily a measure of the fresh air ventilation rate. The simple calculation using the multi-cell model illustrates this quite clearly.

A secondary conclusion, therefore, is that care is needed in the interpretation of the results of tracer decay measurements. The overall decay rate for all channels may be a guide to the total amount of fresh air entering the building, but that fresh air may be distributed in a highly non-uniform fashion, even if the decay rates of individual channels are similar.

Regarding experimental technique, the experience of this project is that the small, portable gas chromatograph fitted with an electron capture detector, and using sulphur hexafluoride as a tracer, is sufficiently sensitive, robust and reliable for field measurements, and is to be preferred to the infra-red gas analyser.

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TABLE 1 SUMMARY OF RESULTS

V = Ventilation Rate, a.c.h. N = No. of points R = Correlation coefficient

Run Number	Tracer		Channel Number 1	2	3	4	5	6	Average
		V	0.100	0.091	0.069	-0.108	-0.043	0.008	0.015
BO1RO1	N_2O	N	5	5	5	5	5	5	30
		R	0.480	0.987	0.839	0.990	0.557	0.406	0.065
		V	0.087	0.038	0.047	0.103	0.065	0.043	0.055
BO1RO2	N_2O	N	5	5	5	4	5	5	29
		R	0.972	0.811	0.948	0.890	0.920	0.967	0.436
		V	1.25	1.57	1.42	1.54	1.37	*	1.42
BO2RO1	N_2O	N	12	12	13	13	12		62
		R	0.942	0.995	0.977	0.963	0.944		0.933
		V	0.884	0.879	0.836	0.846	0.814	*	0.850
BO2RO2	N_2O	N	18	19	19	19	19		94
		R	0.969	0.997	0.926	0.986	0.988		0.964
		V	0.888	0.853	1.018	0.783	0.779	*	0.864
BO2RO3	N_2O	N	20	21	20	20	20		101
		R	0.988	0.988	0.981	0.991	0.988		0.961
		V	0.522	**					0.522
BO2RO4	SF_6	N	29						29
		R	0.928						0.928
		V	0.739	**					0.739
BO2RO5		N	18						18
		R	0.985						0.985
		V	1.076	0.806	0.839	0.965	1.038	*	0.947
BO2RO6	N_2O	N	22	21	21	21	21		106
		R	0.983	0.987	0.932	0.984	0.976		0.957

Channel 6 was used to monitor external air as a zero check

Only one channel was available for these runs

TABLE 1 SUMMARY OF RESULTS (Continued)

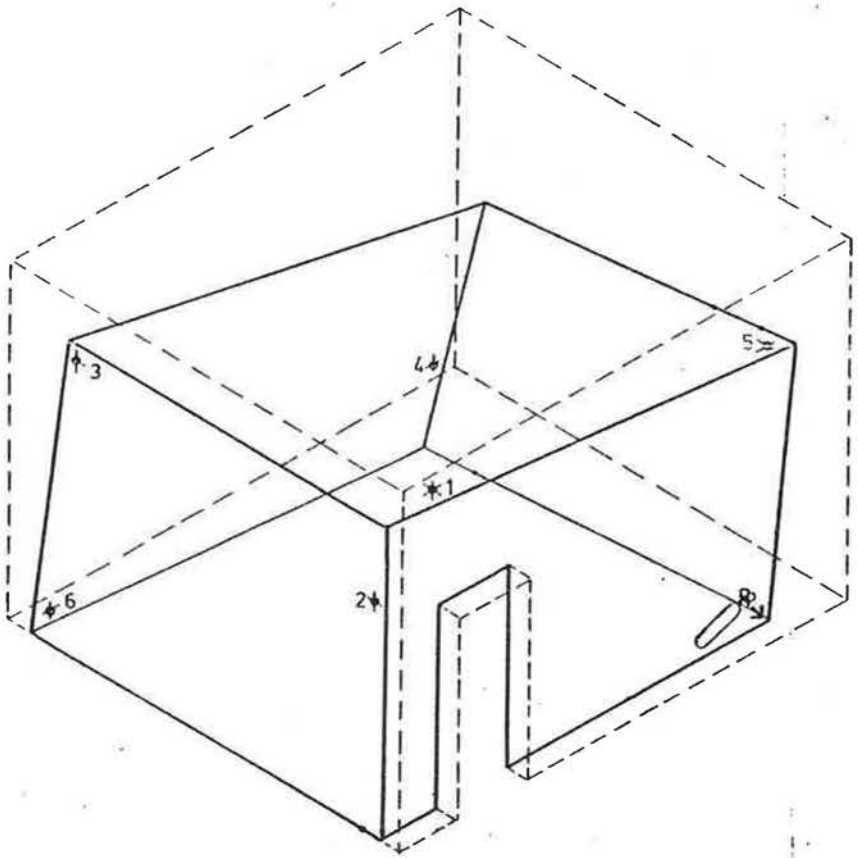
V = Ventilation Rate, a.c.h. N = No. of points R = Correlation coefficient

Run Number	Tracer		Channel Number 1	2	3	4	5	6	Average
		V	0.589	0.542	0.679	0.624	0.596	0.634	0.613
BO3RO1	SF_6	N	19	19	19	19	19	19	114
		R	0.978	0.954	0.951	0.941	0.957	0.957	0.949
		V	4.145	4.581	4.572	4.514	4.456	4.299	4.423
BO3RO2	SF_6	N	7	7	7	7	7	7	42
		R	0.996	0.996	0.988	0.995	0.998	0.998	0.990
		V	4.203	4.210	4.441	4.436	4.580	4.397	4.387
BO3RO3	SF_6	N	7	7	7	7	7	7	42
		R	0.999	0.999	0.999	0.996	1.000	0.999	0.990
		V	2.837	2.695	2.917	2.752	2.887	2.909	2.817
BO3RO4	SF_6	N	8	8	8	8	8	8	48
		R	0.996	0.977	0.989	0.993	0.995	0.997	0.978
		V	1.446	1.665	1.596	1.733	1.597	1.624	1.613
BO3RO5	SF_6	N	11	11	11	11	11	11	66
		R	0.968	0.993	0.993	0.995	0.996	0.990	0.986
		V	1.384	1.386	1.240	1.104	1.200	1.254	1.266
BO3RO6	SF_6	N	11	11	11	11	11	11	66
		R	0.991	0.992	0.990	0.992	0.992	0.991	0.984
		V	1.898	1.936	1.927	2.092	2.158	2.544	2.127
BO3RO7	SF_6	N	12	11	11	11	11	11	67
		R	0.956	0.978	0.960	0.980	0.973	0.993	0.946
		V	1.548	1.462	1.877	2.002	1.934	1.783	1.793
BO3RO8	SF_6	N	11	11	11	11	11	11	66
		R	0.925	0.959	0.945	0.973	0.987	0.987	0.946

TABLE 2

Eigen values and eigen vectors for the multi-cell example illustrated in figure 11.

Eigen values	-0.0179	-0.0006	-0.0044	-0.0116	-0.0115	-0.0069
Eigen vectors	-0.2746	0.4277	0.6074	-0.1211	-0.0700	0.5254
	0.6067	0.4449	0.0654	0.4994	0.4718	0.4335
	-0.4387	0.4544	-0.4221	-0.5267	-0.5611	0.3528
	0.1865	0.3444	0.4130	-0.3130	-0.3427	-0.3020
	-0.4518	0.3741	-0.1487	-0.5803	0.5730	-0.4467
	0.3538	0.3926	-0.5059	-0.1544	-0.1092	-0.3476



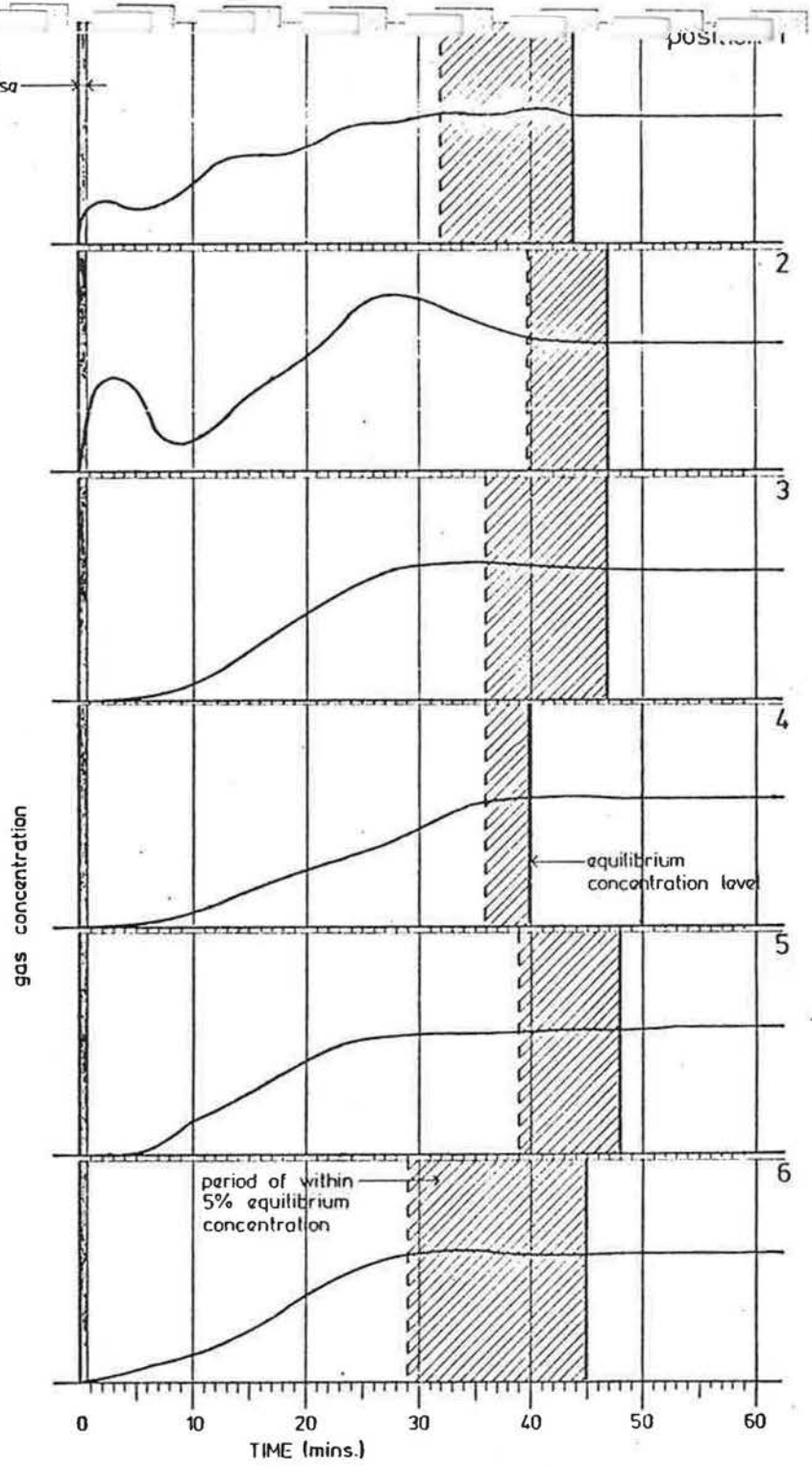
MIXING CONDITIONS : gas released into corner of room, with no artificially induced air movement.

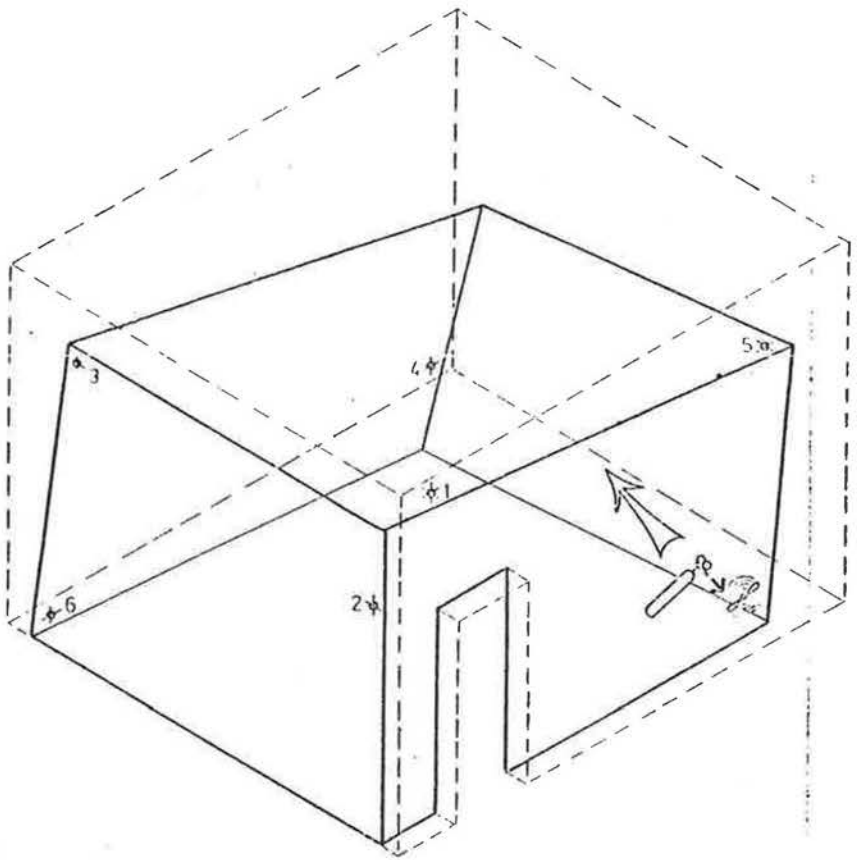
AIR MOVEMENT:

floor level - average air speed 0·02 m/s
range of air speeds 0·01 to 0·03 m/s

100m high - average air speed 0·02 m/s
range of air speeds 0·01 to 0·025 m/s

Figure 1. **Time taken to achieve a uniform concentration of tracer gas : No artificially induced air movement.**

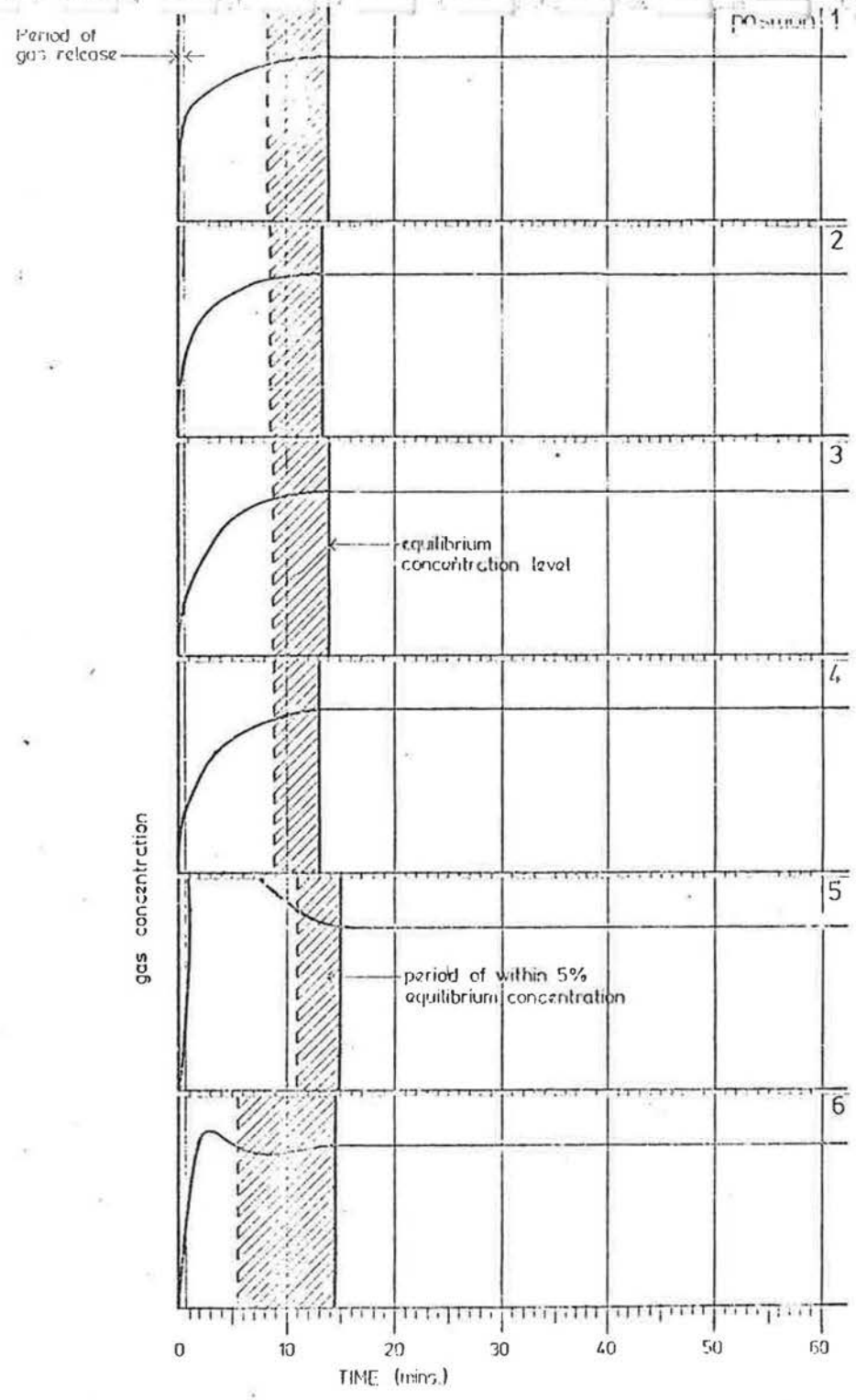


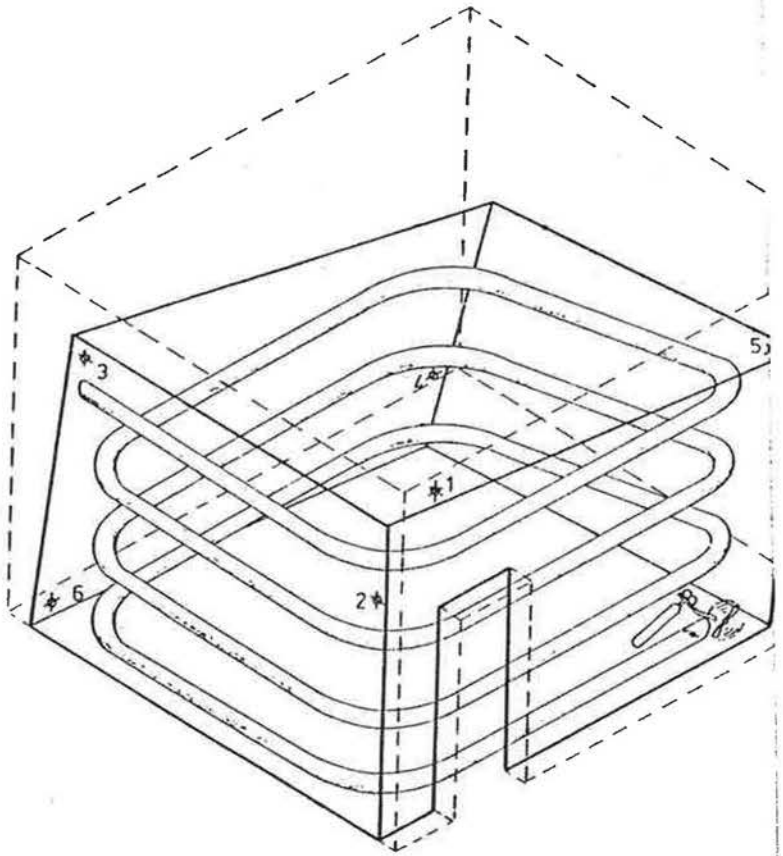


MIXING CONDITIONS: gas released into path of air current generated by a fan unit directed as shown

AIR MOVEMENT: floor level - average air speed 0·15 m/s
range of air speeds 0·10 to 0·30 m/s
120m from fan unit average air speed 1·0 m/s

Figure 2. Time taken to achieve a uniform concentration of tracer gas : Artificially induced air movement.





MIXING CONDITIONS: gas released into path of air current generated by a fan unit inflating a 150mm diameter polythene tube with 2number 3mm diameter diametrical holes at 500mm centres along the 80m length.

AIR MOVEMENT: 100mm from outlets in tubing average air speed 30m/s

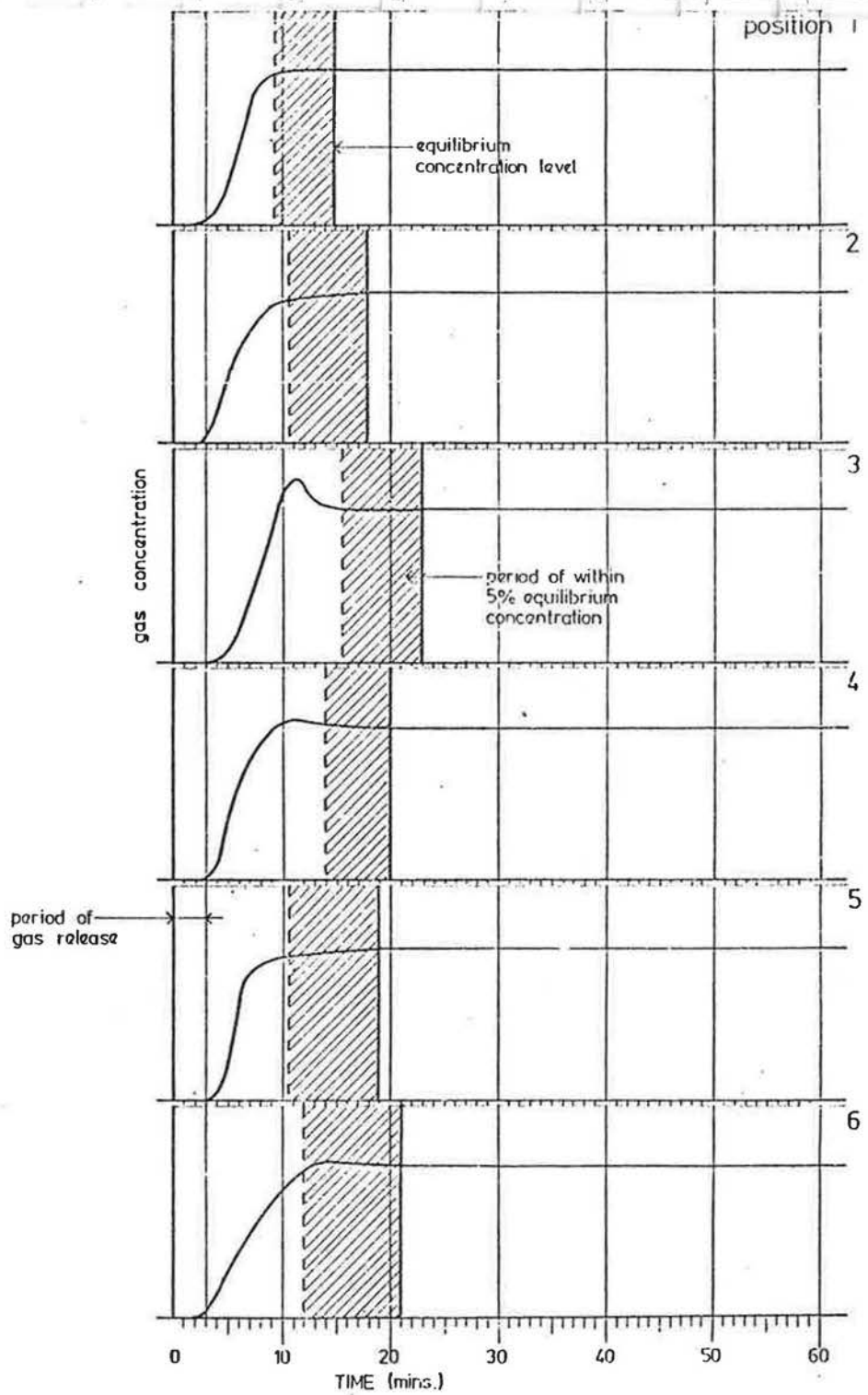


Figure 3. **Time taken to achieve a uniform concentration of tracer Tracer gas bled into fan inflated polyethylence tube.**

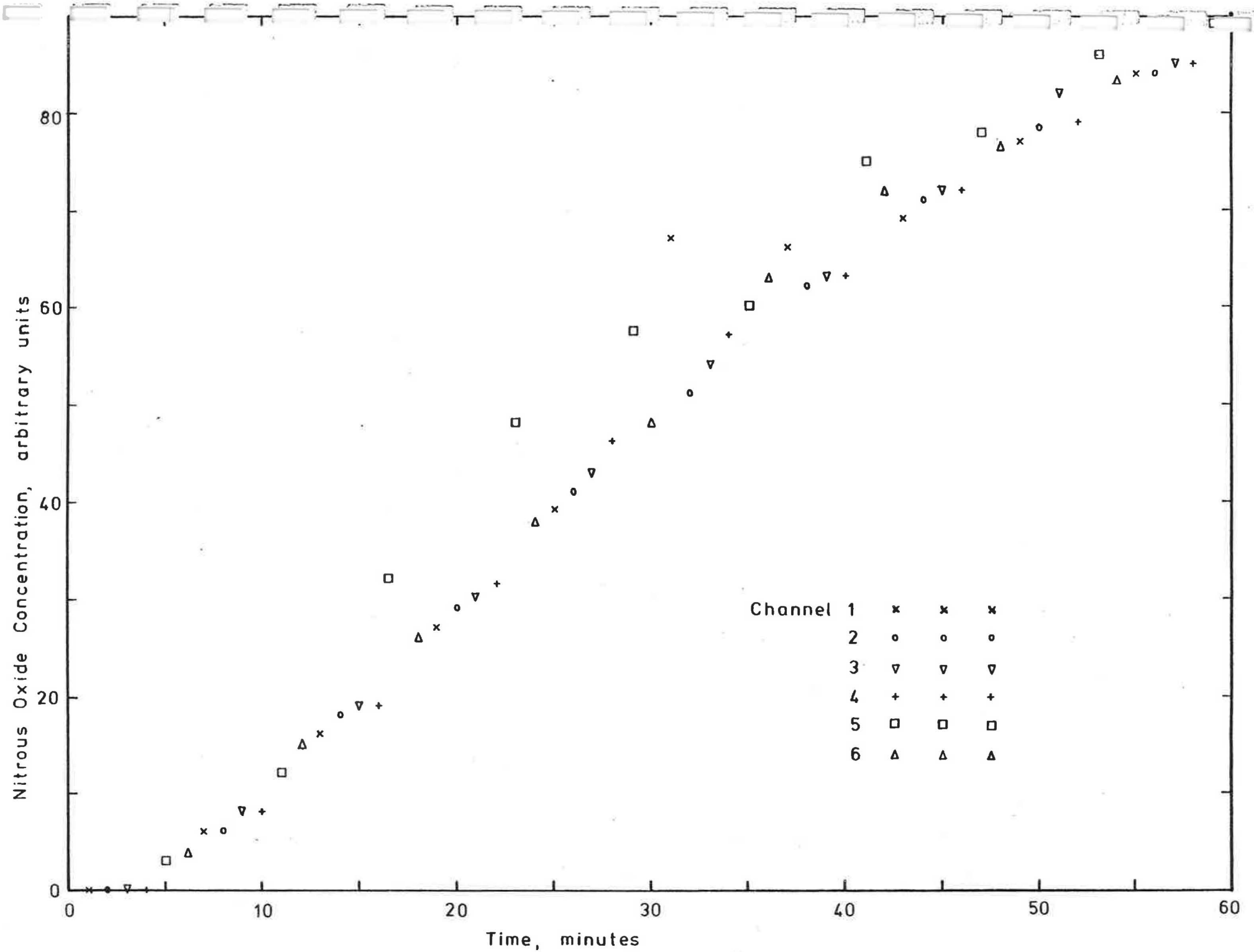
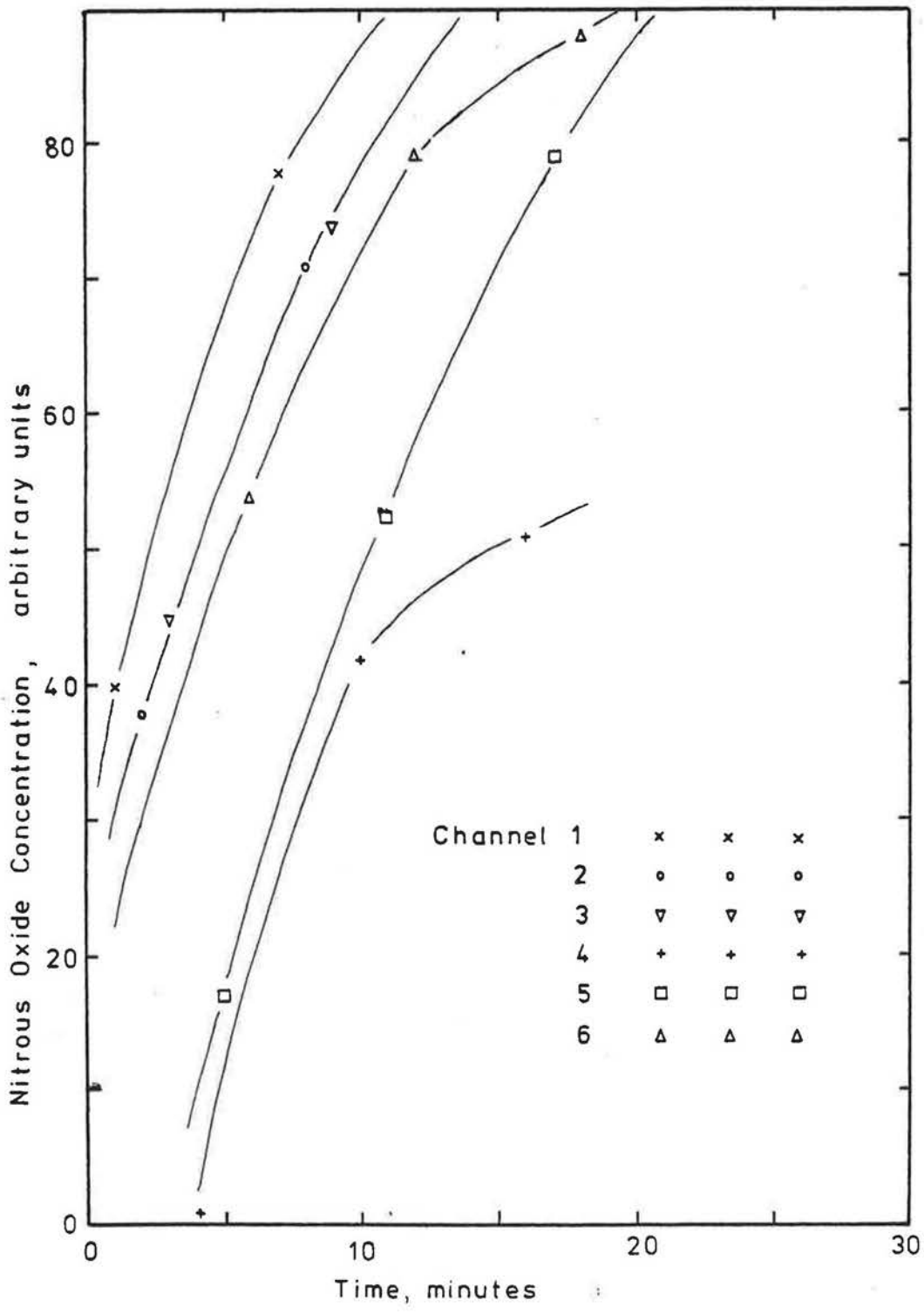
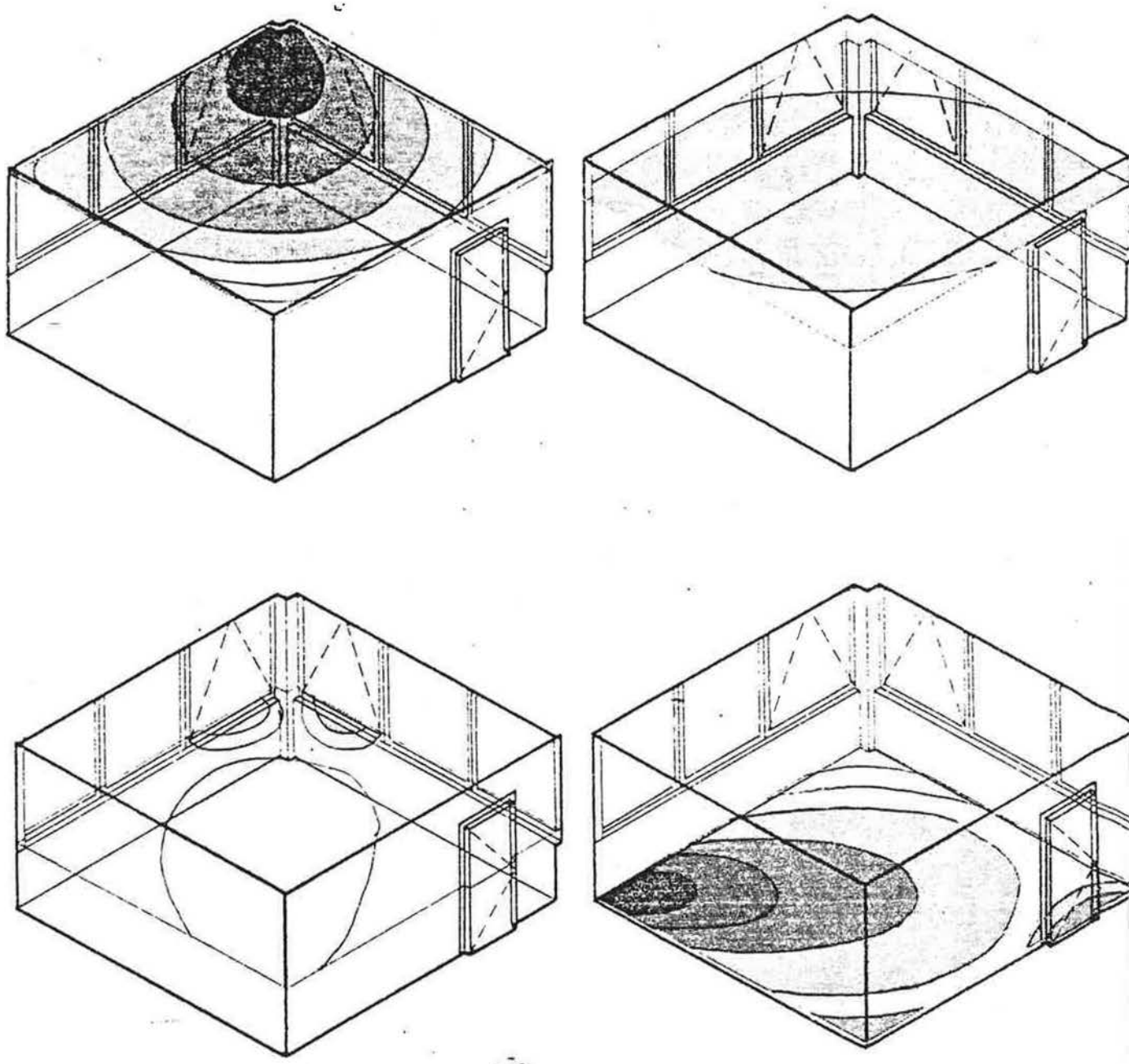

Nitrous Oxide Concentration, arbitrary units
0
20
40
60
80
0
10
20
30
40
50
60
Time, minutes
Channel 1
2
3
4
5
6

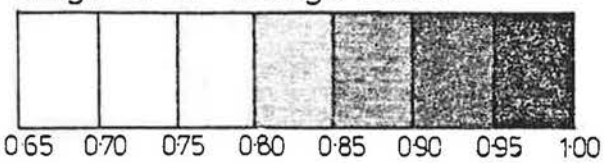
Figure 4

Figure 5


Nitrous Oxide Concentration, arbitrary units
0
20
40
60
80
0
10
20
30
Time, minutes
Channel 1
2
3
4
5
6



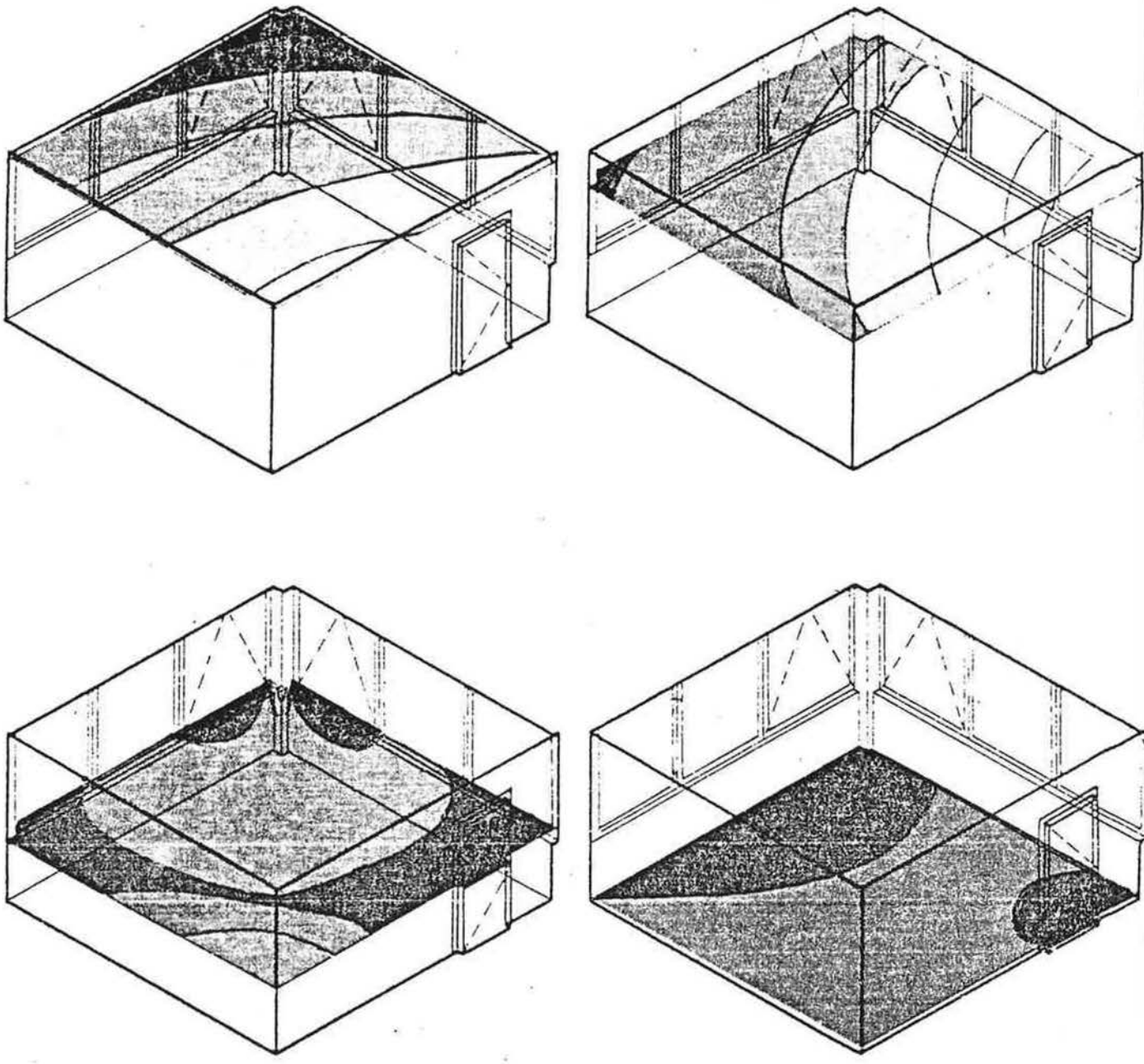
range of air change rates

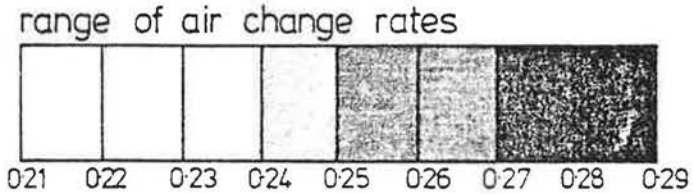


Meteorological conditions :

temperature - mild
wind - gusty
sky - overcast

Figure 6 **Infiltration Pattern : Radiant heat source - gusty conditions.**

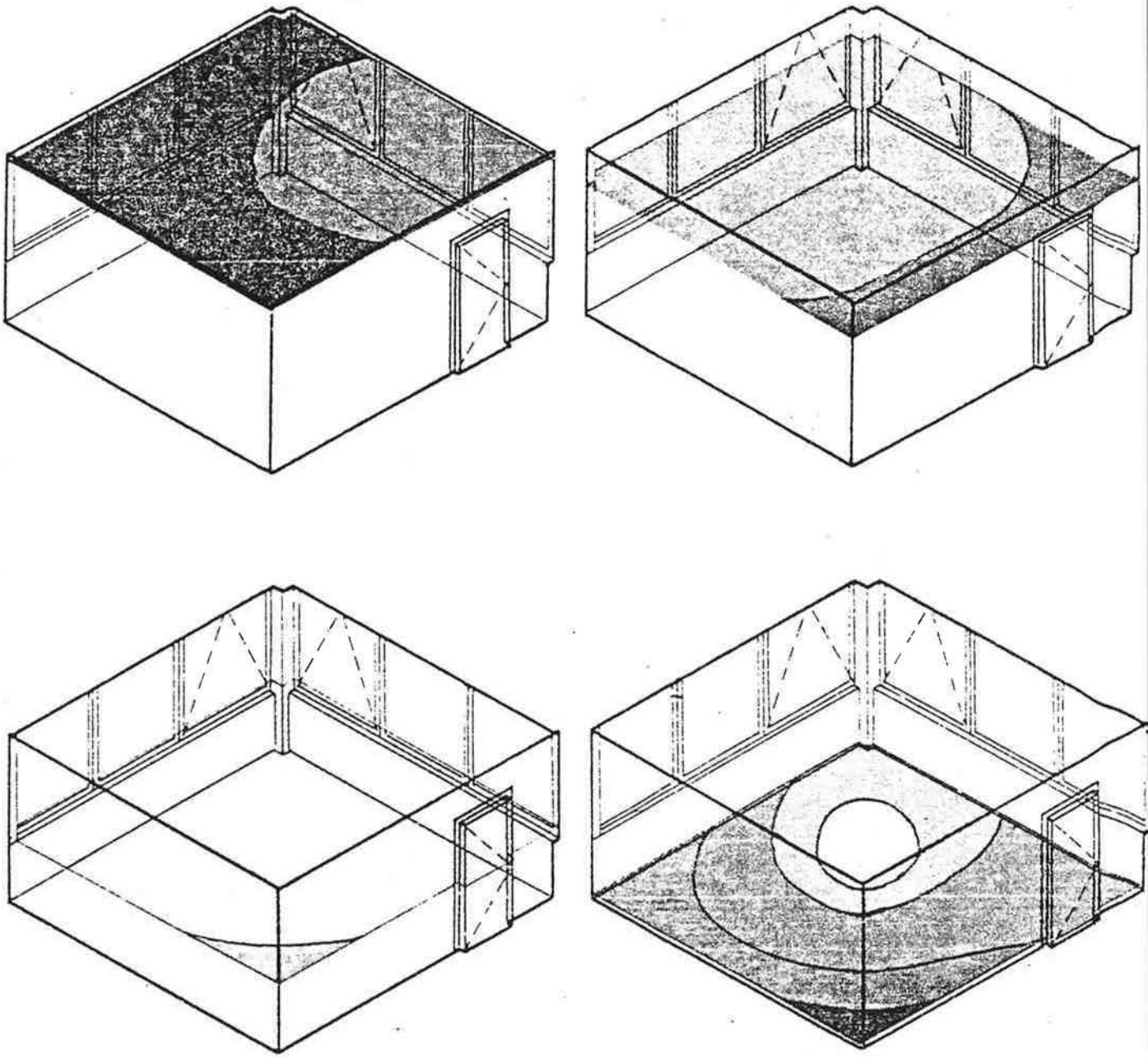


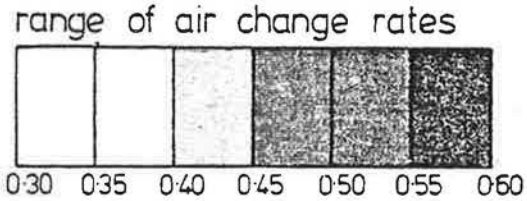


Meteorological conditions :

temperature - mild
wind - still
sky - clear, sunny

Figure 7. Infiltration Pattern : Radiant heat source - still air.





Meteorological conditions :

temperature - cool
wind - still
sky - clear, sunny

Figure 8. Infiltration Pattern : Convective heat source in still air.

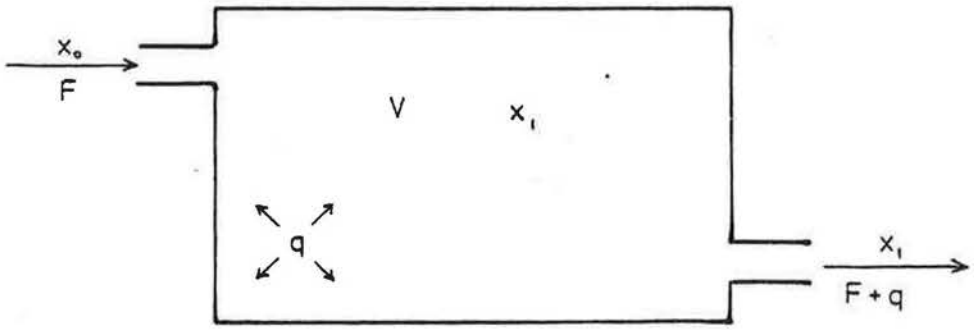


Figure 9 Single cell ventilation model

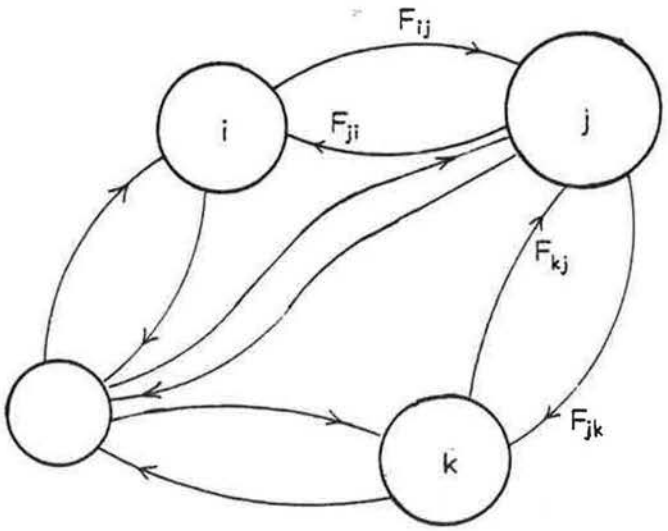
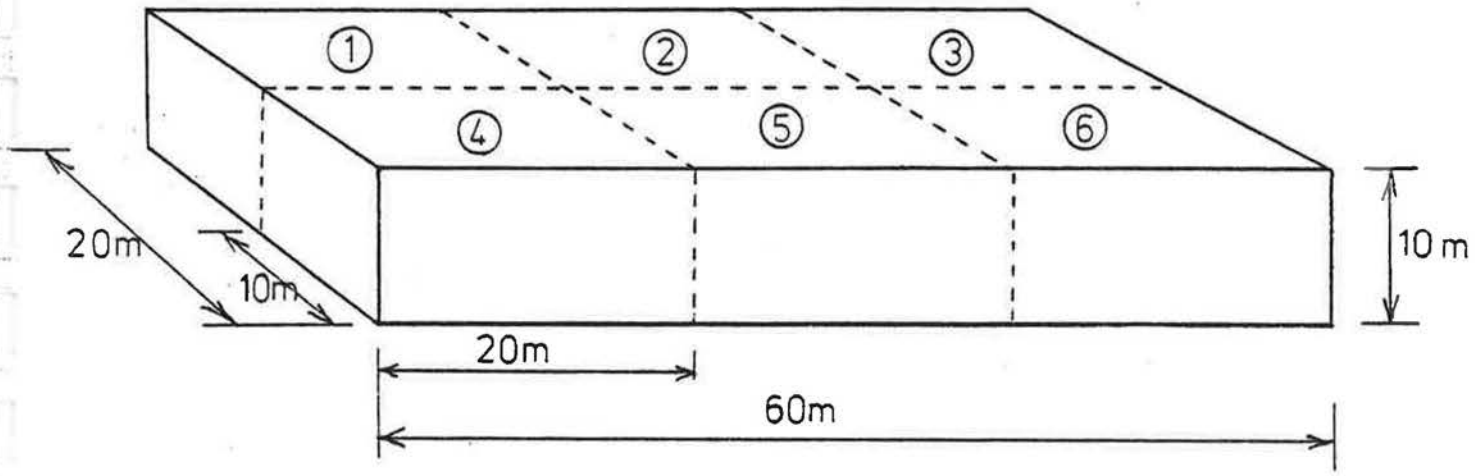


Figure 10 Multi cell ventilation model

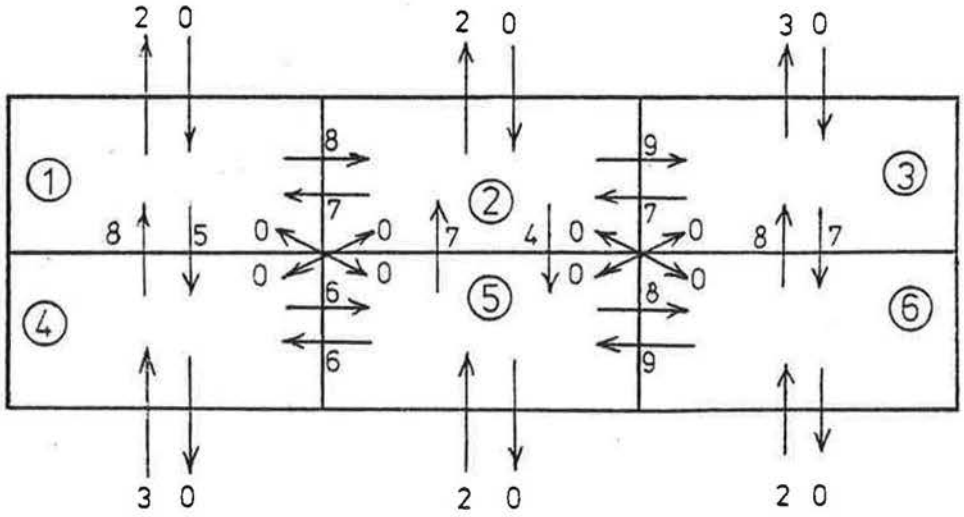
Figure 11

Theoretical Ventilation Rates

A Multi-cell Example



Six Cell Layout of Building



Flow Between Cells

Fig. 12

MULTI-CELL VENTILATION CURVES

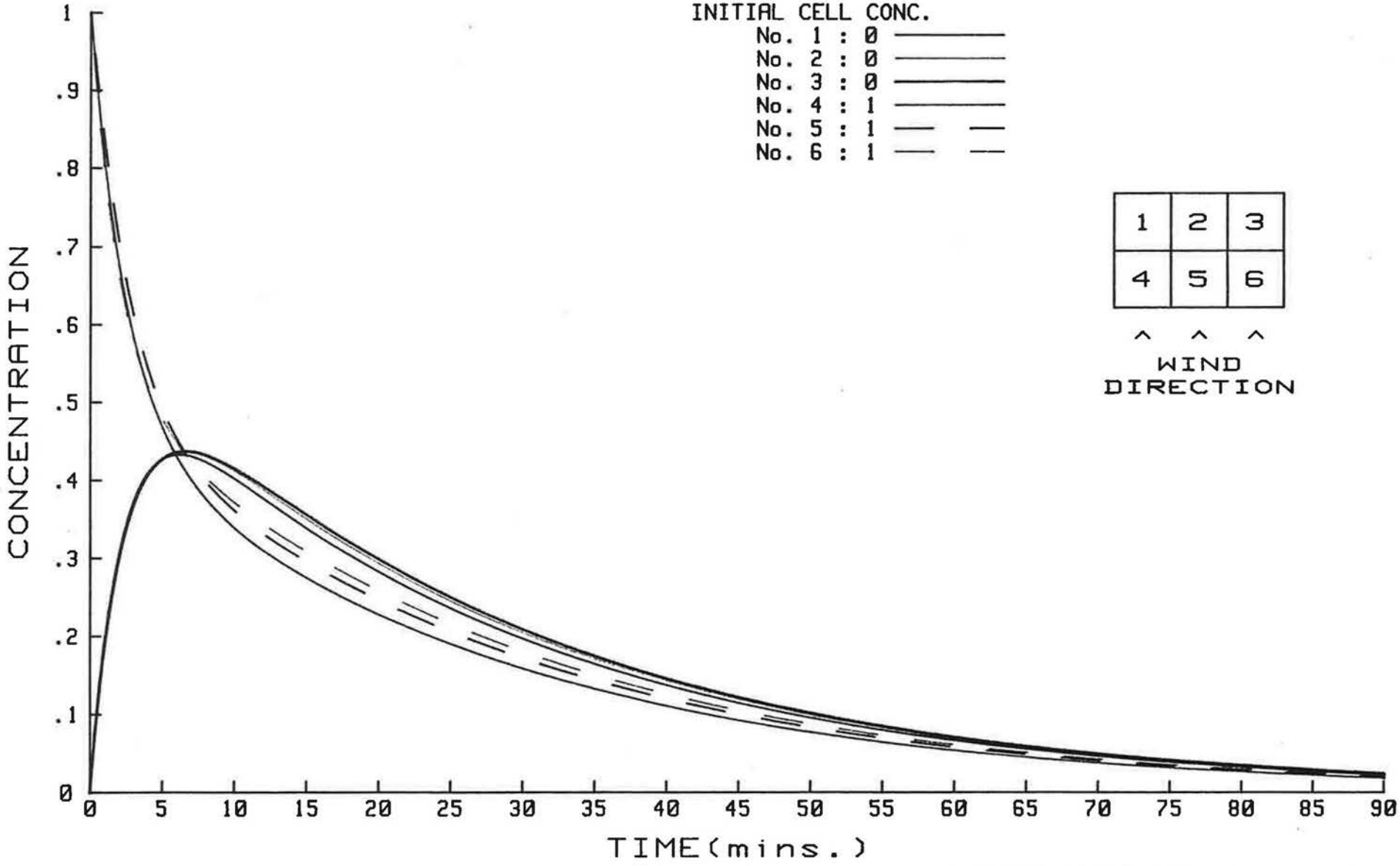


Fig. 13

MULTI-CELL VENTILATION CURVES

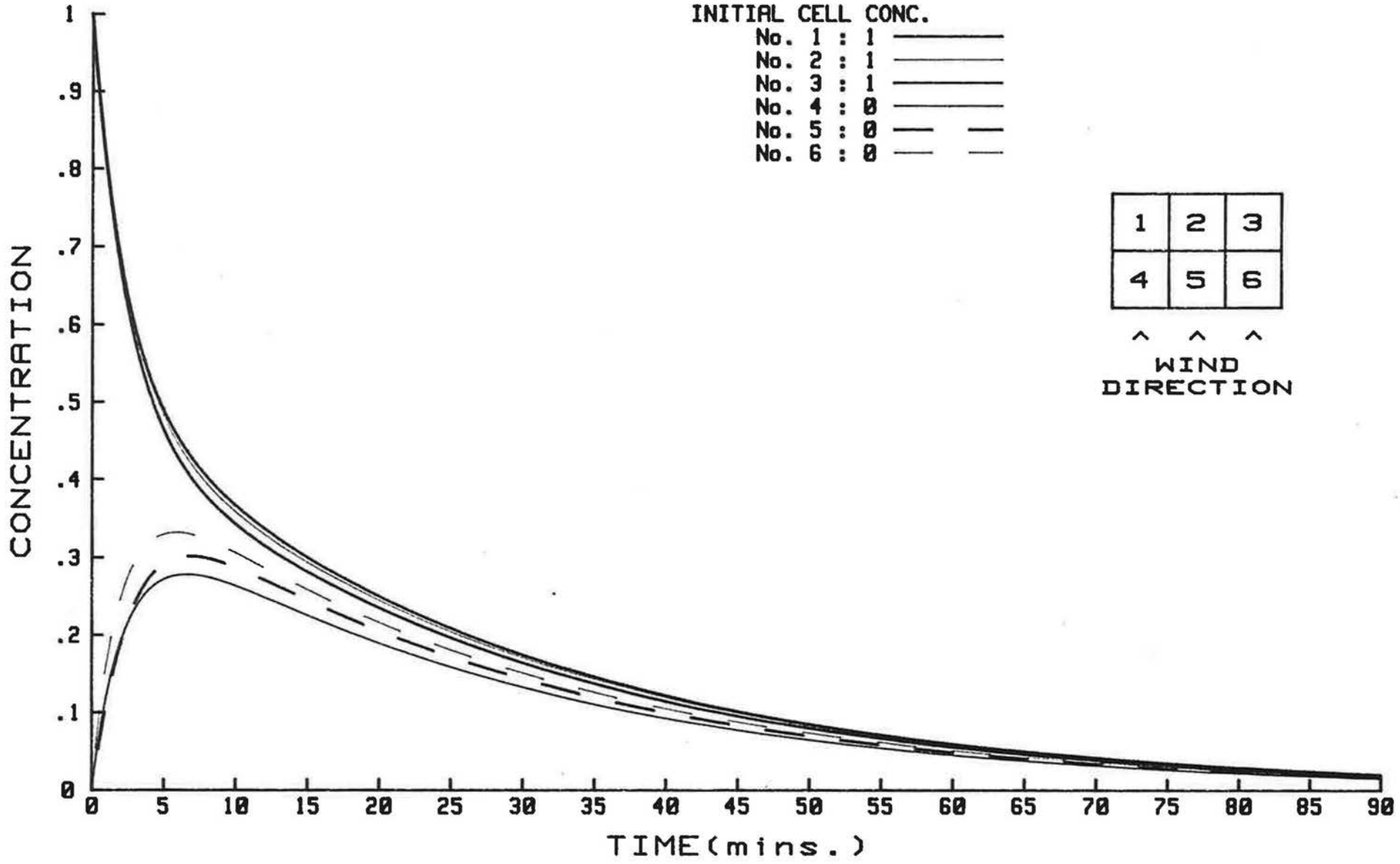


Fig. 14

MULTI-CELL VENTILATION CURVES

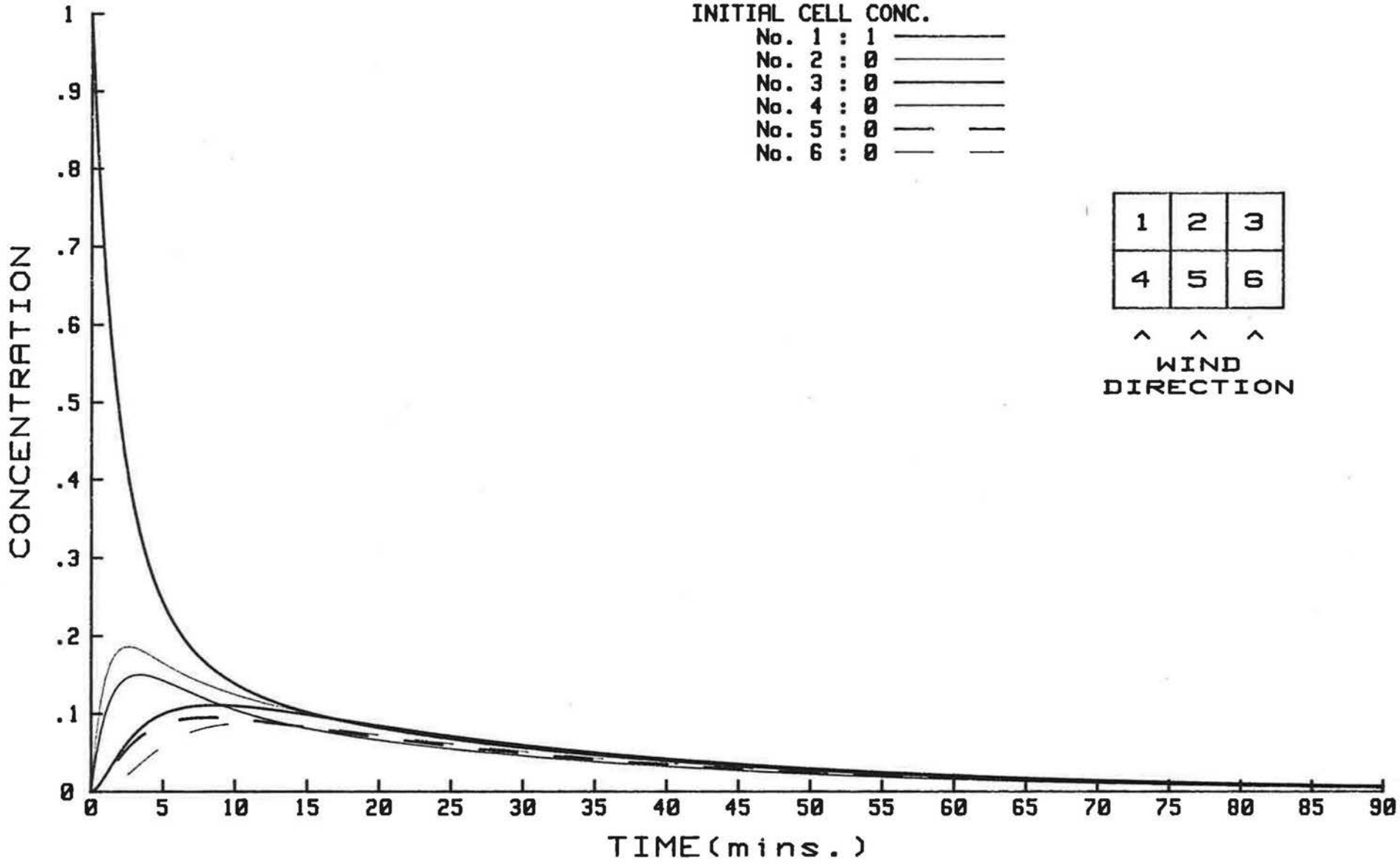


Fig. 15

MULTI-CELL VENTILATION CURVES

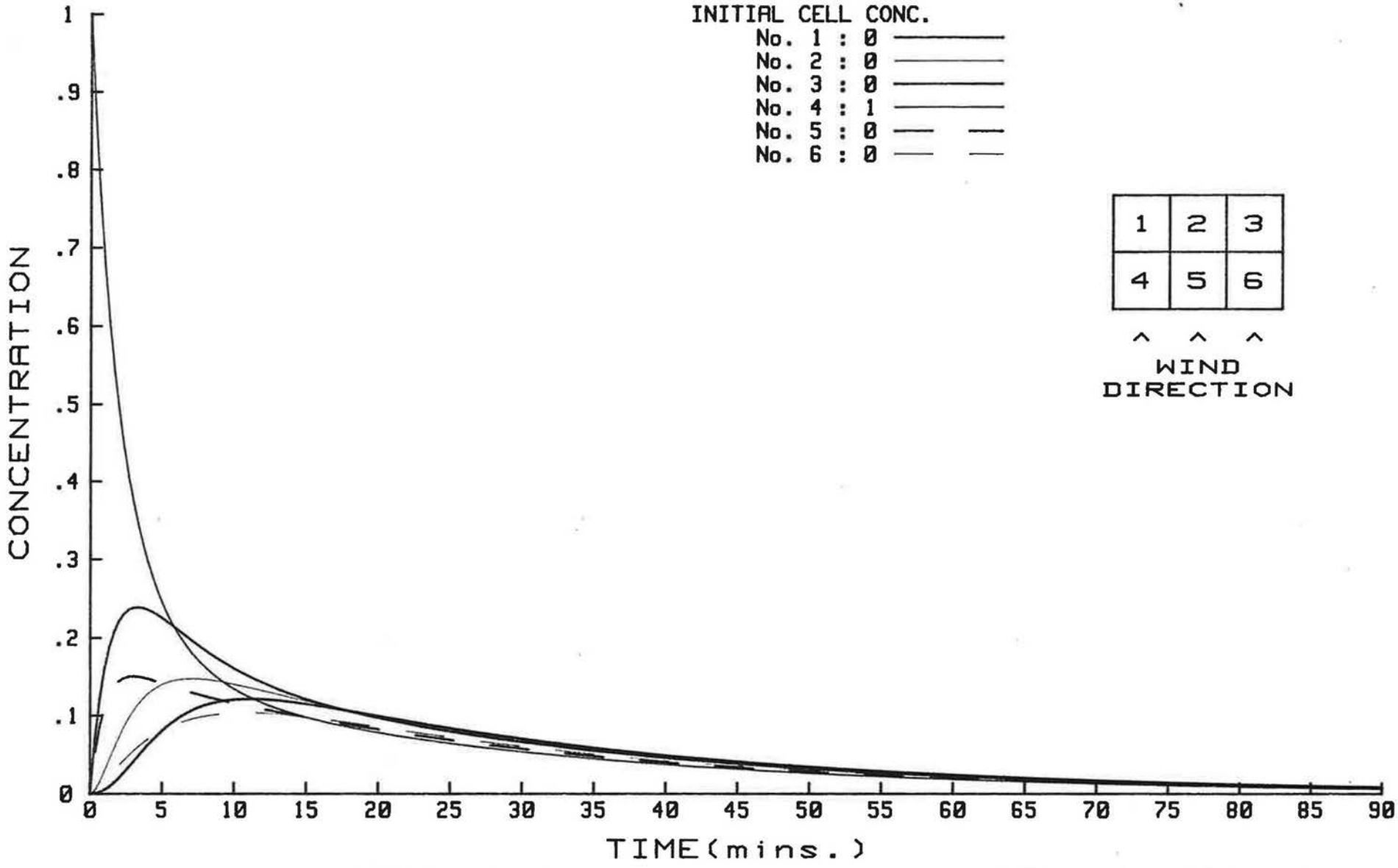
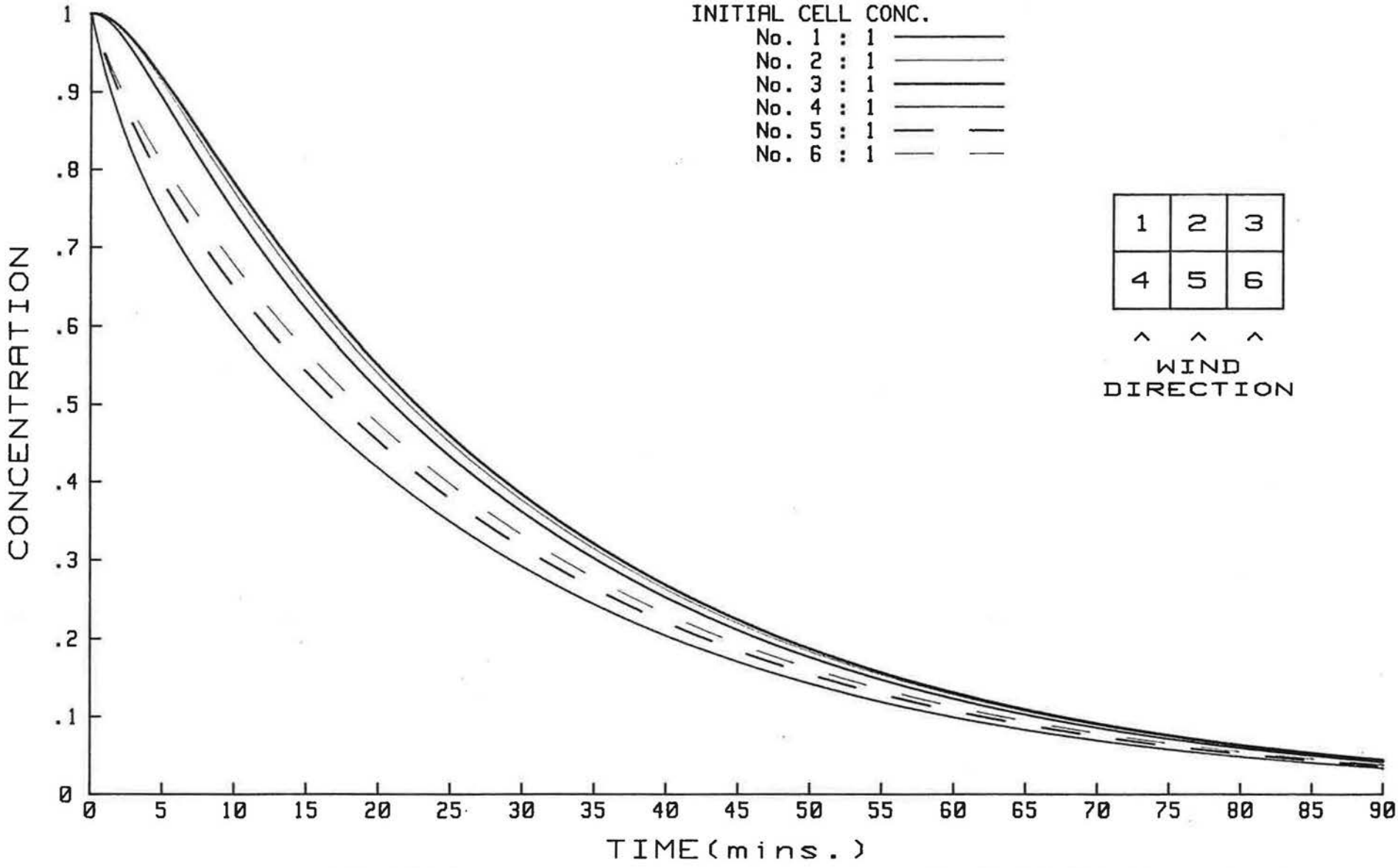


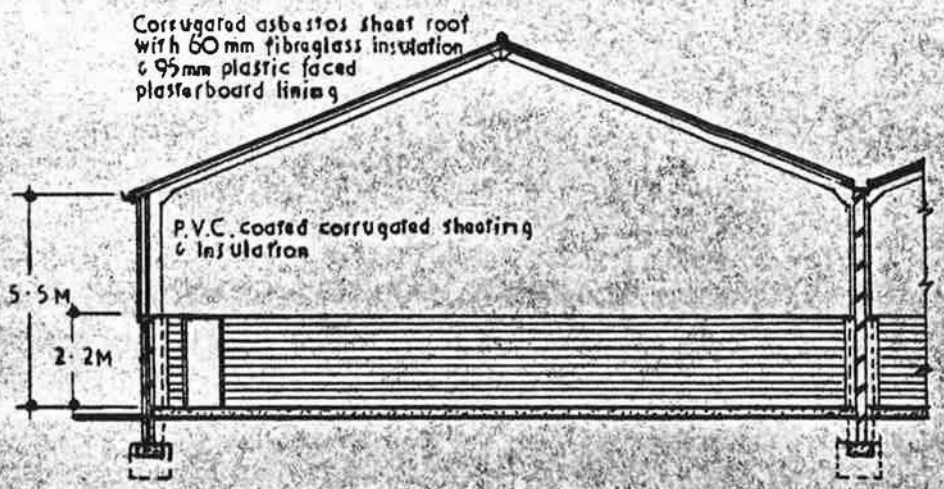
Fig. 16

MULTI-CELL VENTILATION CURVES

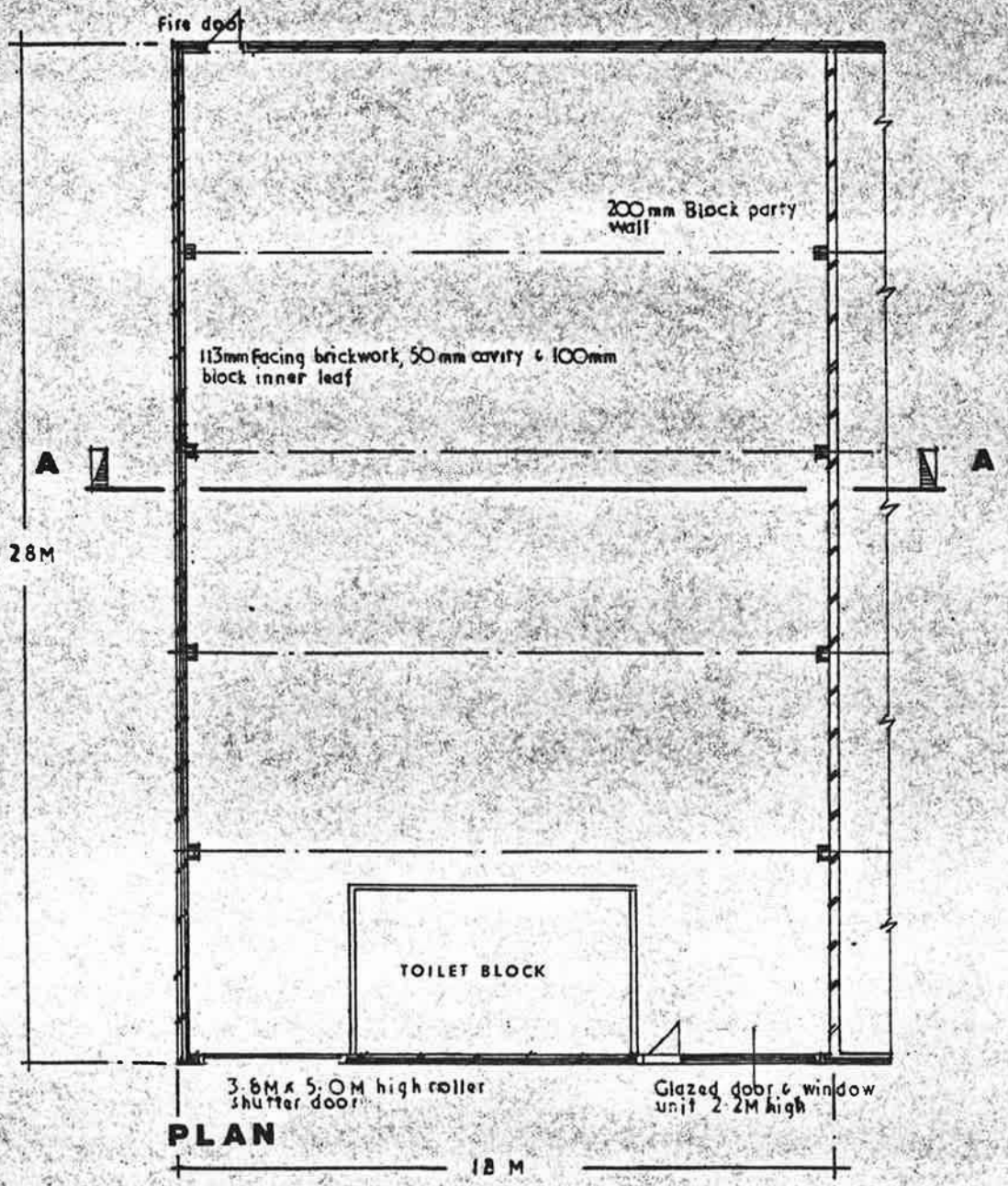


RESULTS SECTION

Building B01
Unit 9, Masefield Road Industrial Estate, Coventry



SECTION THRO' 'A'–'A'



PLAN

B01 R01

Date: 16th December, 1981

Time: 1100 hours to 1200 hours

Tracer Gas: Nitrous Oxide

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1100 hrs	zero	-6.4
1200 hrs	zero	-4.8

Internal Conditions:

air velocity: very low, not measured
temperature: -1^{o}C to + 3^{o}C

Gas Release:

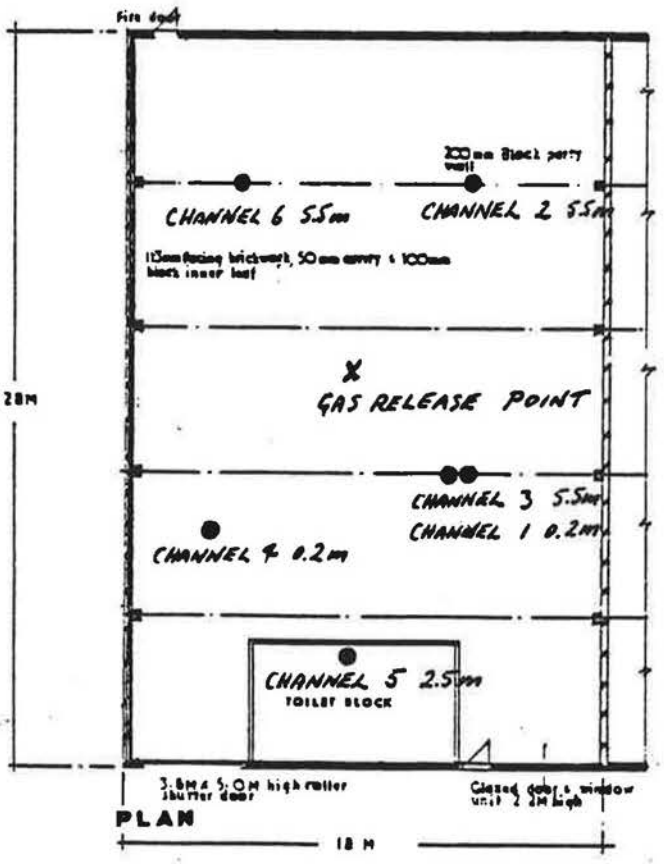
Gas released into path of small fan at point shown on plan.

Sample Positions:

As shown on plan.

Comment: Roller shutter door open 300 mm and one small window open, both on s.w. face of building.

N.B. With roller shutter door and window closed there was no detectable fall in tracer concentration.



****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B01R01
Location: Unit9, Masefield Road Ind. Estate,COVENTRY
Date: 16/12/81
Tracer gas: N2O

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5			Channel 6		
****	**********			**********			**********			**********			**********			**********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	1.0	266	5.583	2.0	269	5.595	3.0	265	5.580	4.0	235	5.460	5.0	253	5.533	6.0	261	5.565
2	7.0	245	5.501	8.0	265	5.580	9.0	261	5.565	10.0	240	5.481	11.0	259	5.557	12.0	263	5.572
3	13.0	246	5.505	14.0	264	5.576	15.0	257	5.549	16.0	242	5.489	17.0	260	5.561	18.0	261	5.565
4	19.0	251	5.525	20.0	261	5.565	21.0	259	5.557	22.0	244	5.497	23.0	256	5.545	24.0	261	5.565
5	25.0	250	5.521	26.0	259	5.557	27.0	257	5.549	28.0	246	5.505	29.0	260	5.561	30.0	261	5.565

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	Df	SS	MS	F
Regression	1	.001	.001	.881
Residual	3	.003	.001	
Total	4	.004		

INTERCEPT= 5.549039794
GRADIENT= -1.66460000089D-03

Ventilation rate is .100 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	Df	SS	MS	F
Regression	1	.001	.001 -	112.583
Residual	3	.000	.000	
Total	4	.001		

INTERCEPT= 5.59857580130
GRADIENT= -.001516267575

Ventilation rate is .091 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	Df	SS	MS	F
Regression	1	.000	.000	7.839
Residual	3	.000	.000	
Total	4	.001		

INTERCEPT= 5.57700004006
GRADIENT= -1.14999713333D-03

Ventilation rate is .069 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	Df	SS	MS	F
Regression	1	.001	.001	52.943
Residual	3	.000	.000	
Total	4	.001		

INTERCEPT= 5.45752669289
GRADIENT= 1.80035575556D-03

Ventilation rate is -.108 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	Df	SS	MS	F
Regression	1	.000	.000	1.403
Residual	3	.000	.000	
Total	4	.001		

INTERCEPT= 5.5301871123
GRADIENT= 7.15861122222D-04

Ventilation rate is .043 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 6

Source	Df	SS	MS	F
Regression	1	.000	.000	.420
Residual	3	.000	.000	
Total	4	.000		

INTERCEPT= 5.56033721973
GRADIENT= -1.27227000554D-04

Ventilation rate is .008 air changes per hour

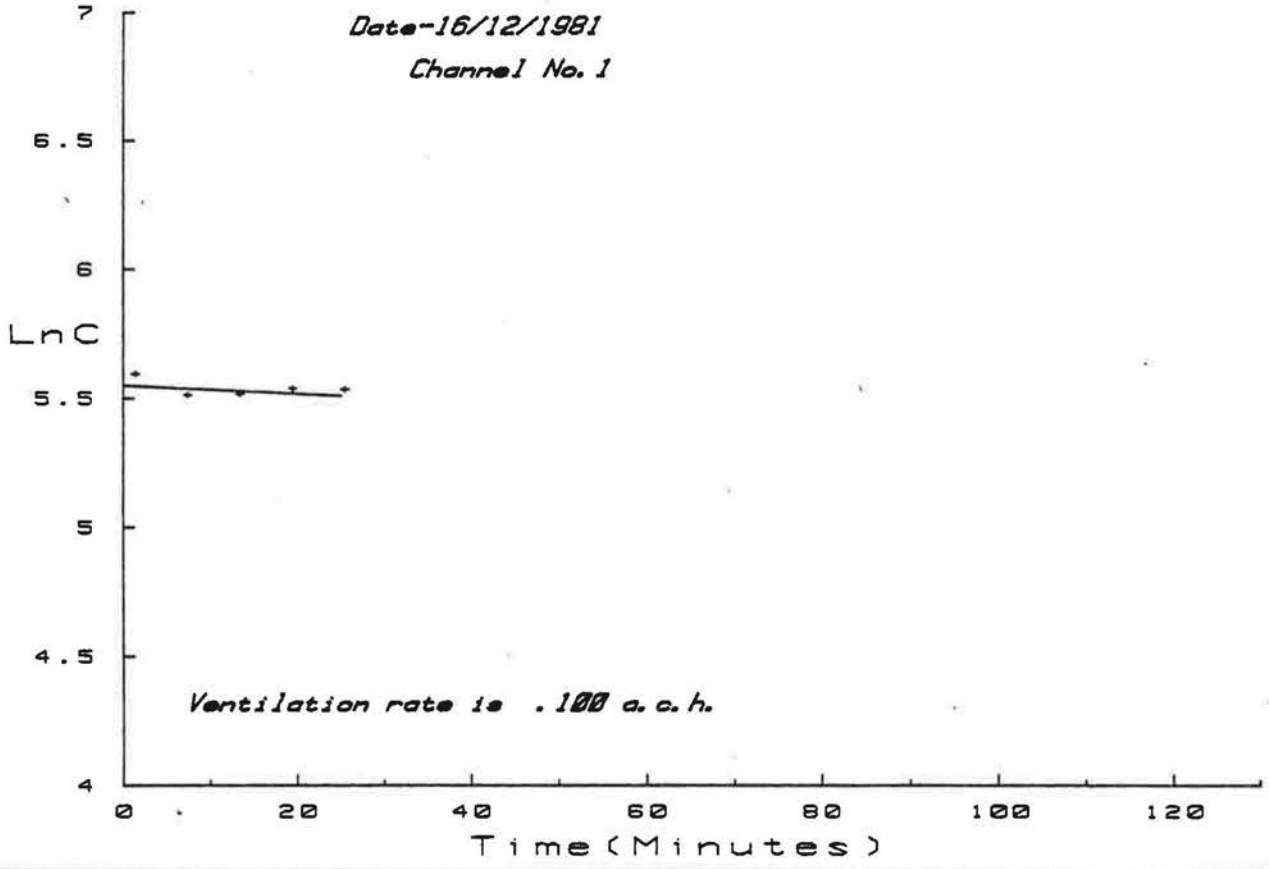
STATISTICAL ANALYSIS - ALL CHANNELS

Source	Df	SS	MS	F
Regression	1	.000	.000	.120
Residual	28	.034	.001	
Total	29	.034		

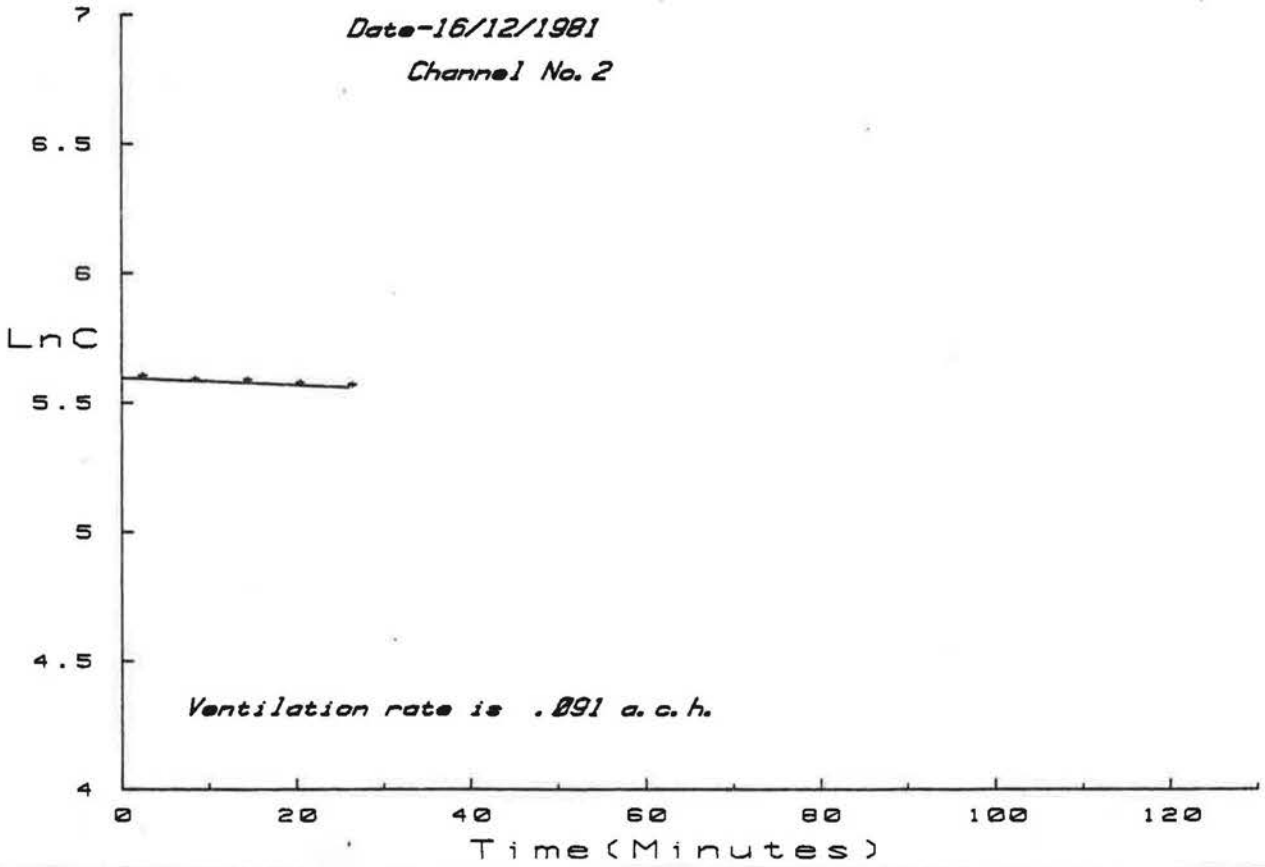
INTERCEPT= 5.54816880673
GRADIENT= -2.54660262514D-04

Ventilation rate is .015 air changes per hour

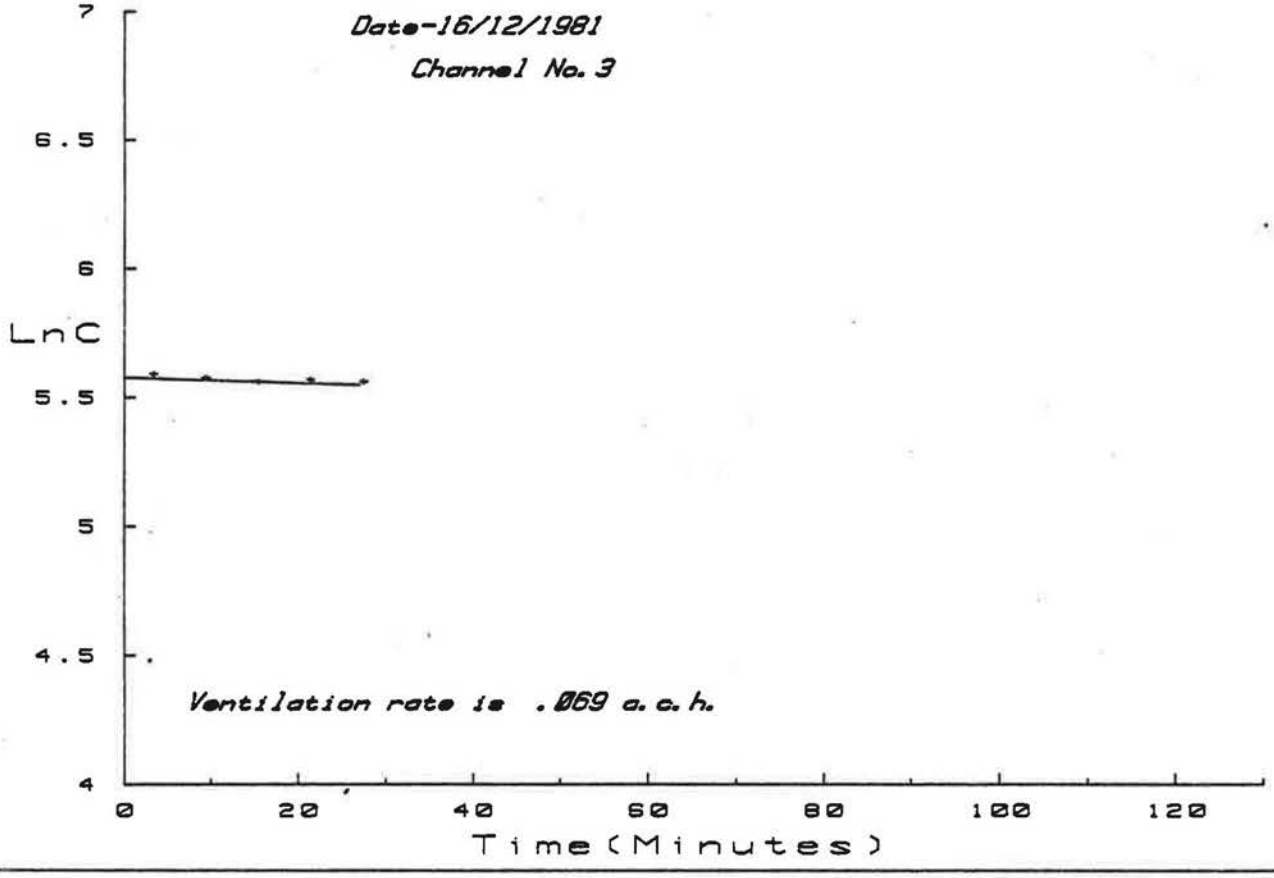
Run-B01R01
Location-UNIT 9, MASEFIELD RD. IND. ESTATE, COVENTRY.
Gas-N2O
Date-16/12/1981
Channel No. 1



Run-B01R01
Location-UNIT 9, MASEFIELD RD. IND. ESTATE, COVENTRY.
Gas-N2O
Date-16/12/1981
Channel No. 2

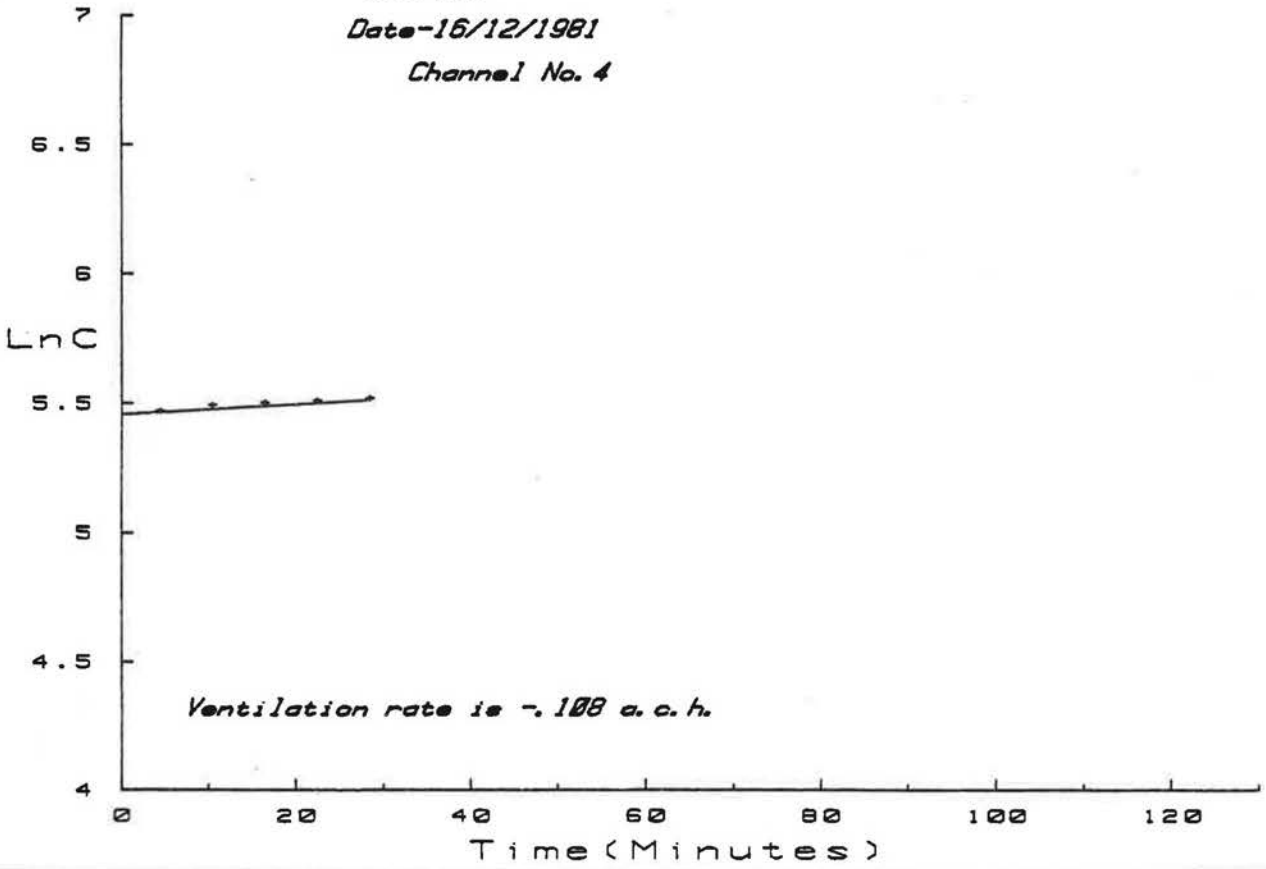


Run-B01R01
Location-UNIT 9, MASEFIELD RD. IND. ESTATE, COVENTRY.
Gas-N2O
Date-16/12/1981
Channel No. 3



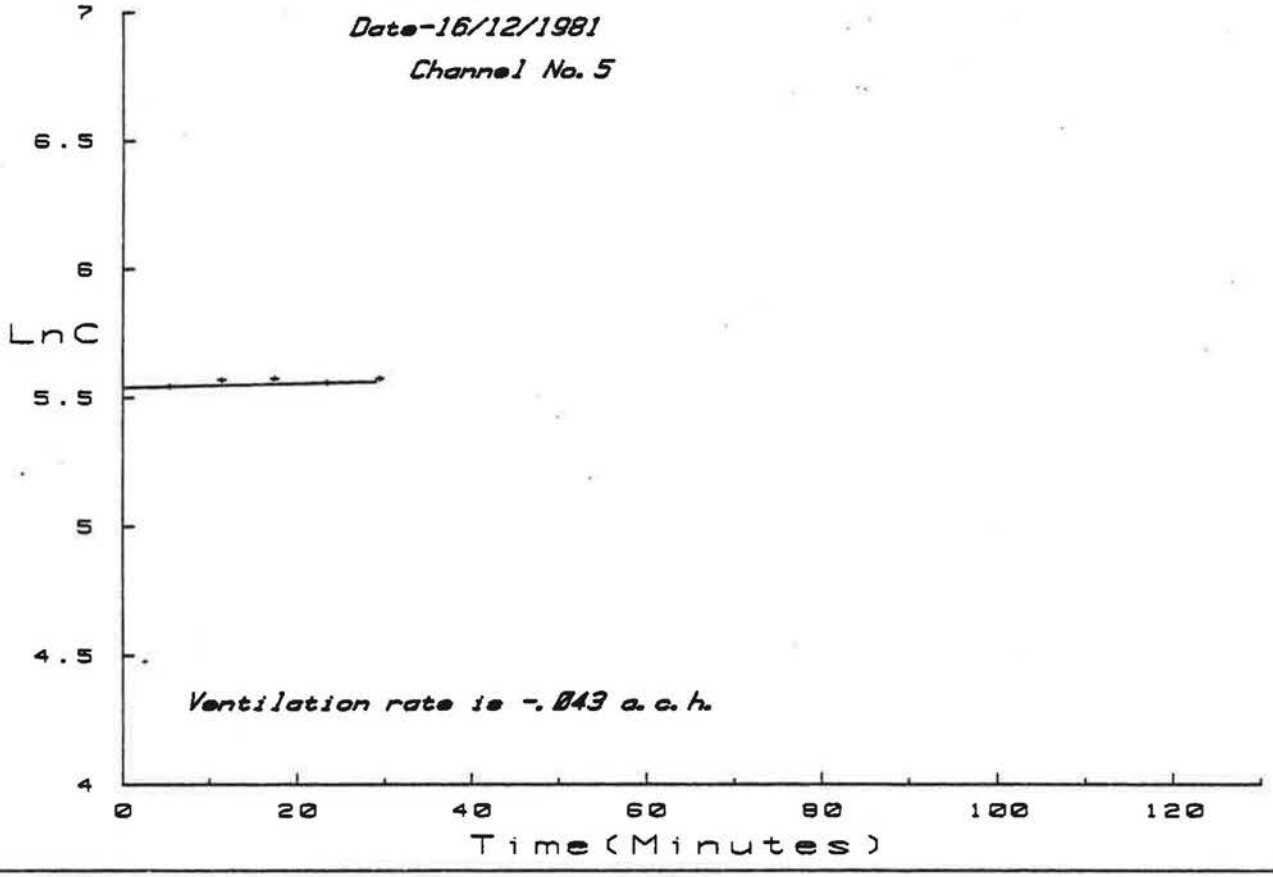
Ventilation rate is .069 a.c.h.

Run-B01R01
Location-UNIT 9, MASEFIELD RD. IND. ESTATE, COVENTRY.
Gas-N2O
Date-16/12/1981
Channel No. 4

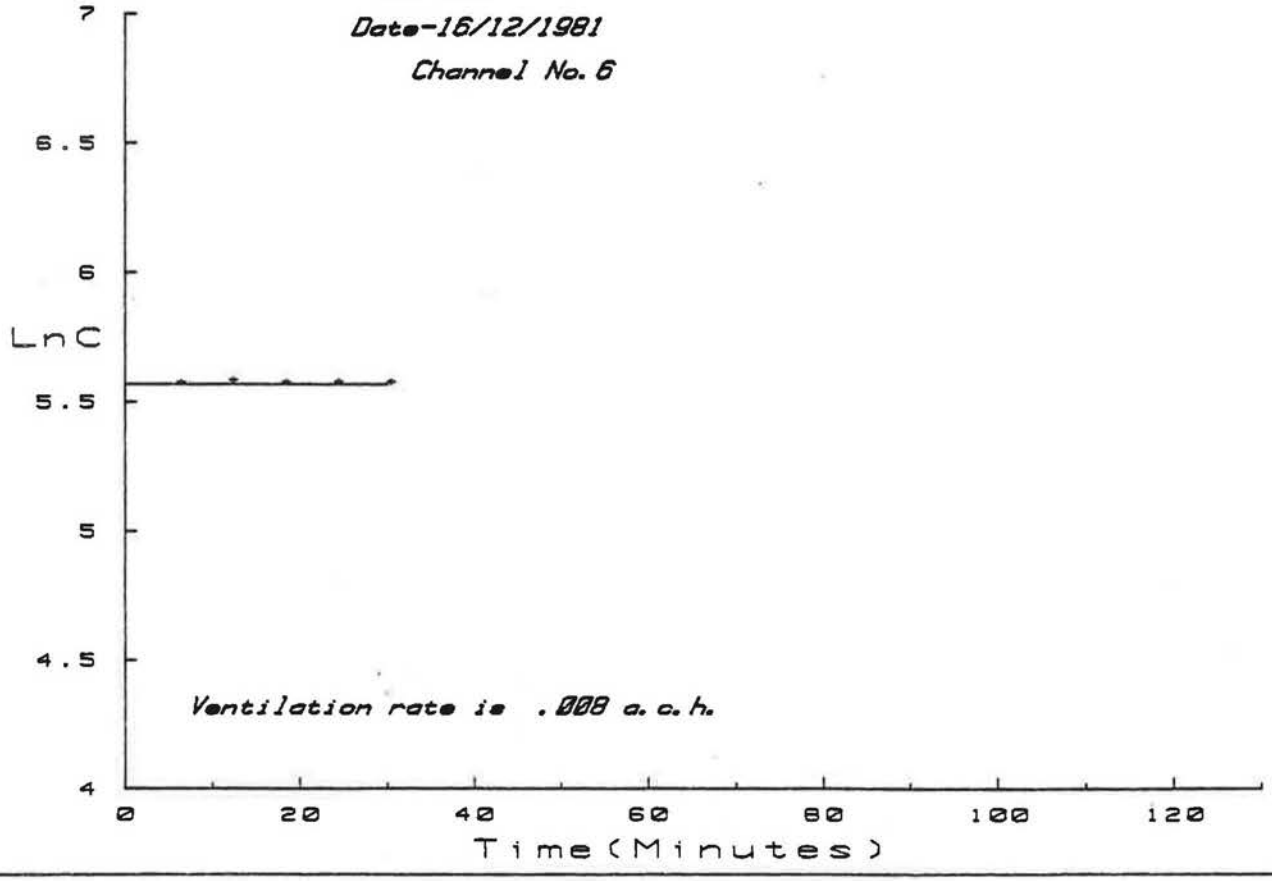


Ventilation rate is -.108 a.c.h.

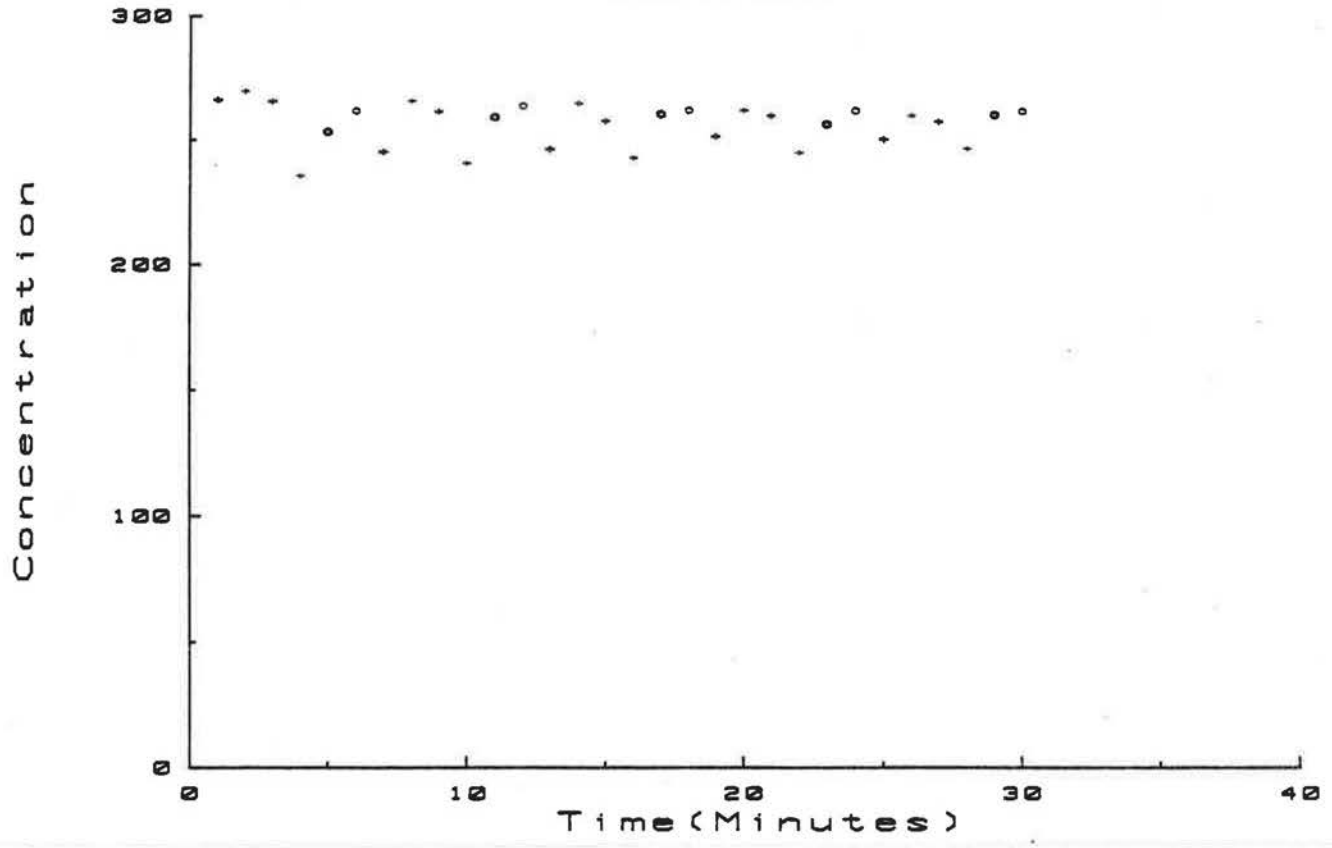
Run-B01R01
Location-UNIT 9, MASEFIELD RD. IND. ESTATE, COVENTRY.
Gas-N2O
Date-16/12/1981
Channel No. 5



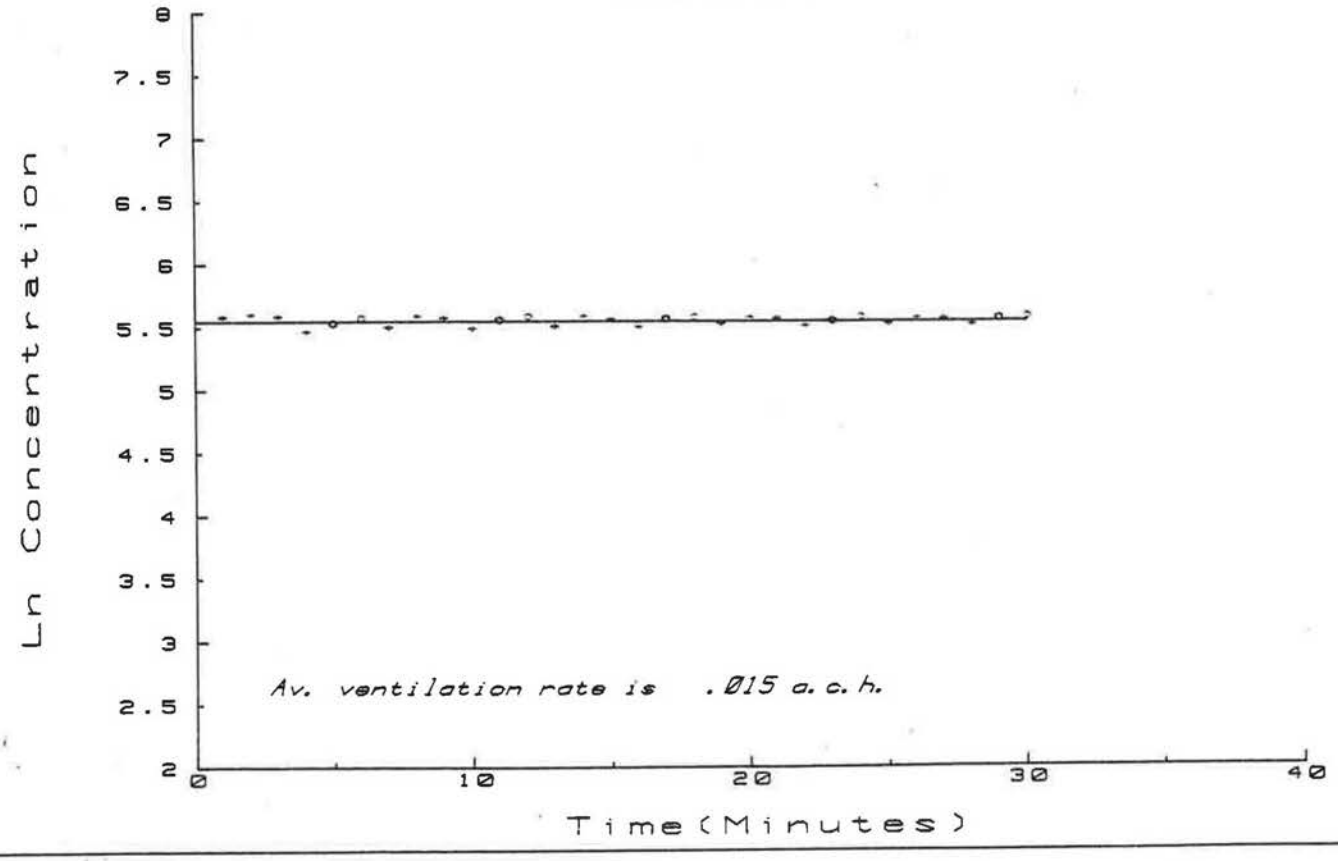
Run-B01R01
Location-UNIT 9, MASEFIELD RD. IND. ESTATE, COVENTRY.
Gas-N2O
Date-16/12/1981
Channel No. 6



Run-B01R01
Location-Unit9, Masefield Road Ind. Estate, COVENTRY
Gas-N2O
Date-16/12/81



Run-B01R01
Location-Unit9, Masefield Road Ind. Estate, COVENTRY
Gas-N2O
Date-16/12/81



B01 R02

Date: 16th December, 1981

Time: 1300 hours to 1400 hours

Tracer Gas: Nitrous Oxide

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1300 hrs	zero	-3.4
1400 hrs	zero	-2.9

Internal Conditions:

air velocity: very low, not measured
temperature: -1^{o}C to +3^{o}C

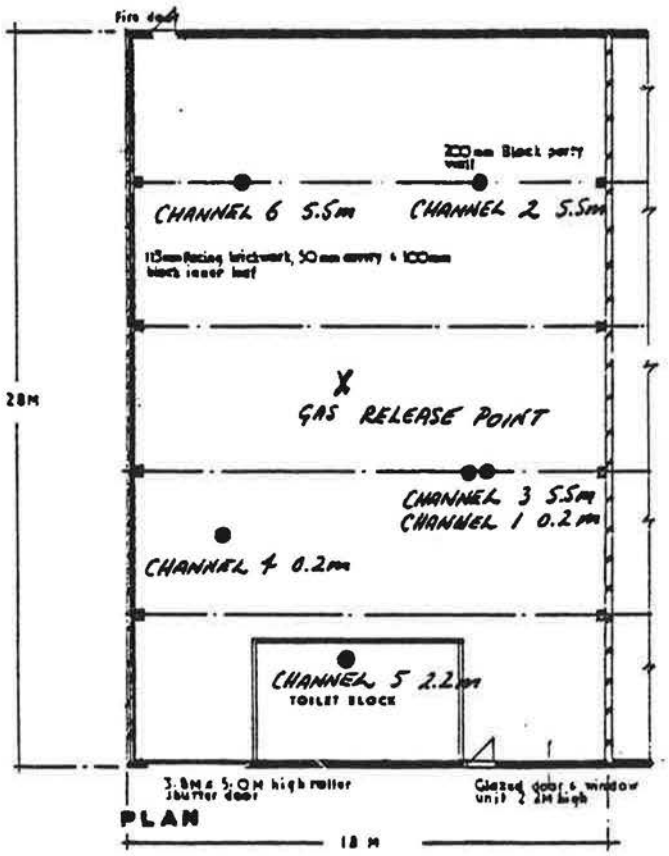
Gas Release:

Gas released into path of small fan at point shown on plan.

Sample Positions:

As shown on plan.

Comment: roller shutter door and small window on s.w. face of building and door on n.e. face of building open.



****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B01R02
Location: Unit 9,Masefield Road Ind. Estate,COVENTRY
Date: 16/12/81
Tracer gas: N2O

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5			Channel 6		
****	**********			**********			**********			**********			**********			**********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	1.0	253	5.533	2.0	257	5.549	3.0	256	5.545	4.0	250	5.521	5.0	255	5.541	6.0	257	5.549
2	7.0	250	5.521	8.0	259	5.557	9.0	256	5.545	10.0	245	5.501	11.0	251	5.525	12.0	256	5.545
3	13.0	248	5.513	14.0	257	5.549	15.0	255	5.541	16.0	245	5.501	17.0	248	5.513	18.0	255	5.541
4	19.0	244	5.497	20.0	256	5.545	21.0	253	5.533	22.0	237	5.468	23.0	248	5.513	24.0	254	5.537
5	25.0	243	5.493	26.0	253	5.533	27.0	251	5.525	34.0	238	5.472	29.0	247	5.509	30.0	252	5.529
6	31.0	243	5.493	32.0	254	5.537	33.0	251	5.525				35.0	246	5.505	36.0	252	5.529

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	Df	SS	MS	F
Regression	1	.001	.001	50.284
Residual	4	.000	.000	
Total	5	.001		

INTERCEPT= 5.53168831437
GRADIENT= -1.44332939048E-03

Ventilation rate is .087 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	Df	SS	MS	F
Regression	1	.000	.000	8.842
Residual	4	.000	.000	
Total	5	.000		

INTERCEPT= 5.55590737499
GRADIENT= -6.32968806349E-04

Ventilation rate is .038 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	Df	SS	MS	F
Regression	1	.000	.000	47.019
Residual	4	.000	.000	
Total	5	.000		

INTERCEPT= 5.5501859277
GRADIENT= -7.88905233333E-04

Ventilation rate is .047 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	Df	SS	MS	F
Regression	1	.002	.002	10.828
Residual	3	.000	.000	
Total	4	.002		

INTERCEPT= 5.52231590617
GRADIENT= -1.71362066441E-03

Ventilation rate is .103 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	Df	SS	MS	F
Regression	1	.001	.001	22.562
Residual	4	.000	.000	
Total	5	.001		

INTERCEPT= 5.53974934195
GRADIENT= -1.08501835397E-03

Ventilation rate is .065 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 6

Source	Df	SS	MS	F
Regression	1	.000	.000	115.808
Residual	4	.000	.000	
Total	5	.000		

INTERCEPT= 5.55355918644
GRADIENT= -7.11473031746E-04

Ventilation rate is .043 air changes per hour

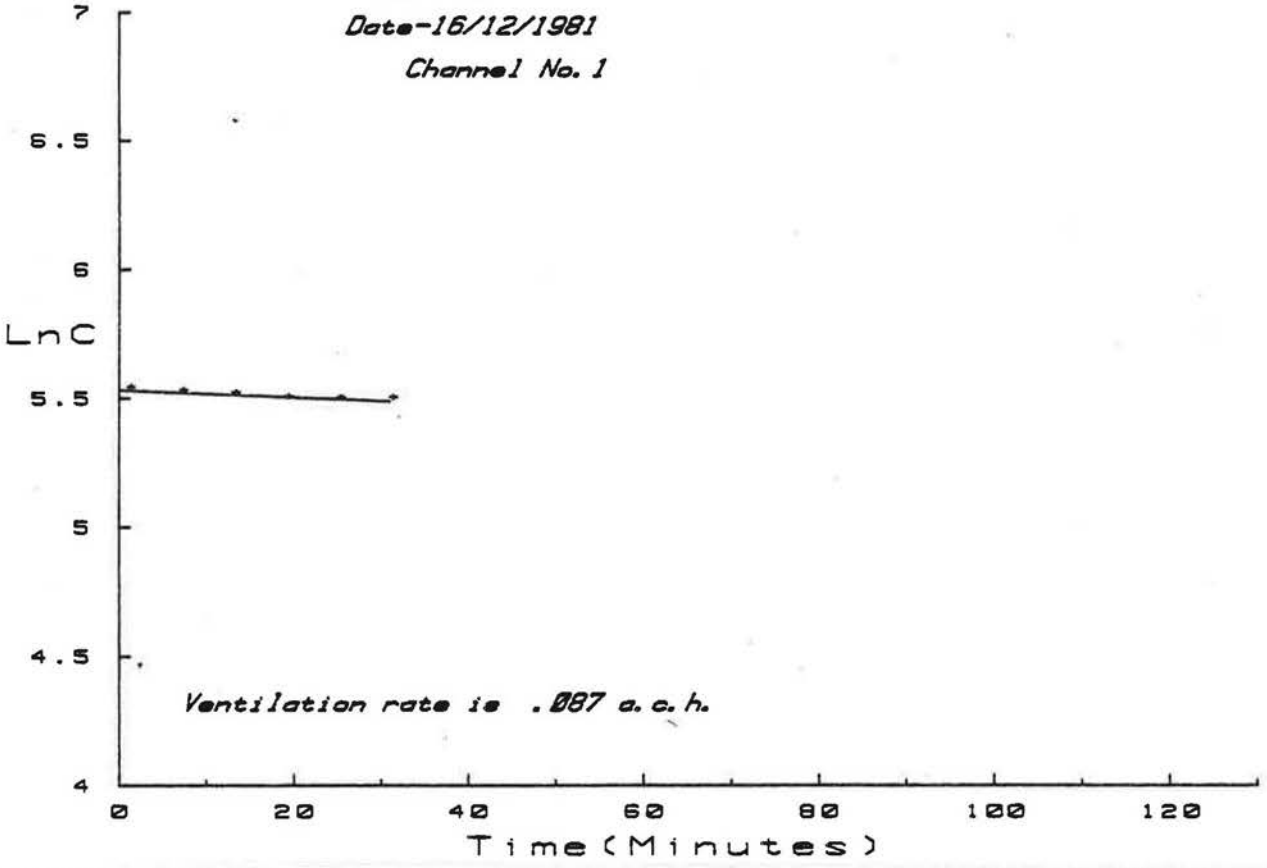
STATISTICAL ANALYSIS - ALL CHANNELS

Source	Df	SS	MS	F
Regression	1	.003	.003	7.770
Residual	33	.014	.000	
Total	34	.017		

INTERCEPT= 5.54078645144
GRADIENT= -9.16690881608E-04

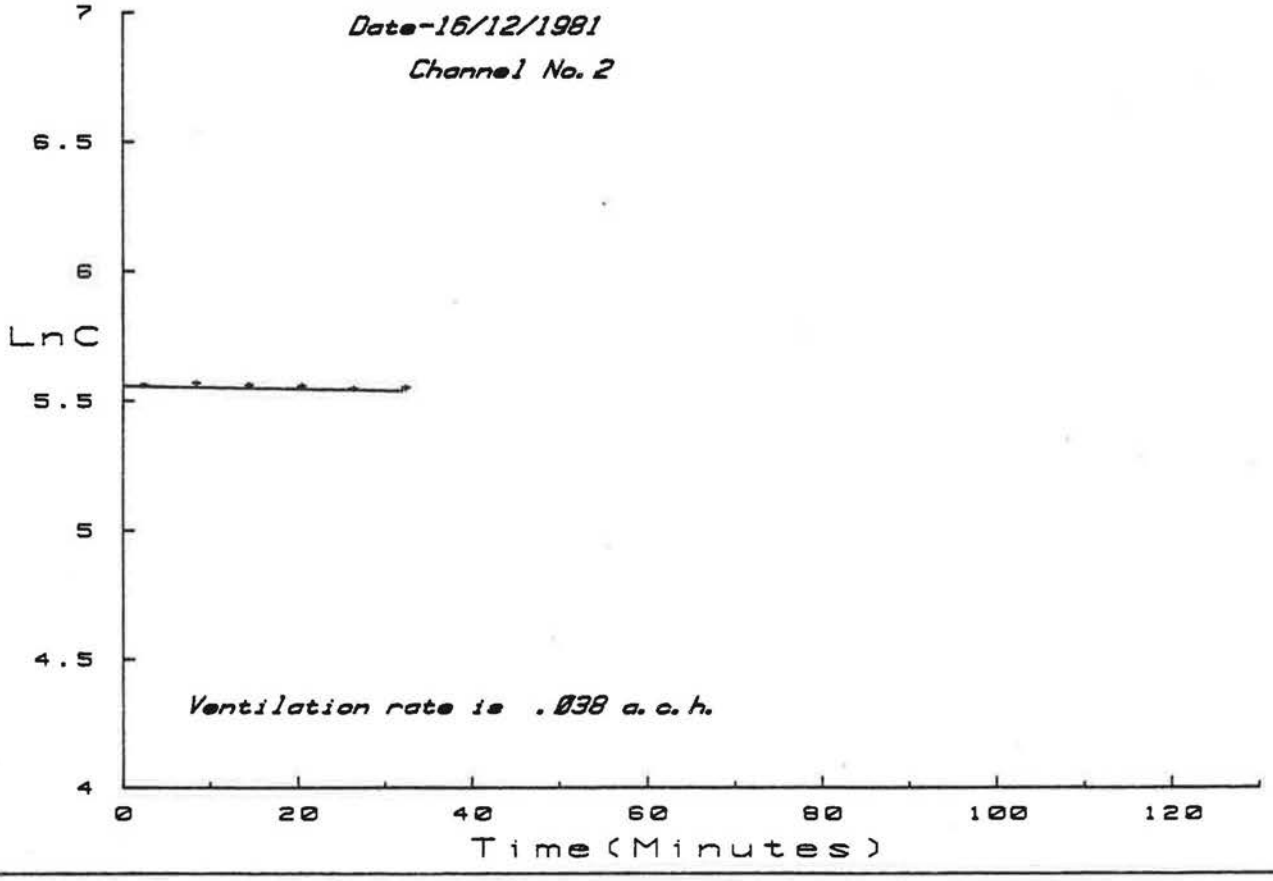
Ventilation rate is .055 air changes per hour

Run-B01R02
Location-UNIT 9, MASEFIELD RD. INDUSTRIAL ESTATE, COVENTRY
Gas-N2O
Date-16/12/1981
Channel No. 1



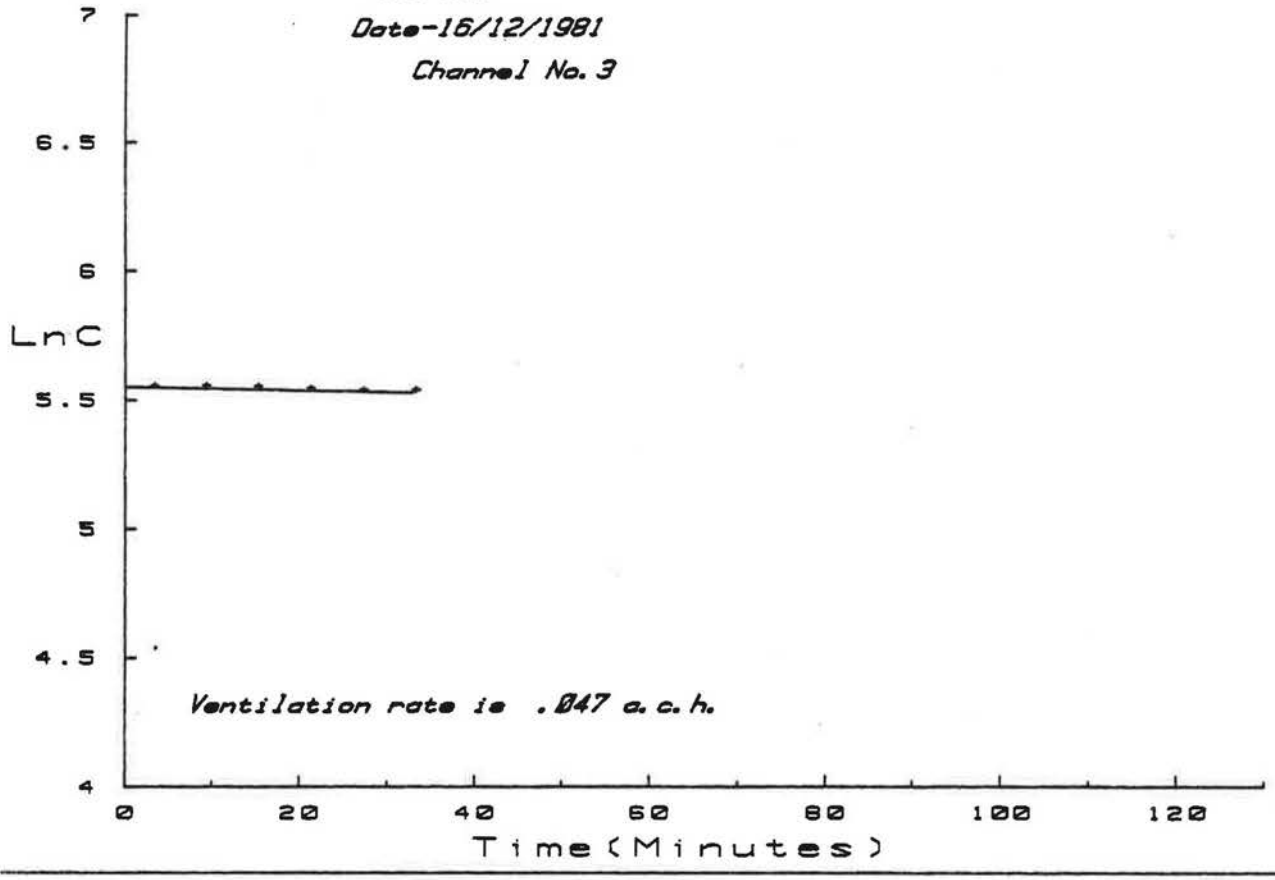
Ventilation rate is .087 a.c.h.

Run-B01R02
Location-UNIT 9, MASEFIELD RD. INDUSTRIAL ESTATE, COVENTRY
Gas-N2O
Date-16/12/1981
Channel No. 2



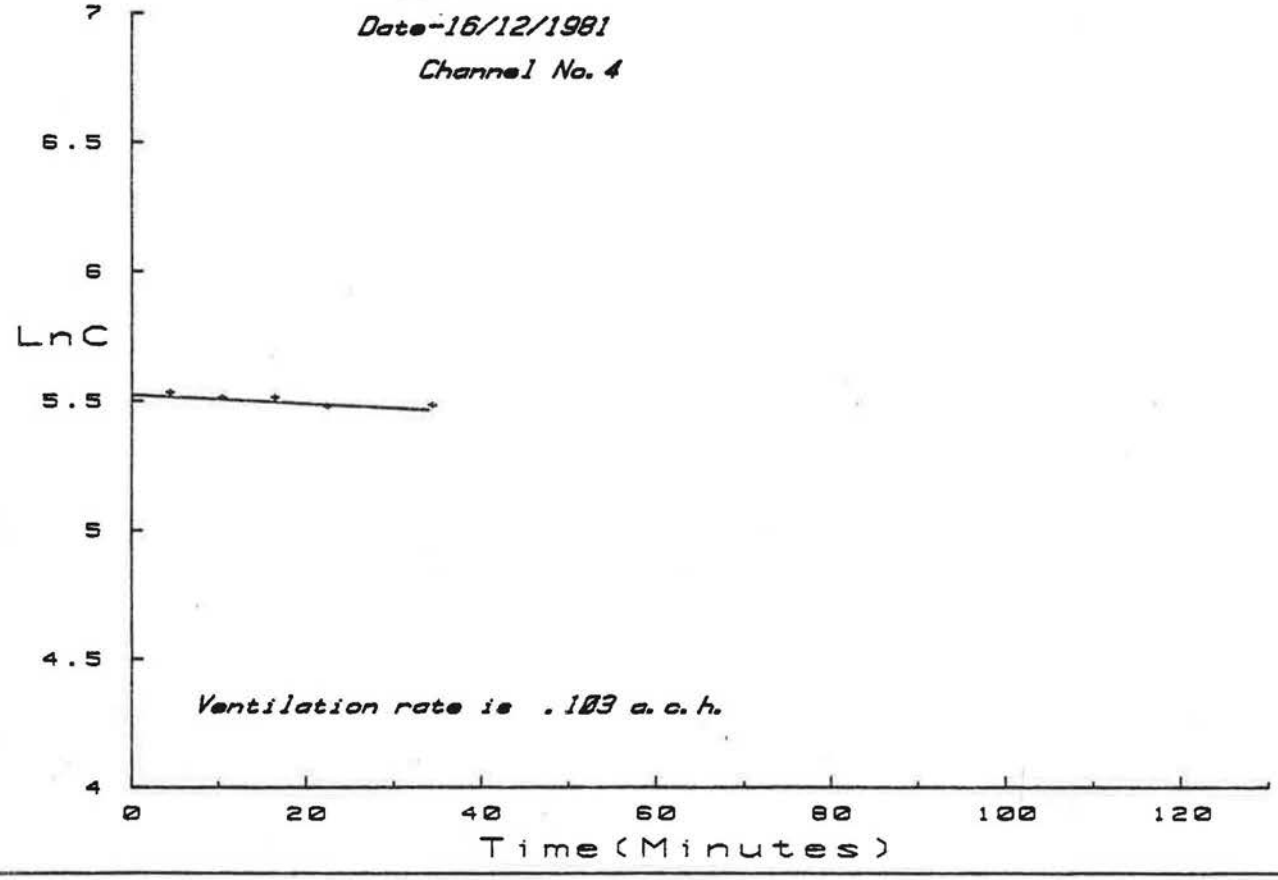
Ventilation rate is .038 a.c.h.

Run-B01R02
Location-UNIT 9, MASEFIELD RD. INDUSTRIAL ESTATE, COVENTRY
Gas-N2O
Date-16/12/1981
Channel No. 3



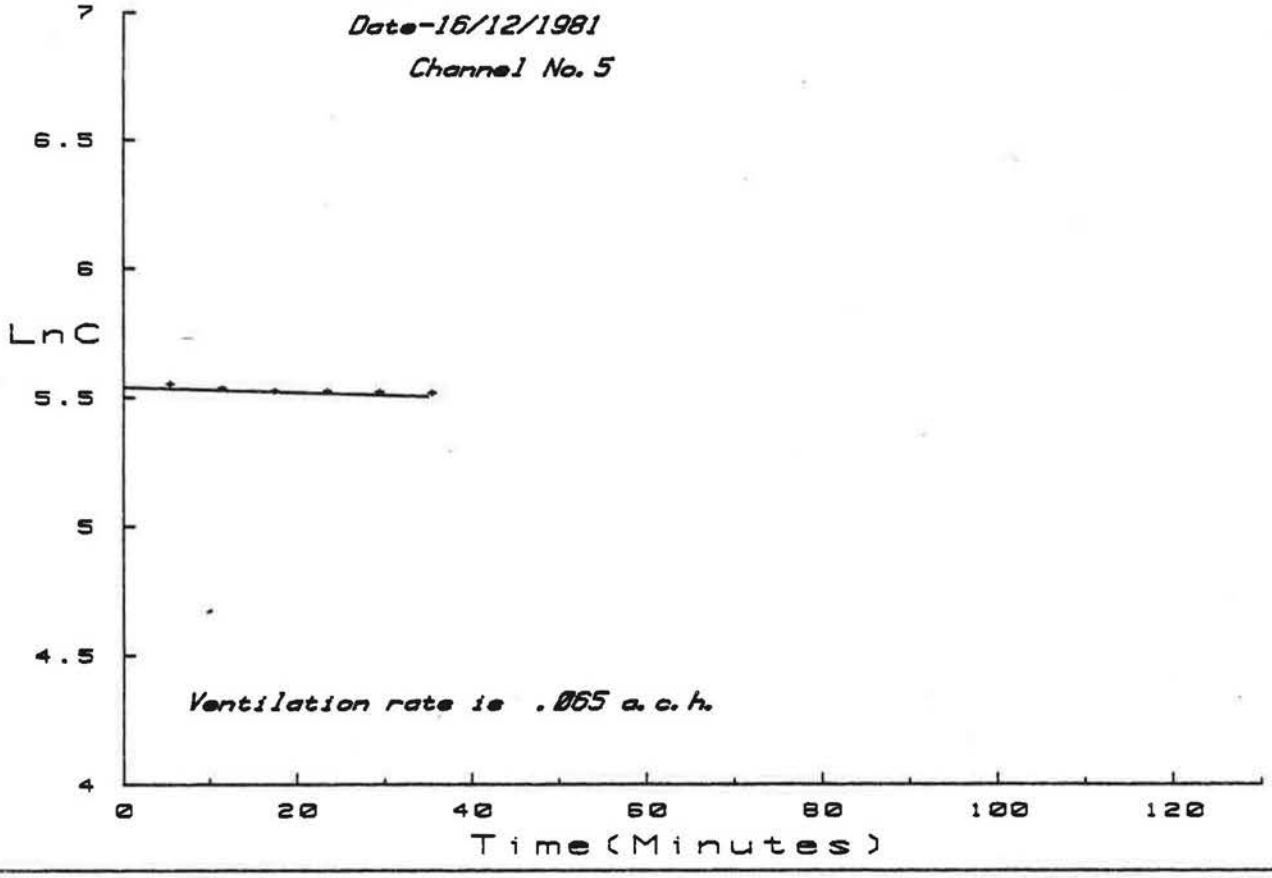
Ventilation rate is .047 a.c.h.

Run-B01R02
Location-UNIT 9, MASEFIELD RD. INDUSTRIAL ESTATE, COVENTRY
Gas-N2O
Date-16/12/1981
Channel No. 4

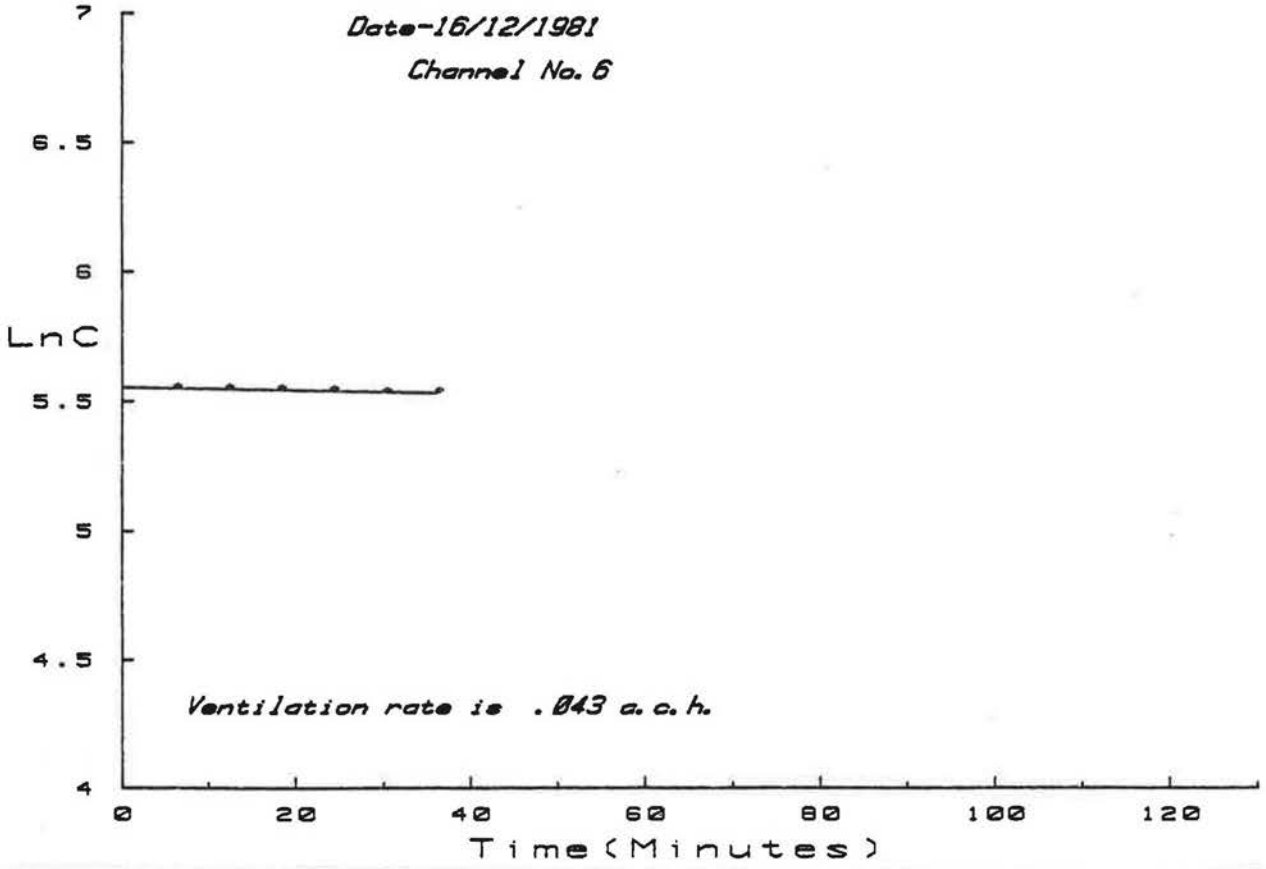


Ventilation rate is .103 a.c.h.

Run-B01R02
Location-UNIT 9, MASEFIELD RD. INDUSTRIAL ESTATE, COVENTRY
Gas-N2O
Date-16/12/1981
Channel No. 5



Run-B01R02
Location-UNIT 9, MASEFIELD RD. INDUSTRIAL ESTATE, COVENTRY
Gas-N2O
Date-16/12/1981
Channel No. 6

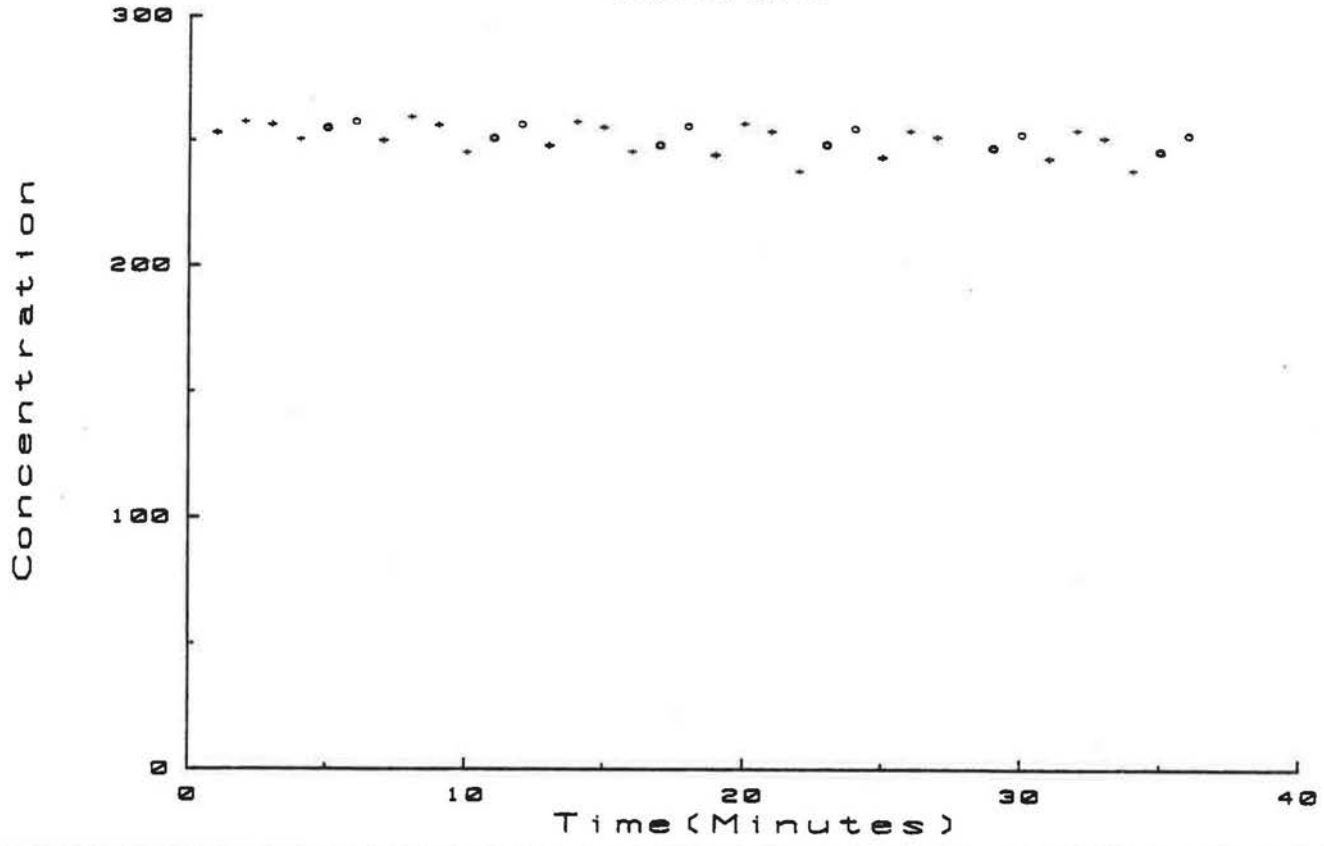


Run-B01R02

Location-Unit 9, Masefield Road Ind. Estate, COVENTRY

Gas-N2O

Date-16/12/81

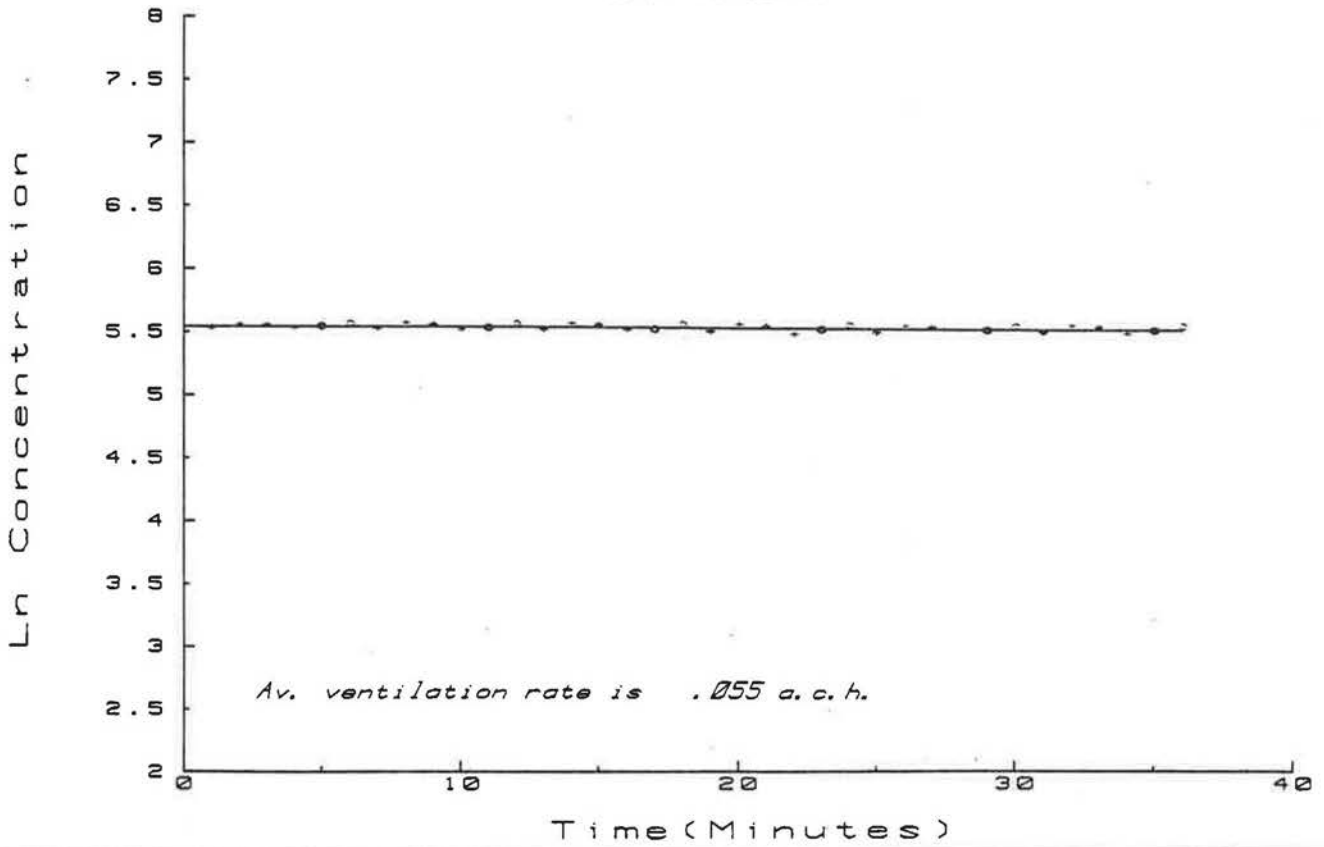


Run-B01R02

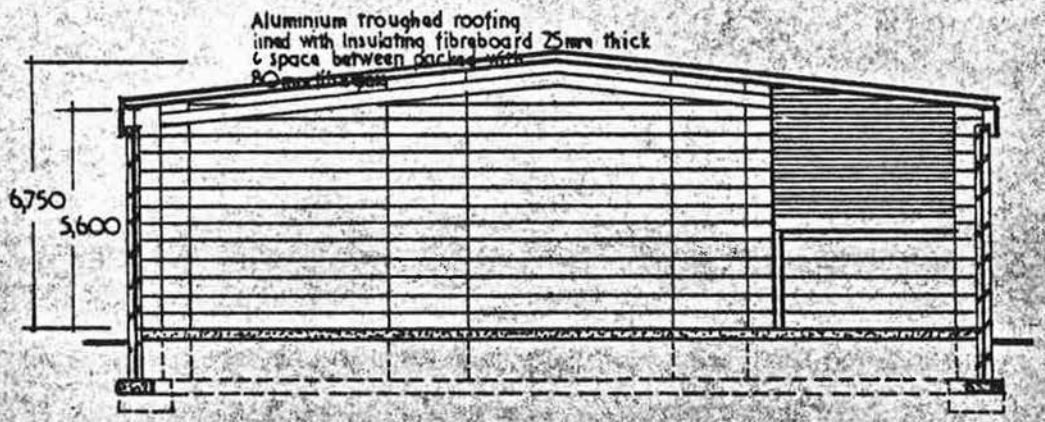
Location-Unit 9, Masefield Road Ind. Estate, COVENTRY

Gas-N2O

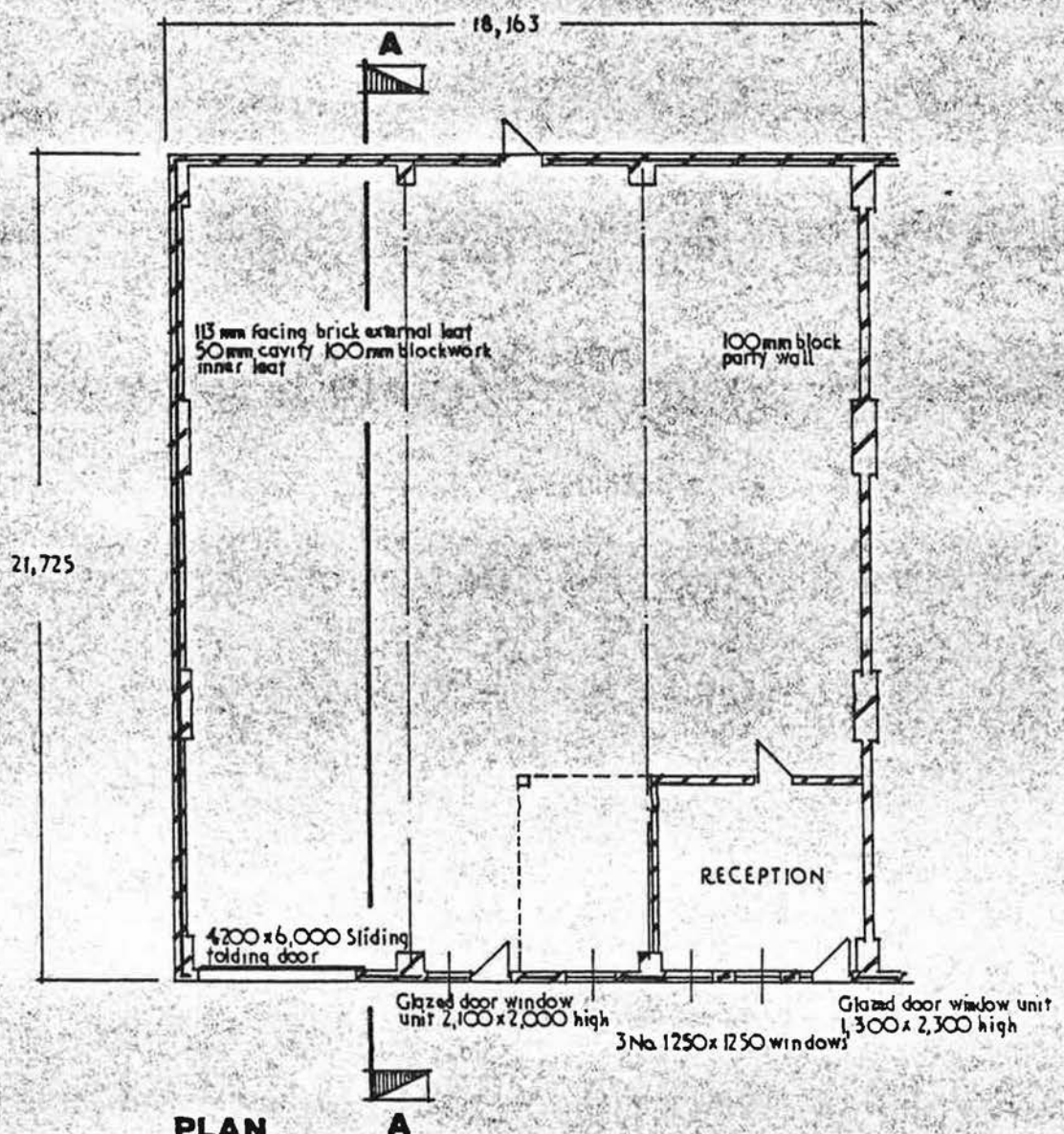
Date-16/12/81



Building B02
Stag Industrial Estate, Coventry.



SECTION THRO' 'A'–'A'



PLAN

B02 R01

Date: 16th March, 1982

Time: 1500 hours to 1600 hours

Tracer Gas: Nitrous Oxide

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1500 hrs	7.2	7.5
1600 hrs	7.2	7.5

Wind Direction: west south west

Internal Conditions:

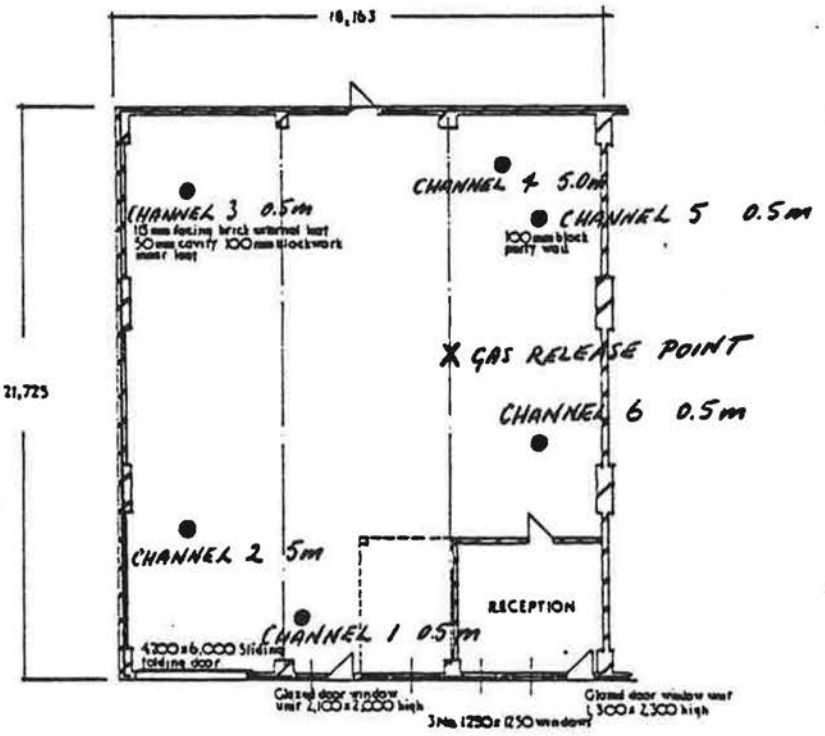
air velocity: 0.02 to 0.10 m/s
temperature: 8.1 to 9.5^{o}C

Gas Release:

Gas released into path of small fan at point shown on plan.

Sample Positions:

As shown on plan.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B02R01
Location: Stag Industrial Estate, COVENTRY
Date: 16/3/82
Tracer gas: N2O

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	3.0	507	6.229	5.0	859	6.756	0.0	912	6.816	1.0	861	6.758	2.0	627	6.441
2	9.0	501	6.217	11.0	741	6.608	6.0	668	6.504	7.0	682	6.525	8.0	565	6.337
3	15.0	452	6.114	17.0	638	6.458	12.0	582	6.366	13.0	612	6.417	14.0	531	6.275
4	21.0	322	5.775	23.0	513	6.240	18.0	525	6.263	19.0	513	6.240	20.0	442	6.091
5	27.0	245	5.501	29.0	501	6.217	24.0	440	6.087	25.0	488	6.190	26.0	376	5.930
6	33.0	295	5.687	35.0	398	5.986	30.0	331	5.802	31.0	347	5.849	32.0	309	5.733
7	39.0	214	5.366	41.0	355	5.872	36.0	327	5.790	37.0	351	5.861	38.0	355	5.872
8	45.0	207	5.333	47.0	282	5.642	42.0	316	5.756	43.0	355	5.872	44.0	376	5.930
9	51.0	197	5.283	53.0	245	5.501	48.0	316	5.756	49.0	275	5.617	50.0	204	5.318
10	57.0	211	5.352	59.0	243	5.493	54.0	248	5.513	55.0	295	5.687	56.0	229	5.434
11	63.0	180	5.193	65.0	174	5.159	60.0	229	5.434	61.0	224	5.412	62.0	180	5.193
12	69.0	100	4.605	71.0	145	4.977	66.0	168	5.124	67.0	126	4.836	68.0	108	4.682
13							72.0	119	4.779	73.0	104	4.644			

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	Df	SS	MS	F
Regression	1	2.226	2.226	79.753
Residual	10	.279	.028	
Total	11	2.506		

INTERCEPT= 6.30310708605
GRADIENT= -2.079587251948-02

Ventilation rate is 1.248 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	Df	SS	MS	F
Regression	1	3.525	3.525	960.312
Residual	10	.037	.004	
Total	11	3.561		

INTERCEPT= 6.90342812331
GRADIENT= -.026165706451

Ventilation rate is 1.570 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	Df	SS	MS	F
Regression	1	3.660	3.660	226.314
Residual	11	.178	.016	
Total	12	3.838		

INTERCEPT= 6.69629450528
GRADIENT= -2.363558925678-02

Ventilation rate is 1.418 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	Df	SS	MS	F
Regression	1	4.286	4.286	140.078
Residual	11	.337	.031	
Total	12	4.623		

INTERCEPT= 6.78549716053
GRADIENT= -2.557738313198-02

Ventilation rate is 1.535 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	Df	SS	MS	F
Regression	1	2.694	2.694	81.208
Residual	10	.332	.033	
Total	11	3.026		

INTERCEPT= 6.57029854844
GRADIENT= -.022876597566

Ventilation rate is 1.373 air changes per hour

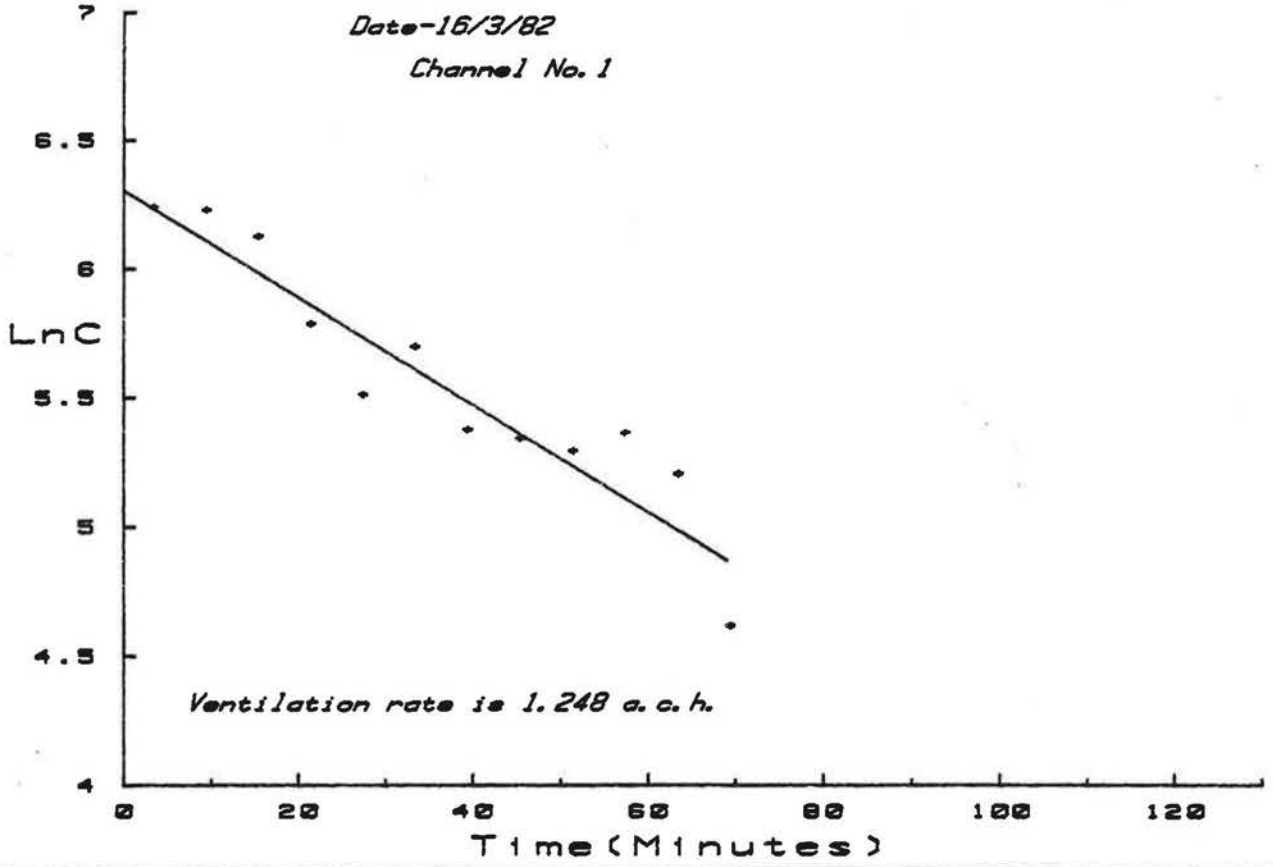
STATISTICAL ANALYSIS - ALL CHANNELS

Source	Df	SS	MS	F
Regression	1	16.072	16.072	403.036
Residual	60	2.393	.040	
Total	61	18.465		

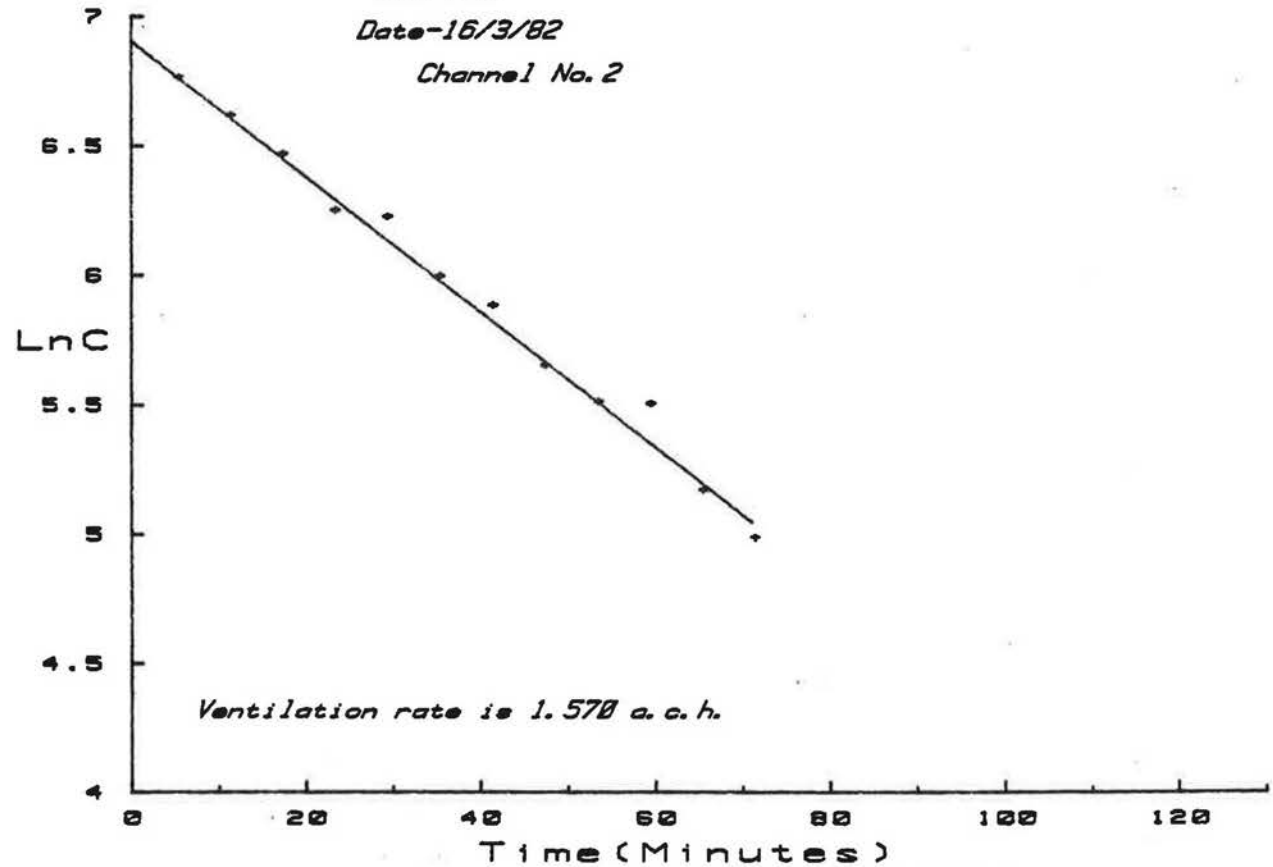
INTERCEPT= 6.64824587844
GRADIENT= -2.370122942878-02

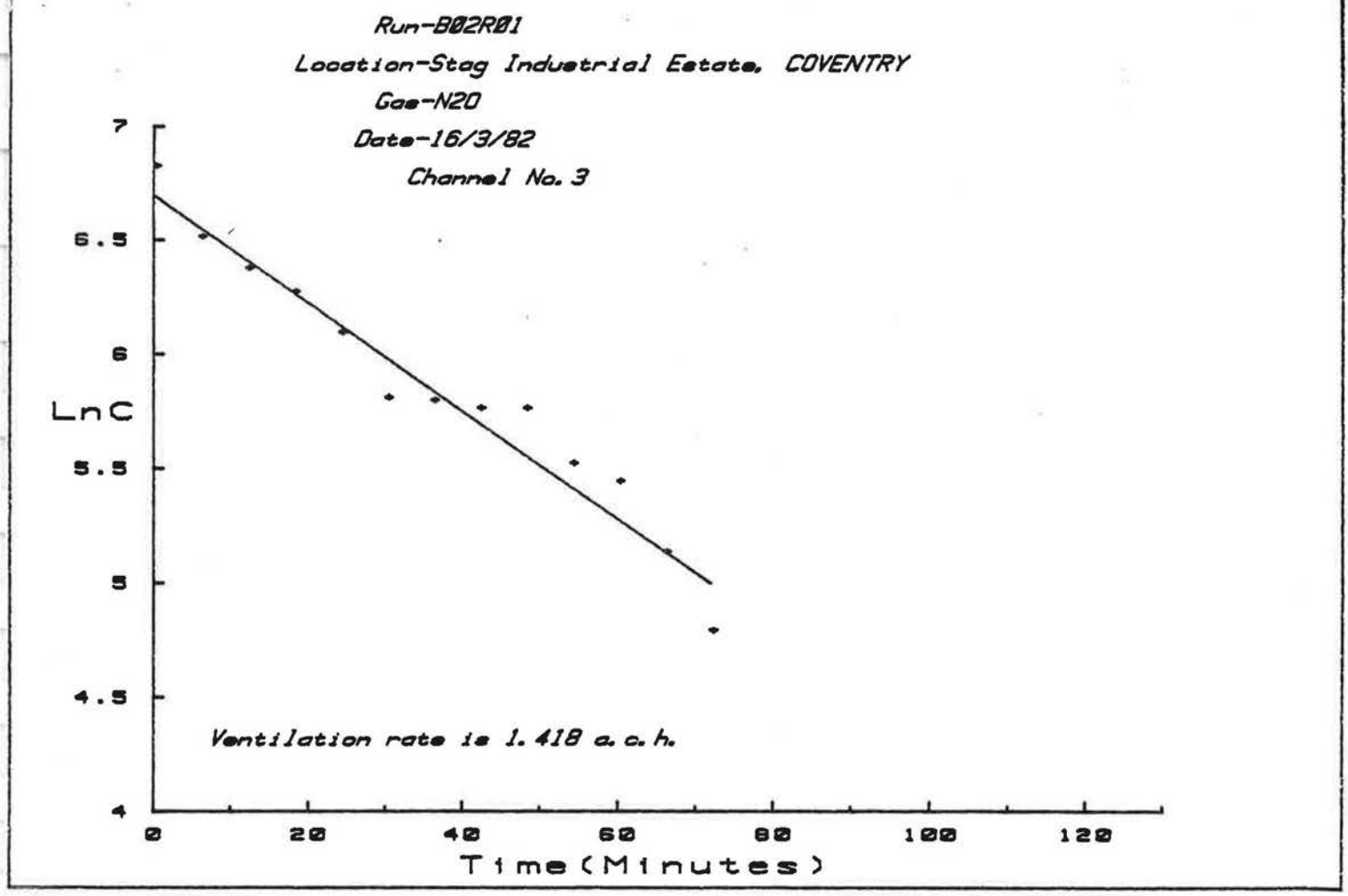
Ventilation rate is 1.422 air changes per hour

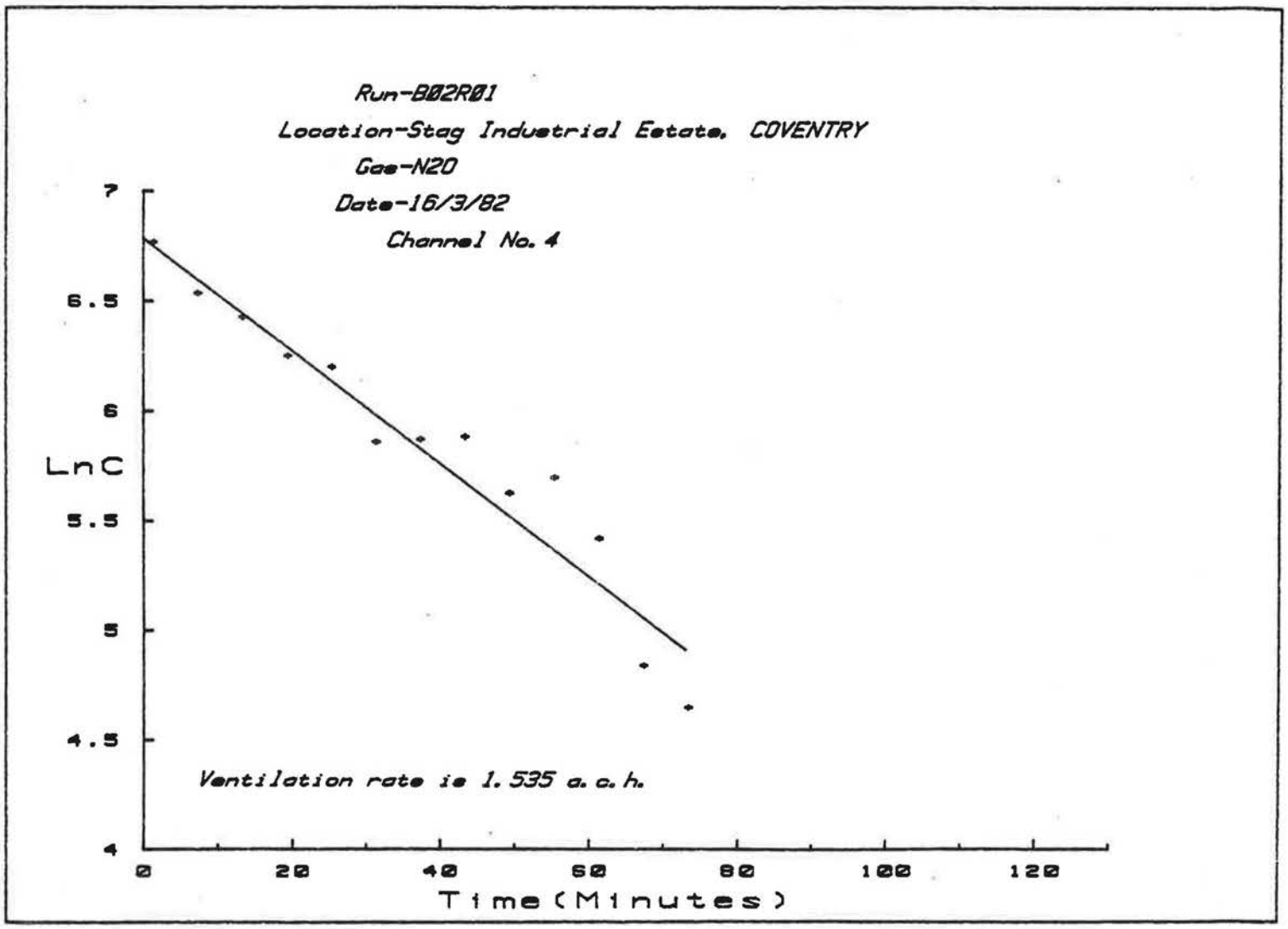
Run-B02R01
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-16/3/82
Channel No. 1



Run-B02R01
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-16/3/82
Channel No. 2




Run-B02R01
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-16/3/82
Channel No. 3
LnC
7
6.5
6
5.5
5
4.5
4
Ventilation rate is 1.418 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)


Run-B02R01
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-16/3/82
Channel No. 4
LnC
7
6.5
6
5.5
5
4.5
4
Ventilation rate is 1.535 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)

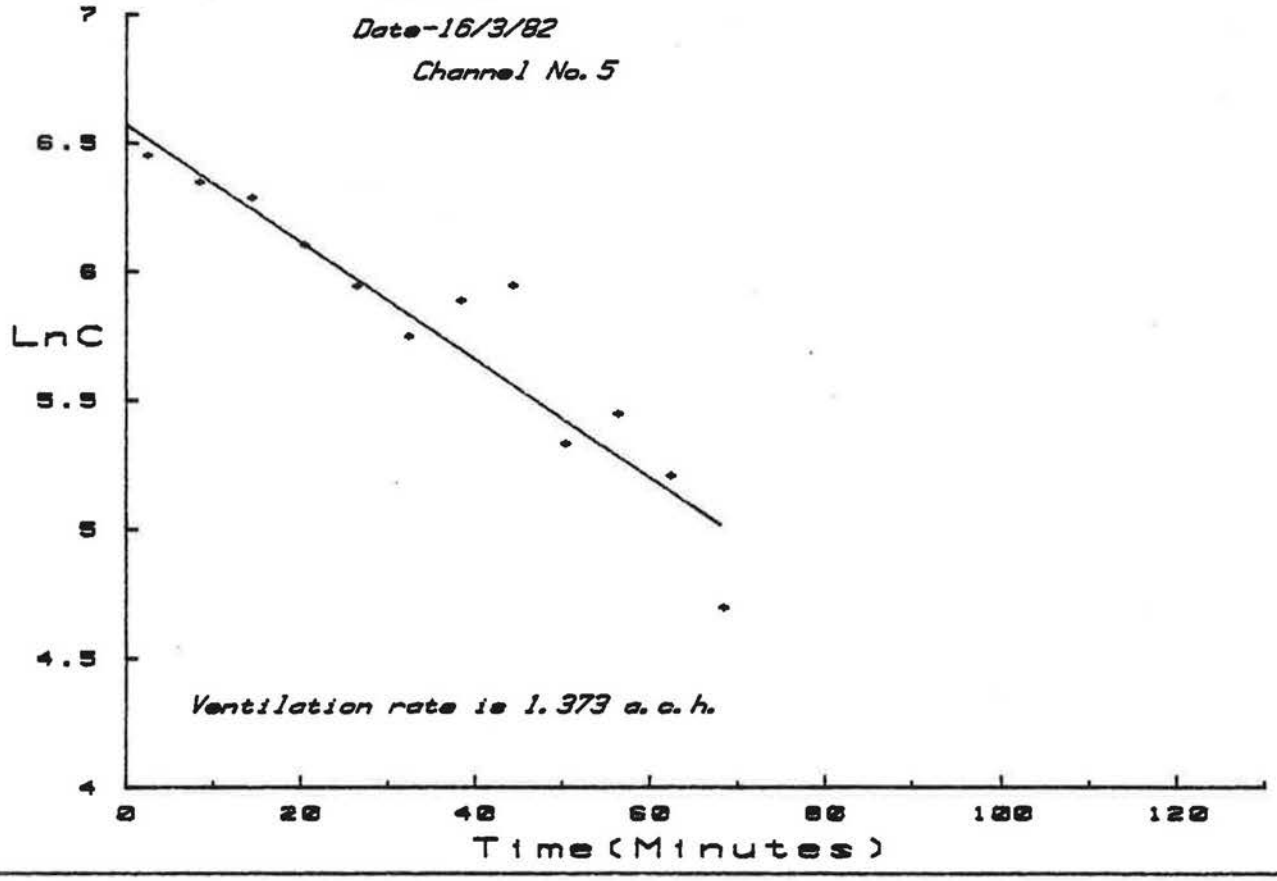
Run-B02R01

Location-Stag Industrial Estate, COVENTRY

Gas-N2O

Date-16/3/82

Channel No. 5

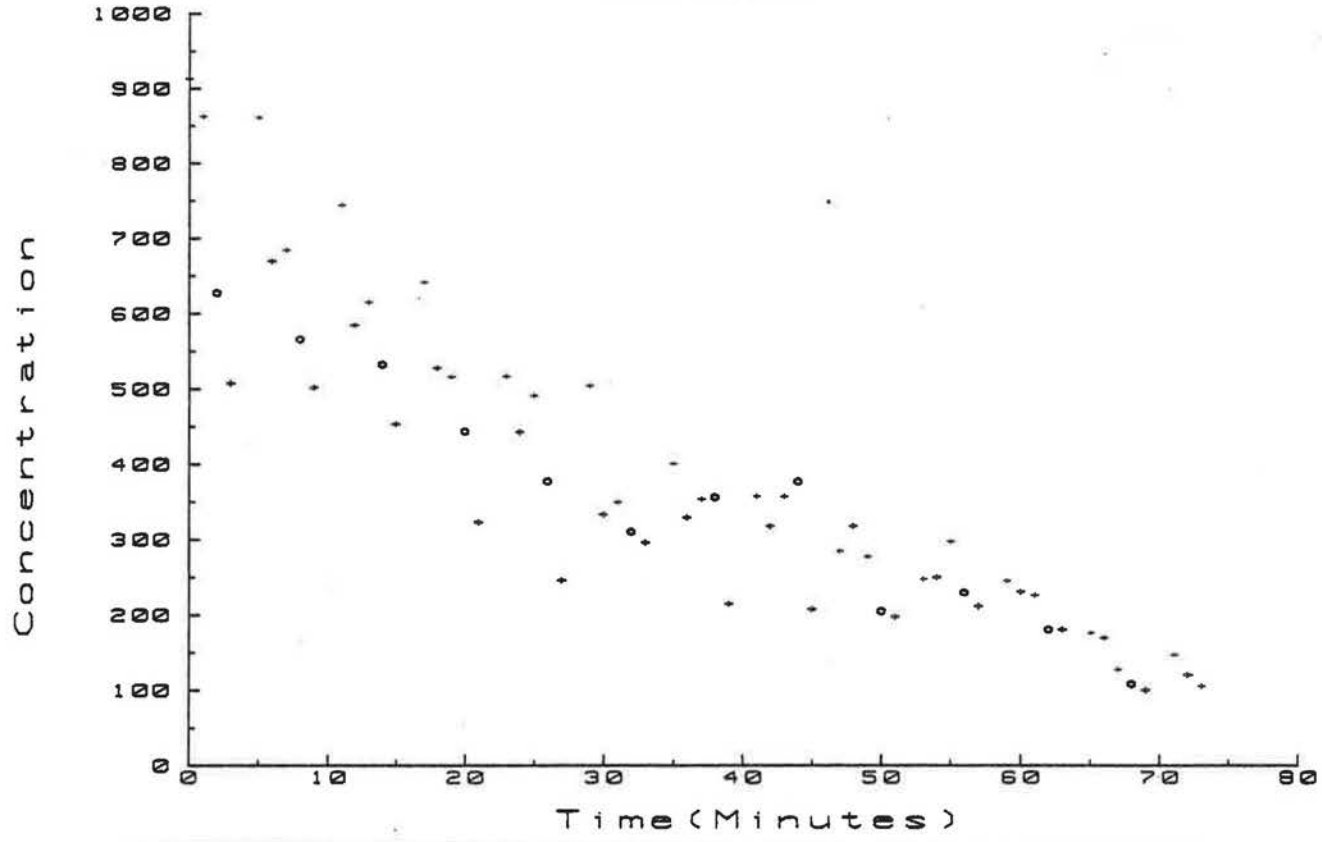


Run-B02R01

Location-Stag Industrial Estate, COVENTRY

Gas-N2O

Date-16/3/82

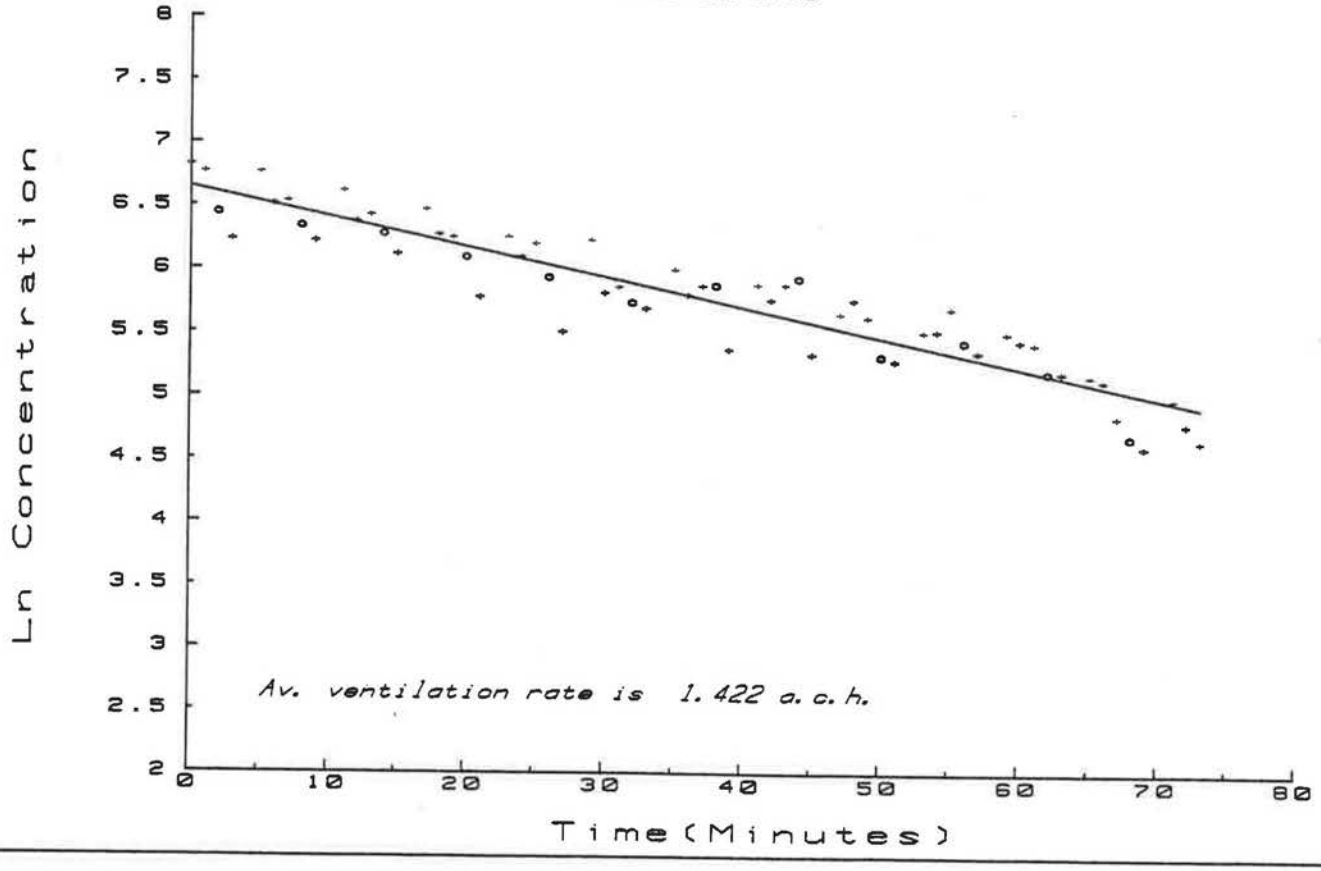


Run-B02R01

Location-Stag Industrial Estate, COVENTRY

Gas-N2O

Date-16/3/82



B02 R02

Date: 17th March, 1982

Time: 1400 hours to 1600 hours

Tracer Gas: Nitrous Oxide

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1400 hrs	6.2	6.8
1500 hrs	4.6	7.2
1600 hrs	8.8	7.9

Wind direction: west north west

Internal Conditions:

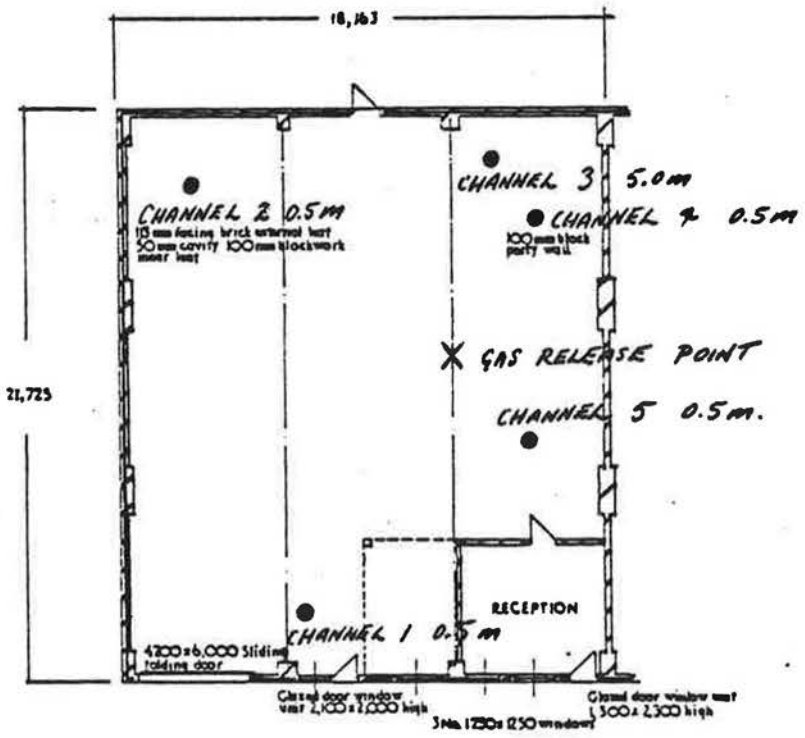
air velocity: 0.01 to 0.06 m/s
temperature: 7.5 to 8.5^{o}C

Gas Release:

Gas released into path of small fan at point shown on plan.

Sample Positions:

As shown on plan. Channel 6 positioned outside the building to monitor external air as a zero check.
Comment: This run occurred simultaneously with run B02 R04.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B02R02
Location: Stag Industrial Estate,COVENTRY
Date: 17/3/82
Tracer gas: N2O

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	4.0	980	6.888	0.0	1000	6.908	1.0	810	6.697	2.0	920	6.824	3.0	900	6.802
2	10.0	800	6.685	6.0	890	6.791	7.0	785	6.666	8.0	880	6.780	9.0	835	6.727
3	16.0	650	6.477	12.0	835	6.727	13.0	770	6.646	14.0	845	6.739	15.0	710	6.565
4	22.0	645	6.469	18.0	740	6.607	19.0	690	6.537	20.0	710	6.565	21.0	650	6.477
5	28.0	615	6.422	24.0	670	6.507	25.0	595	6.389	26.0	615	6.422	27.0	600	6.397
6	34.0	540	6.292	30.0	620	6.430	31.0	555	6.319	32.0	595	6.389	33.0	480	6.174
7	40.0	460	6.131	36.0	565	6.337	37.0	400	5.991	38.0	550	6.310	39.0	550	6.310
8	46.0	490	6.194	42.0	520	6.254	43.0	280	5.635	44.0	500	6.215	45.0	490	6.194
9	52.0	335	5.814	48.0	465	6.142	49.0	285	5.652	50.0	430	6.064	51.0	430	6.064
10	58.0	305	5.720	54.0	395	5.979	55.0	335	5.814	56.0	355	5.872	57.0	405	6.004
11	64.0	285	5.652	60.0	385	5.953	61.0	370	5.914	62.0	360	5.886	63.0	370	5.914
12	70.0	265	5.580	66.0	370	5.914	67.0	435	6.075	68.0	340	5.829	69.0	315	5.753
13	76.0	270	5.598	72.0	345	5.844	73.0	355	5.872	74.0	350	5.858	75.0	270	5.598
14	82.0	275	5.617	78.0	295	5.687	79.0	265	5.580	80.0	325	5.784	81.0	310	5.737
15	88.0	270	5.598	84.0	275	5.617	85.0	220	5.394	86.0	315	5.753	87.0	295	5.687
16	94.0	260	5.561	90.0	260	5.561	91.0	215	5.371	92.0	285	5.652	93.0	270	5.598
17	100.0	215	5.371	96.0	230	5.438	97.0	185	5.220	98.0	255	5.541	99.0	240	5.481
18	106.0	190	5.247	102.0	220	5.394	103.0	175	5.165	104.0	200	5.298	105.0	210	5.347
19				108.0	215	5.371	109.0	225	5.416	110.0	185	5.220	111.0	190	5.247

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	Df	SS	MS	F
Regression	1	3.786	3.786	247.103
Residual	16	.245	.015	
Total	17	4.032		

INTERCEPT= 6.7723487198
GRADIENT= -1.47337844731E-02

Ventilation rate is .884 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	Df	SS	MS	F
Regression	1	4.402	4.402	2912.021
Residual	17	.026	.002	
Total	18	4.427		

INTERCEPT= 6.86765065708
GRADIENT= -.014645872518

Ventilation rate is .879 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	Df	SS	MS	F
Regression	1	3.985	3.985	101.969
Residual	17	.664	.039	
Total	18	4.650		

INTERCEPT= 6.67977374153
GRADIENT= -1.39361657437E-02

Ventilation rate is .836 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	Df	SS	MS	F
Regression	1	4.079	4.079	603.975
Residual	17	.115	.007	
Total	18	4.194		

INTERCEPT= 6.84228971176
GRADIENT= -1.40998005249E-02

Ventilation rate is .846 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	Df	SS	MS	F
Regression	1	3.773	3.773	678.847
Residual	17	.094	.006	
Total	18	3.867		

INTERCEPT= 6.77686199688
GRADIENT= -1.35589701501E-02

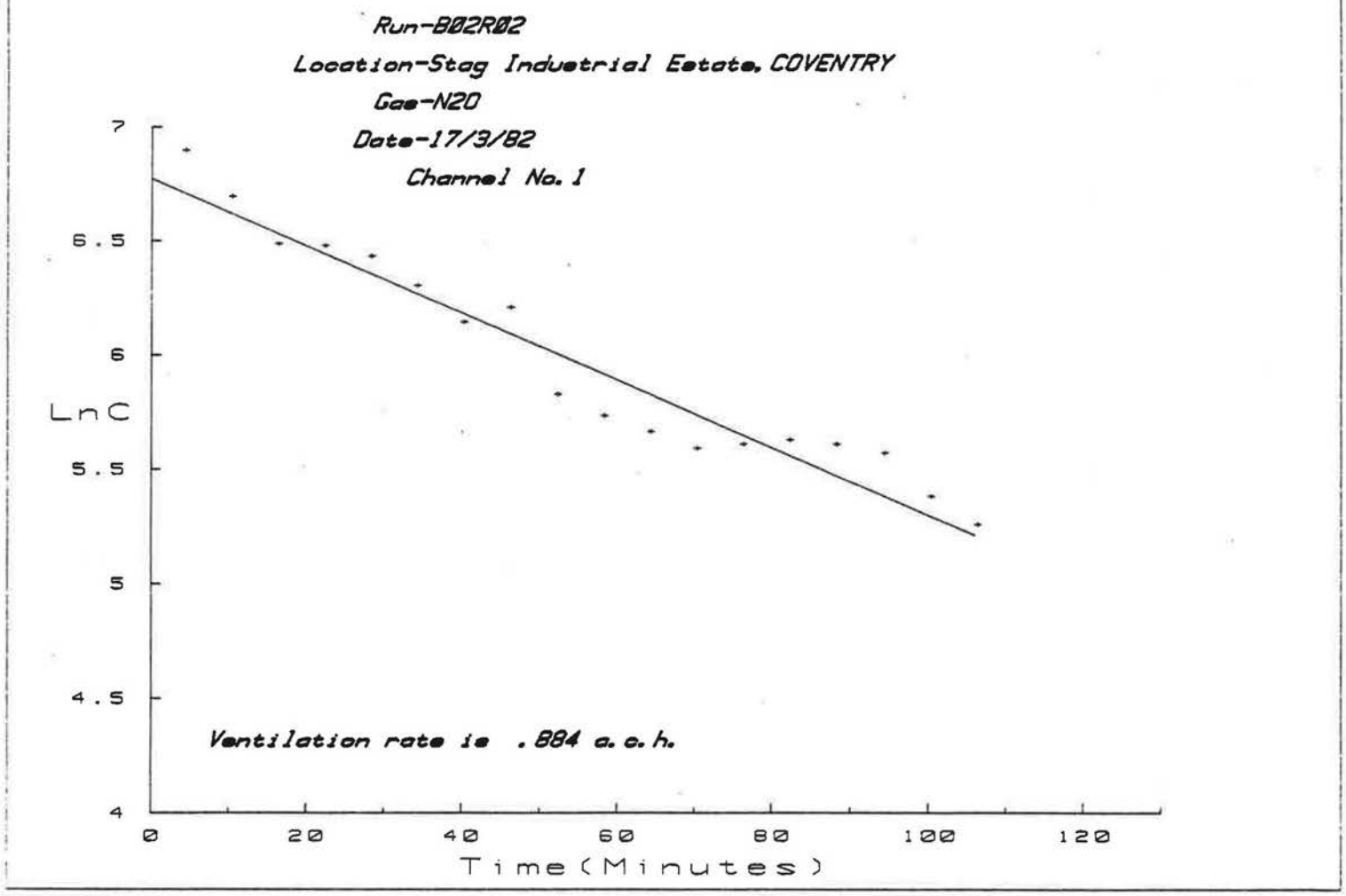
Ventilation rate is .814 air changes per hour

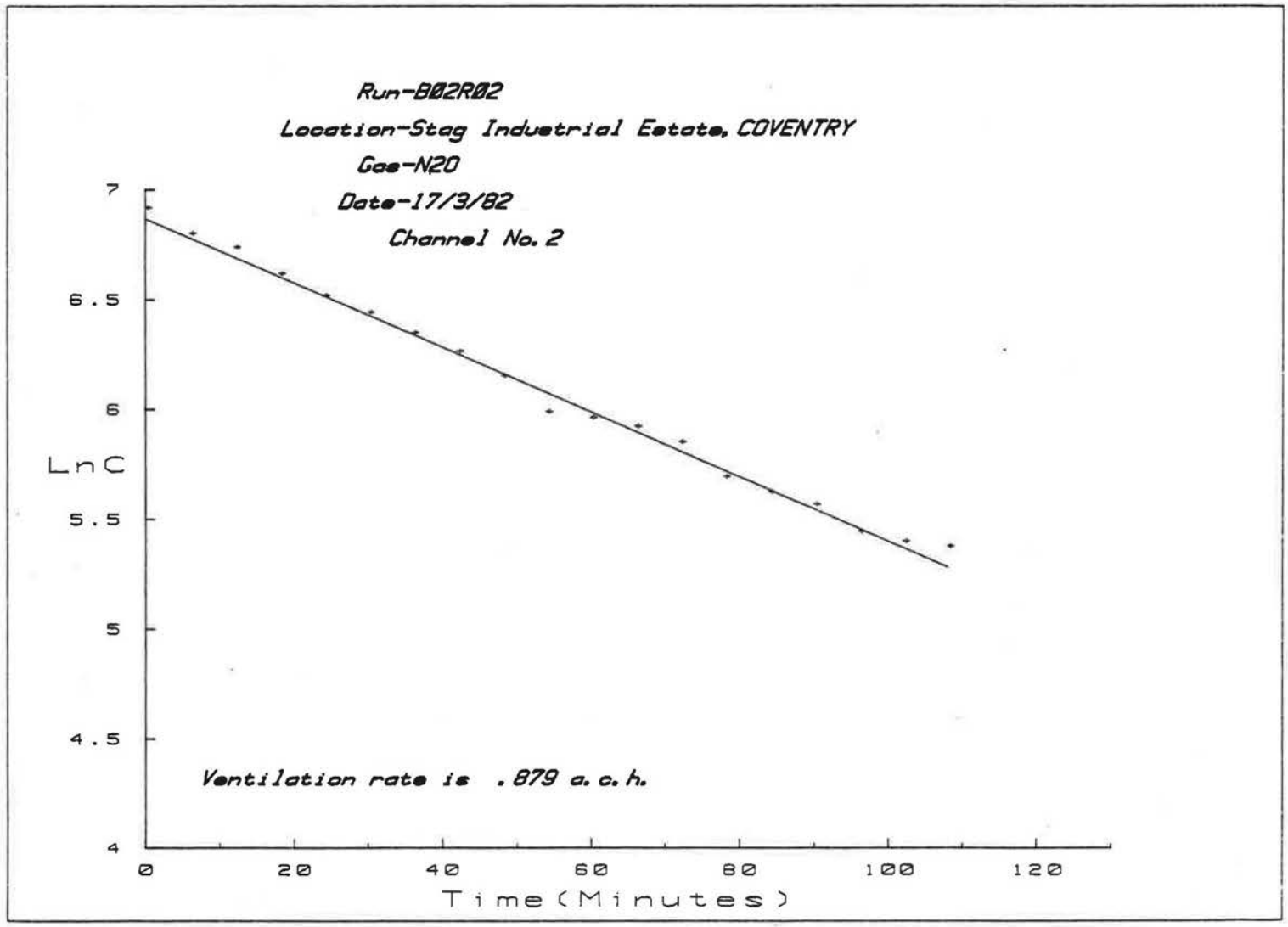
STATISTICAL ANALYSIS - ALL CHANNELS

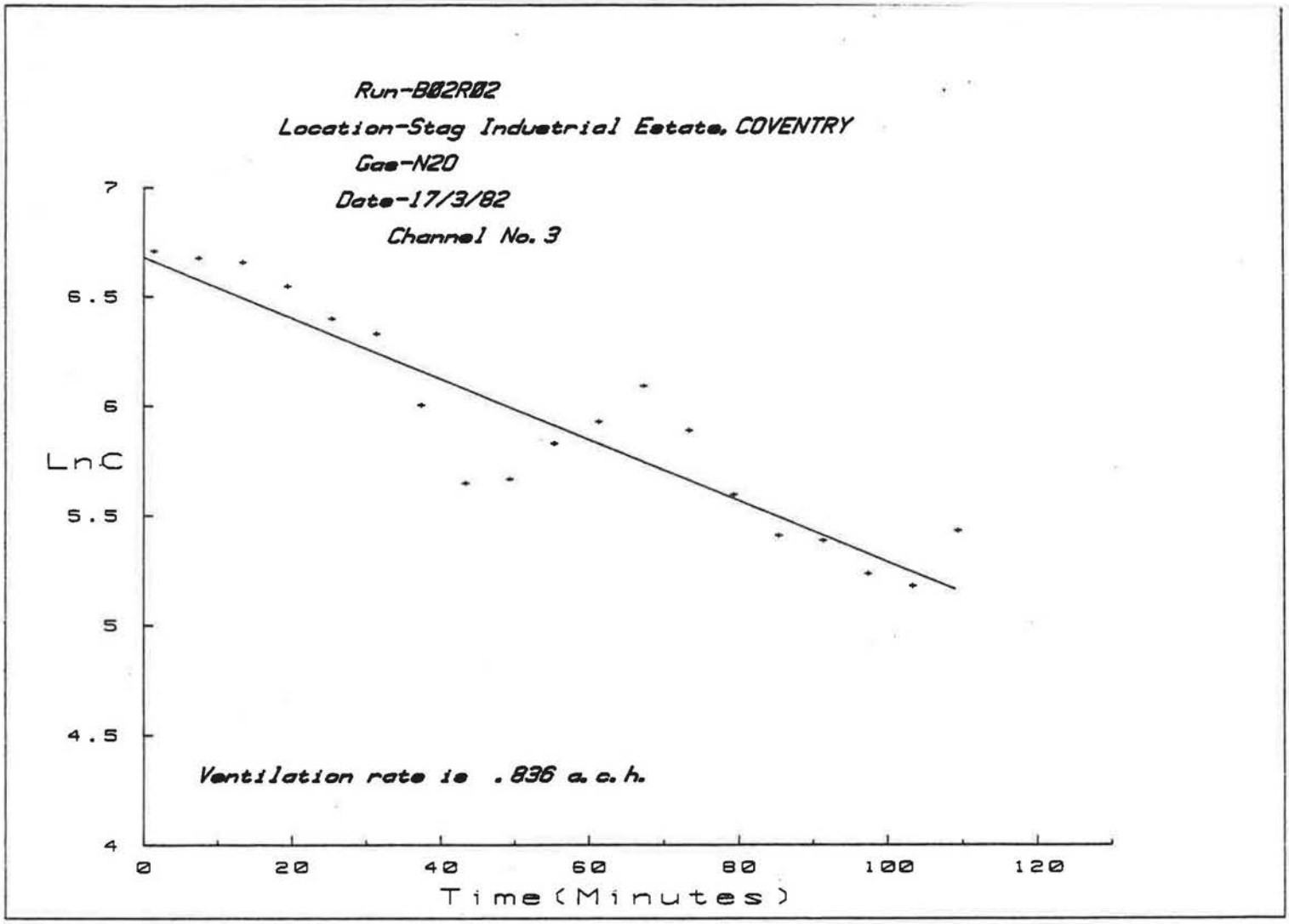
Source	Df	SS	MS	F
Regression	1	19.997	19.997	1221.643
Residual	92	1.506	.016	
Total	93	21.503		

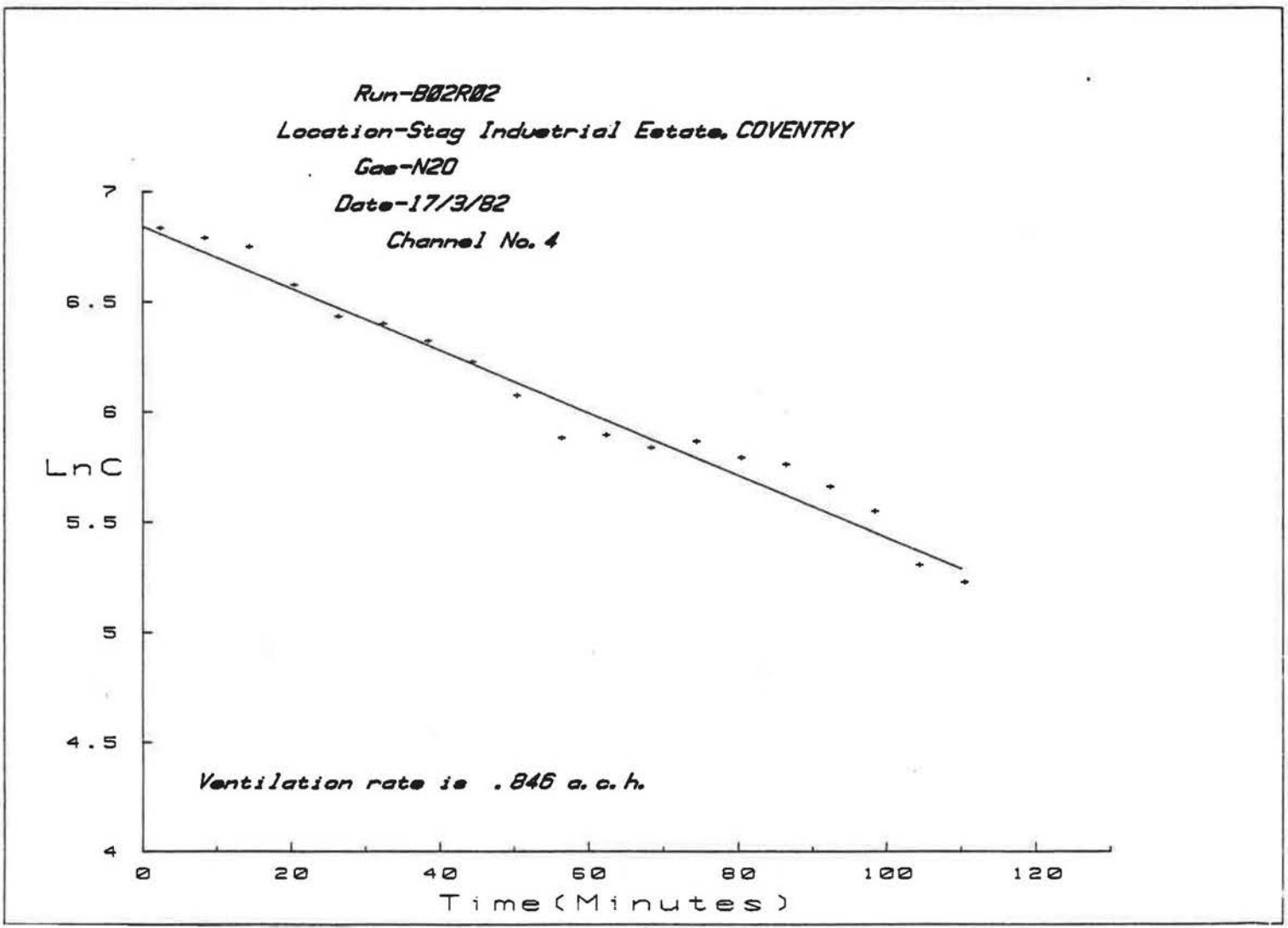
INTERCEPT= 6.78714653027
GRADIENT= -.014168108356

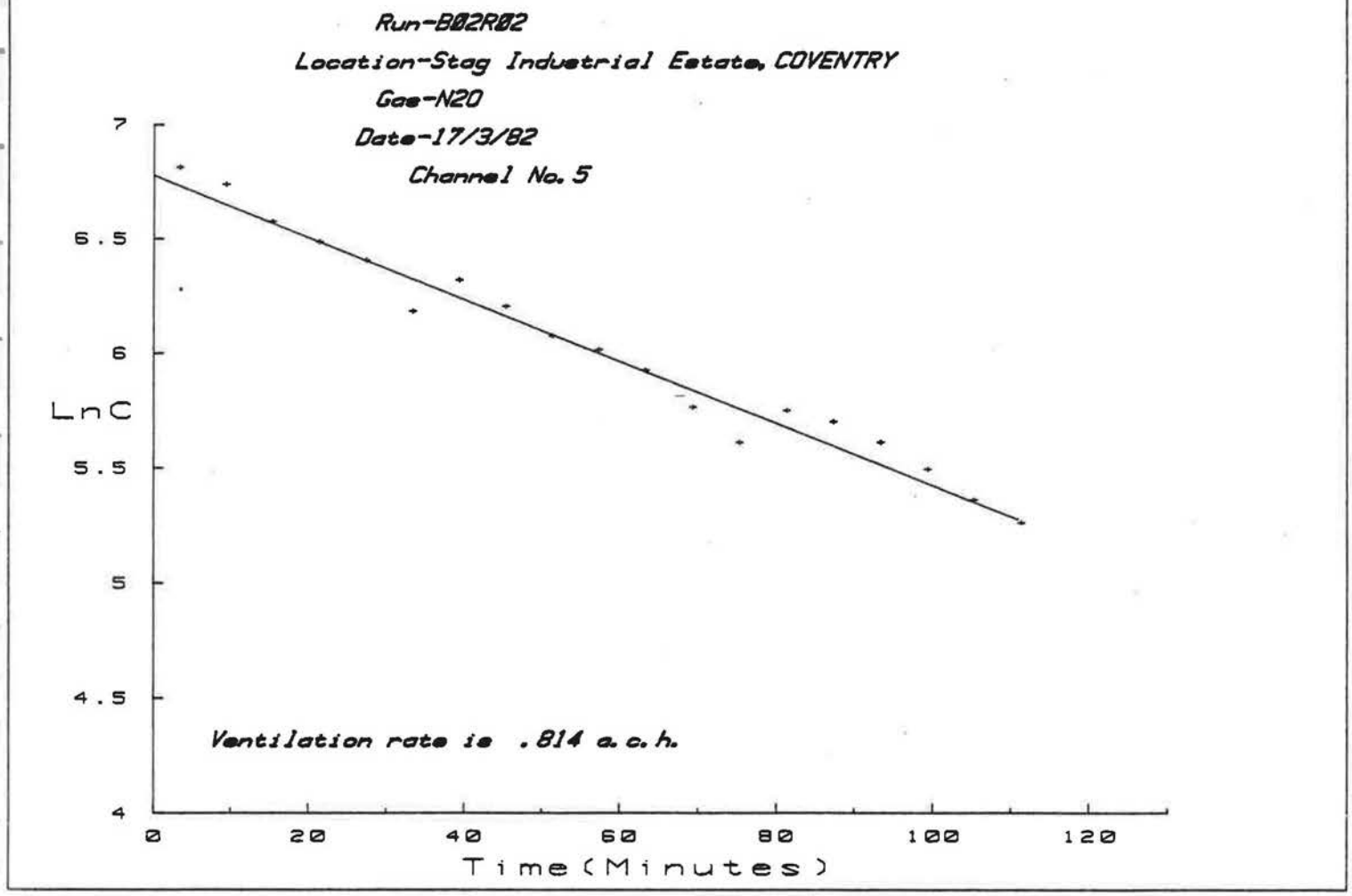
Ventilation rate is .850 air changes per hour


Run-B02R02
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82
Channel No. 1
7
6.5
6
5.5
5
4.5
4
LnC
Ventilation rate is .884 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)

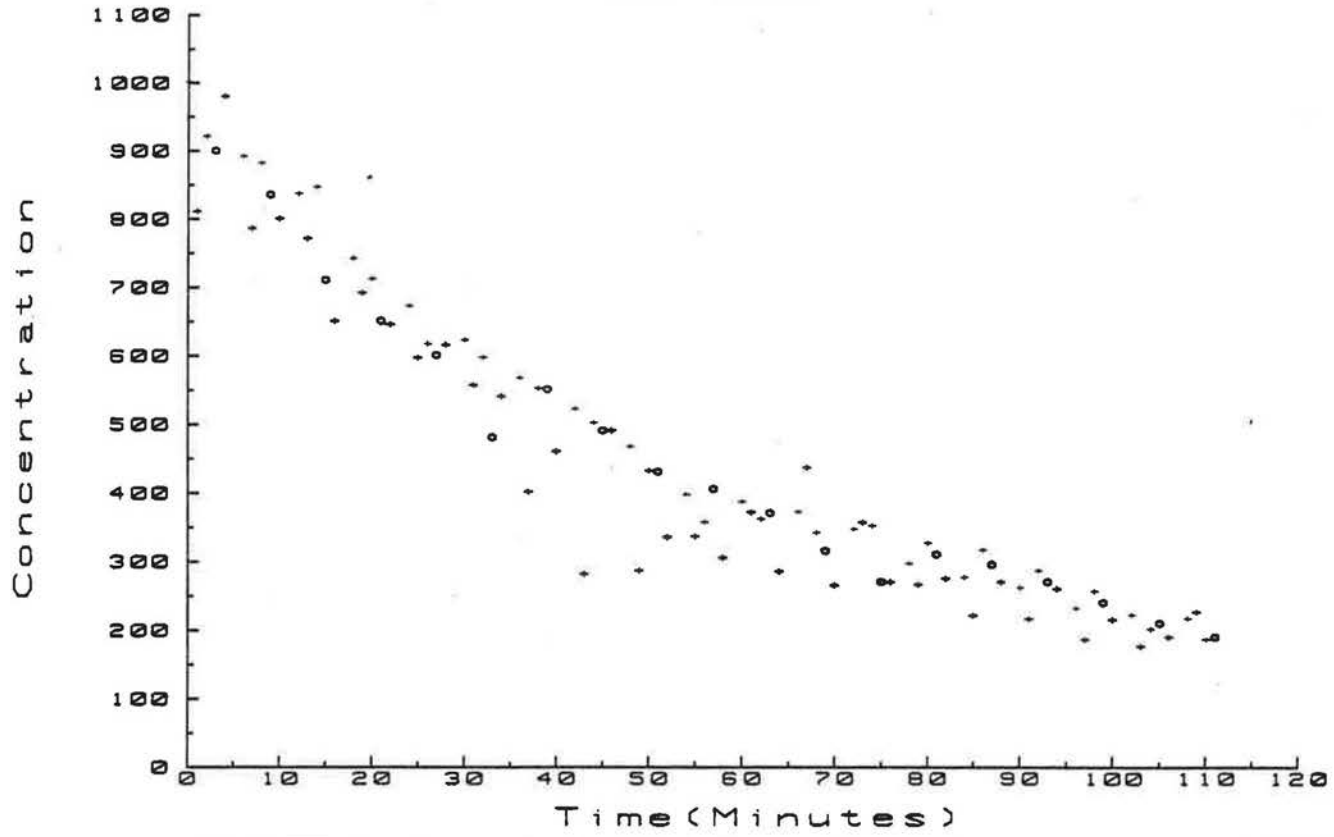

Run-B02R02
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82
Channel No. 2
7
6.5
6
5.5
5
4.5
4
LnC
Ventilation rate is .879 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)


Run-B02R02
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82
Channel No. 3
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is .836 a.c.h.

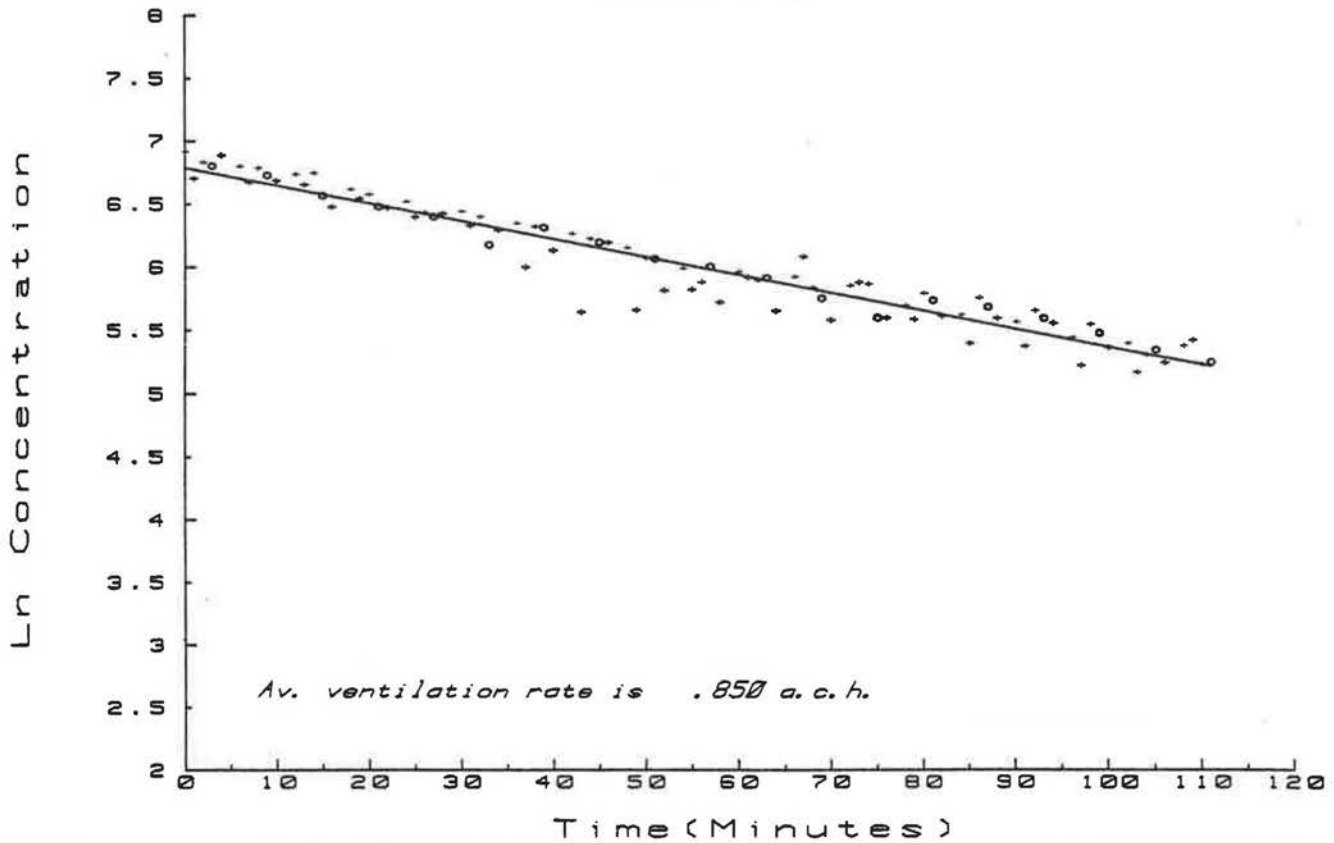

Run-B02R02
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82
Channel No. 4
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is .846 a.c.h.


Run-B02R02
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82
Channel No. 5
7
6.5
6
5.5
5
4.5
4
LnC
Ventilation rate is .814 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)

Run-B02R02
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82



Run-B02R02
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82



B02 R03

Date: 18th March, 1982

Time: 1040 hours to 1250 hours

Tracer Gas: Nitrous Oxide

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1100 hrs	6.7	6.9
1200 hrs	4.6	6.7
1300 hrs	4.1	7.2

Wind direction: west north west

Internal Conditions:

air velocity: 0.001 to 0.08 m/s
temperature: 7.5^{o}C

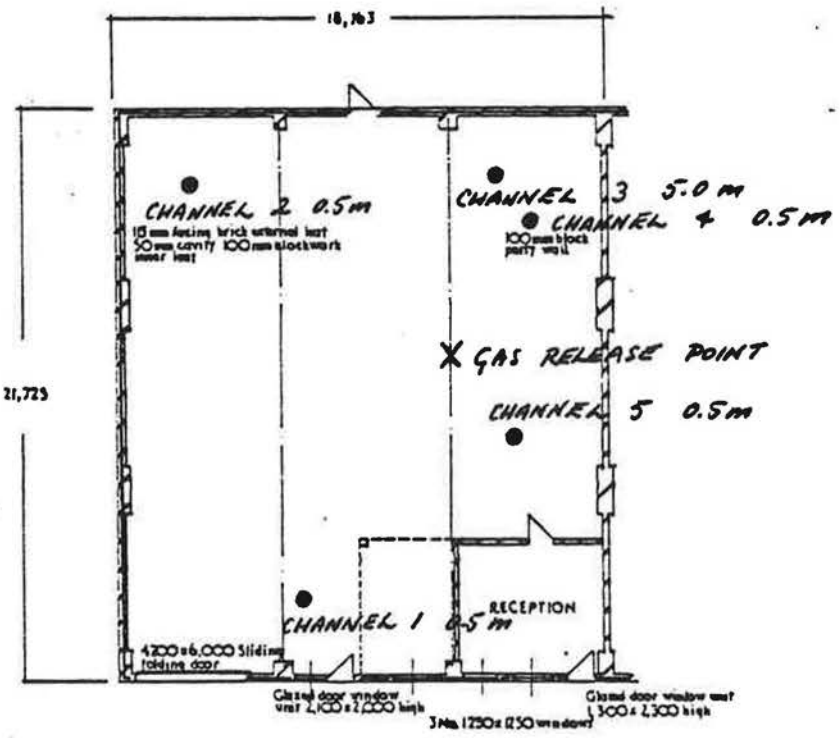
Gas Release:

Gas released into path of small fan at point shown on plan.

Sample Positions:

As shown on plan. Channel 6 positioned outside the building to monitor external air as a zero check.

Comment: This run occurred simultaneously with run B02 R05.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B02R03
Location: Stag Industrial Estate,COVENTRY
Date: 10/3/82
Tracer gas: N2O

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	4.0	760	6.633	0.0	795	6.678	1.0	865	6.763	2.0	860	6.757	3.0	820	6.709
2	10.0	685	6.529	6.0	805	6.691	7.0	800	6.685	8.0	805	6.691	9.0	740	6.607
3	16.0	675	6.515	12.0	770	6.646	13.0	760	6.633	14.0	755	6.627	15.0	720	6.579
4	22.0	650	6.477	18.0	725	6.586	19.0	715	6.572	20.0	720	6.579	21.0	685	6.529
5	28.0	610	6.413	24.0	700	6.551	25.0	690	6.537	26.0	705	6.558	27.0	665	6.500
6	34.0	465	6.142	30.0	610	6.413	31.0	580	6.363	32.0	645	6.469	33.0	600	6.397
7	40.0	460	6.131	36.0	560	6.328	37.0	560	6.328	38.0	610	6.413	39.0	565	6.337
8	46.0	415	6.028	42.0	525	6.263	43.0	490	6.194	44.0	585	6.372	45.0	490	6.194
9	52.0	350	5.858	48.0	470	6.153	49.0	425	6.052	50.0	545	6.301	51.0	505	6.225
10	58.0	340	5.829	54.0	450	6.109	55.0	395	5.979	56.0	520	6.254	57.0	475	6.163
11	64.0	280	5.635	60.0	440	6.087	61.0	315	5.753	62.0	455	6.120	63.0	425	6.052
12	70.0	290	5.670	66.0	430	6.064	67.0	240	5.481	68.0	415	6.028	69.0	390	5.966
13	76.0	280	5.635	72.0	350	5.858	73.0	245	5.501	74.0	385	5.953	75.0	370	5.914
14	82.0	240	5.481	78.0	295	5.687	79.0	240	5.481	80.0	330	5.799	81.0	335	5.814
15	88.0	220	5.394	84.0	275	5.617	85.0	205	5.323	86.0	300	5.704	87.0	300	5.704
16	94.0	185	5.220	90.0	250	5.521	91.0	195	5.273	92.0	295	5.687	93.0	310	5.737
17	100.0	195	5.273	96.0	250	5.521	97.0	170	5.136	98.0	285	5.652	99.0	235	5.460
18	106.0	195	5.273	102.0	215	5.371	103.0	135	4.905	104.0	240	5.481	105.0	225	5.416
19	112.0	135	4.905	108.0	160	5.075	109.0	170	5.136	110.0	210	5.347	111.0	205	5.323
20	118.0	165	5.106	114.0	190	5.247	115.0	180	5.193	116.0	195	5.273	117.0	170	5.136
21				120.0	165	5.106									

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	Df	SS	MS	F
Regression	1	5.239	5.239	740.417
Residual	18	.127	.007	
Total	19	5.366		

INTERCEPT= 6.70974867244
GRADIENT= -.01479292884

Ventilation rate is .868 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	Df	SS	MS	F
Regression	1	5.596	5.596	798.661
Residual	19	.133	.007	
Total	20	5.729		

INTERCEPT= 6.83220554107
GRADIENT= -1.42085495361E-02

Ventilation rate is .853 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	Df	SS	MS	F
Regression	1	6.887	6.887	455.588
Residual	18	.272	.015	
Total	19	7.159		

INTERCEPT= 6.84808381491
GRADIENT= -1.69609918459E-02

Ventilation rate is 1.018 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	Df	SS	MS	F
Regression	1	4.073	4.073	961.683
Residual	18	.076	.004	
Total	19	4.150		

INTERCEPT= 6.87290211544
GRADIENT= -1.30442683041E-02

Ventilation rate is .783 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	Df	SS	MS	F
Regression	1	4.039	4.039	761.795
Residual	18	.095	.005	
Total	19	4.135		

INTERCEPT= 6.81743502747
GRADIENT= -1.29896136429E-02

Ventilation rate is .779 air changes per hour

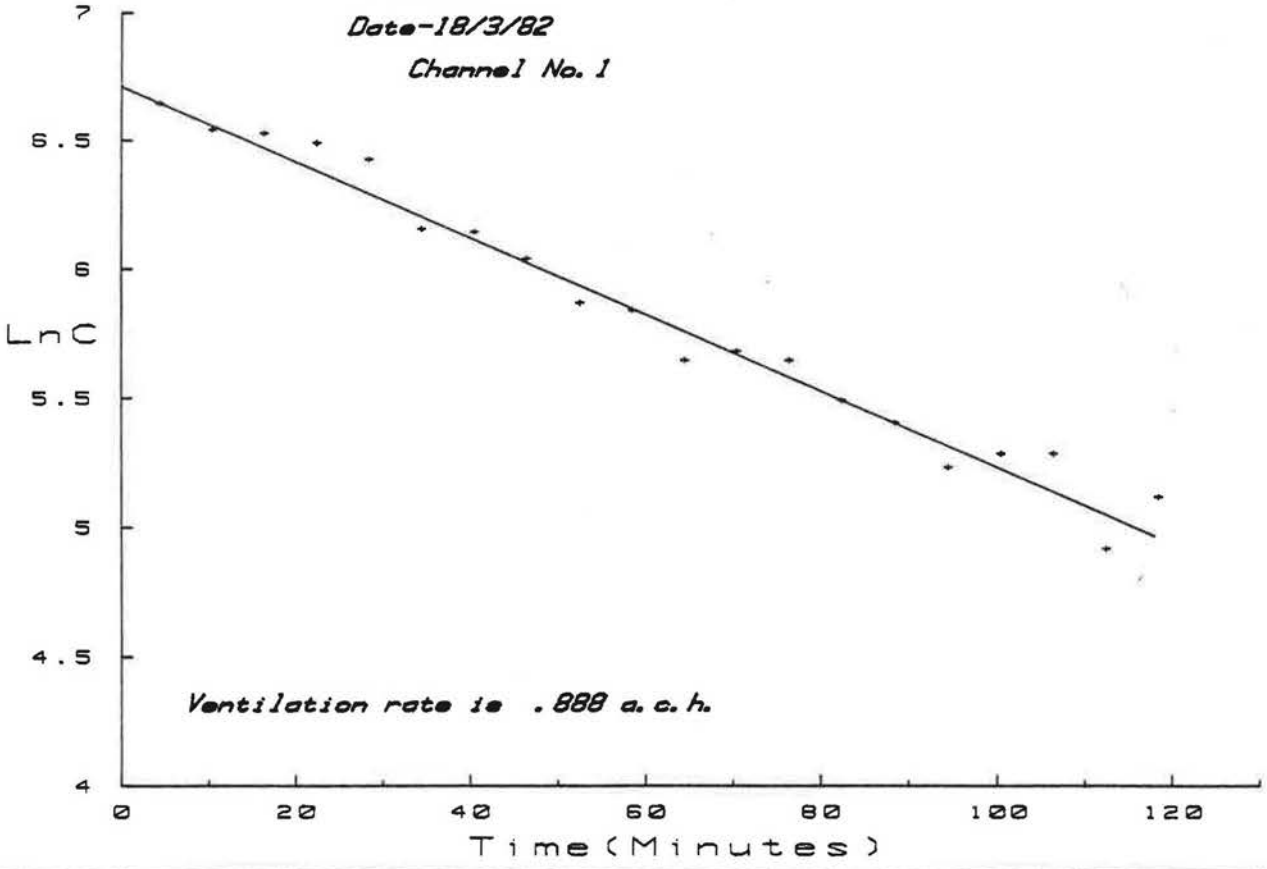
STATISTICAL ANALYSIS - ALL CHANNELS

Source	Df	SS	MS	F
Regression	1	25.622	25.622	1203.926
Residual	99	2.107	.021	
Total	100	27.728		

INTERCEPT= 6.81697815285
GRADIENT= -1.43986334188E-02

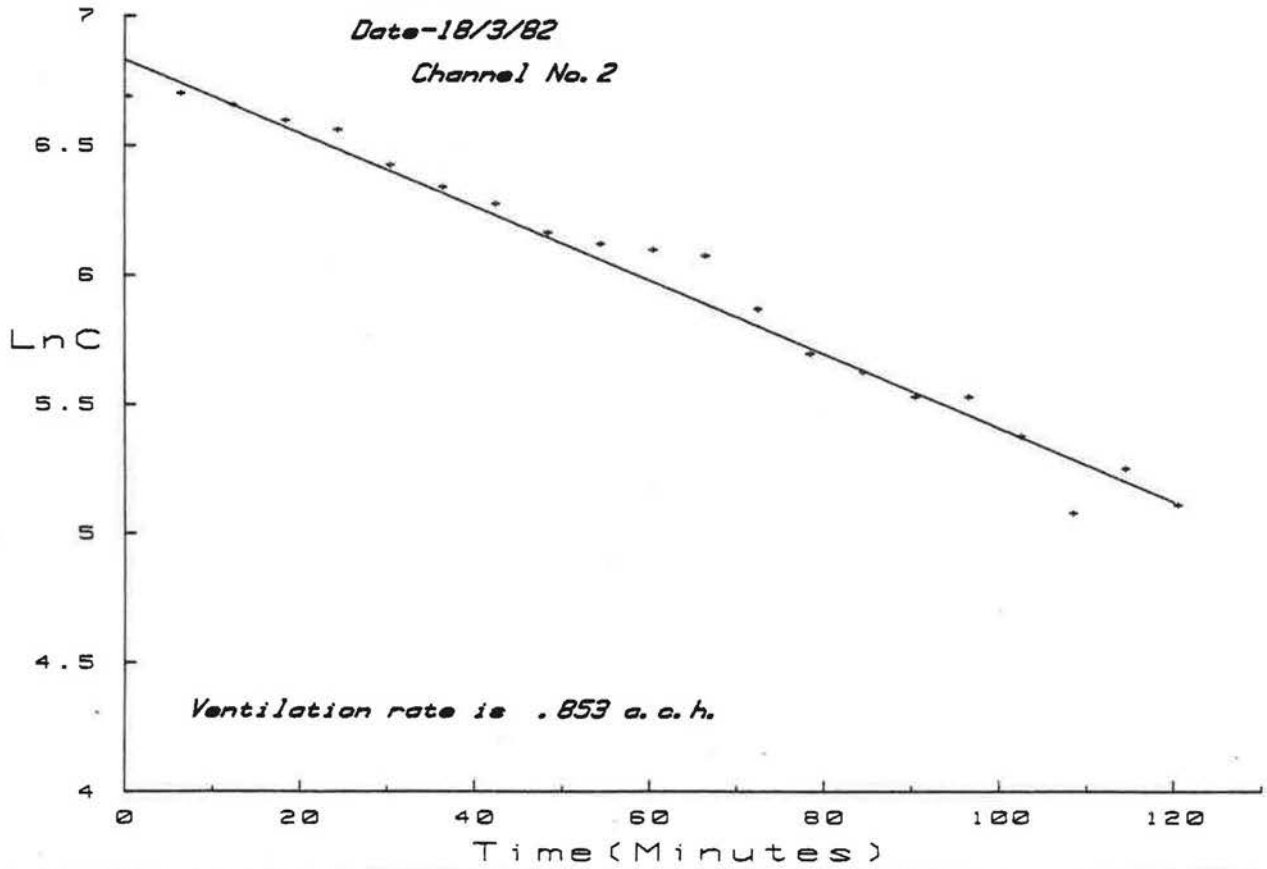
Ventilation rate is .864 air changes per hour

Run-B02R03
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-18/3/82
Channel No. 1

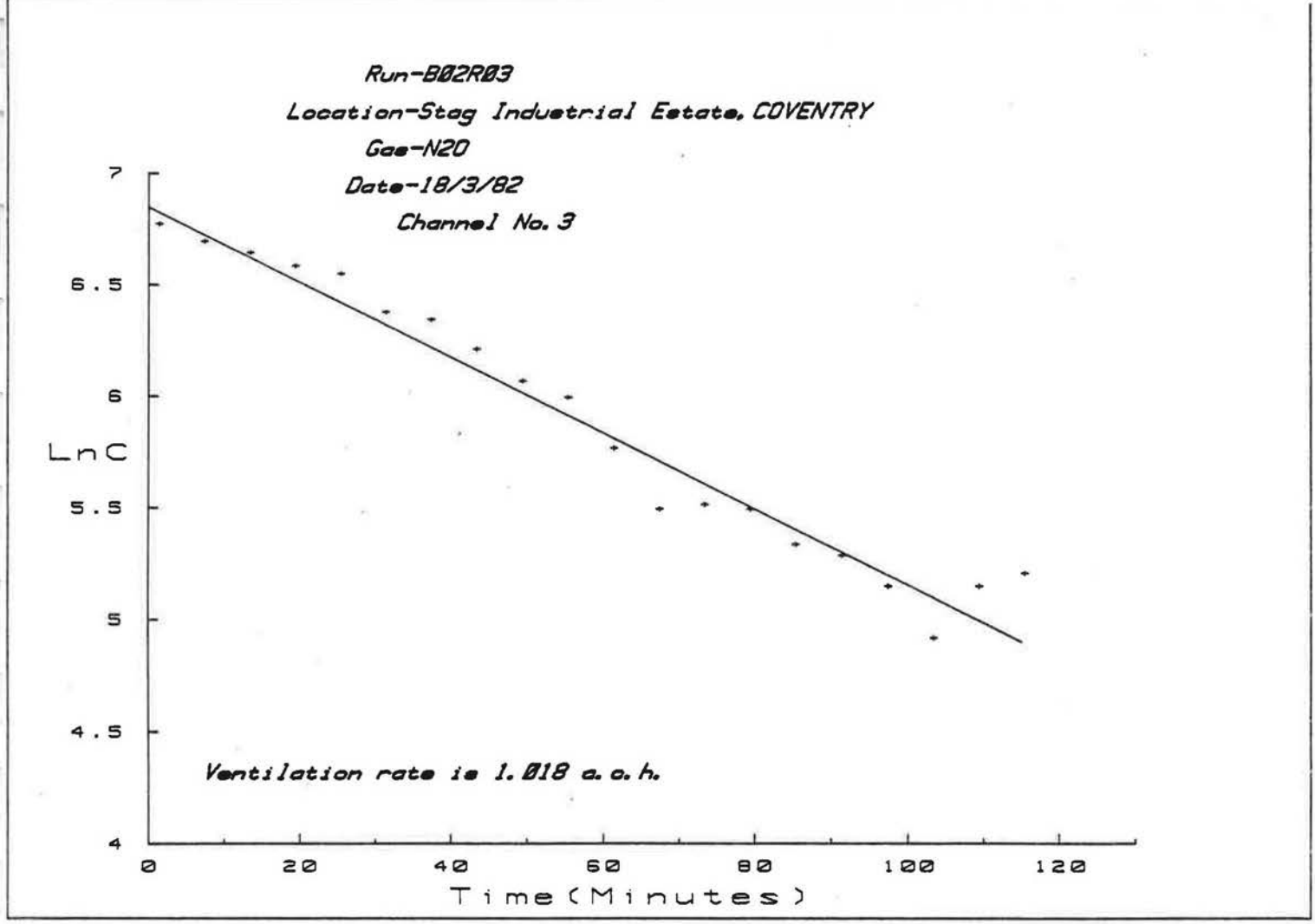


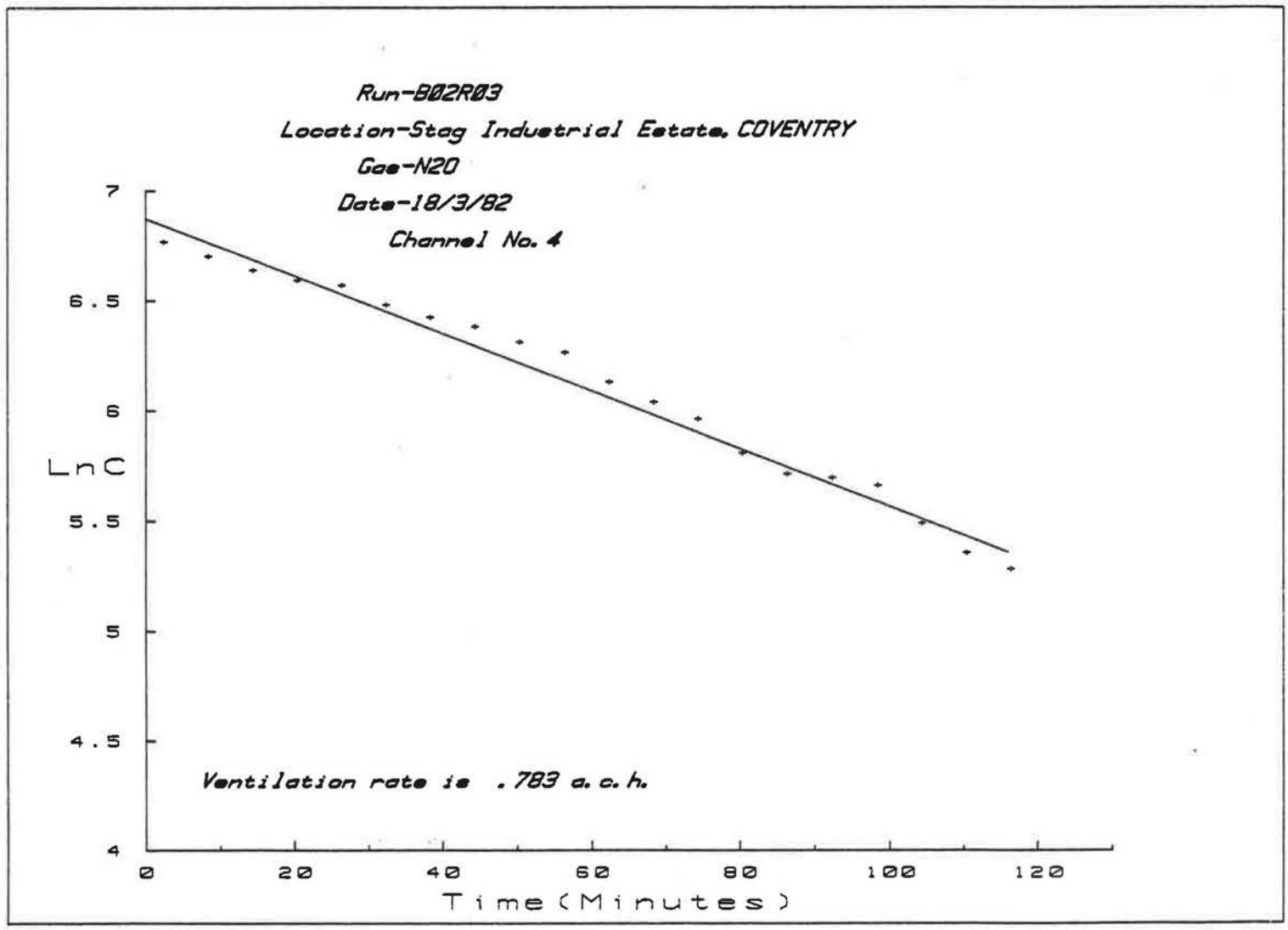
Ventilation rate is .888 a.c.h.

Run-B02R03
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-18/3/82
Channel No. 2



Ventilation rate is .853 a.c.h.


Run-B02R03
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-18/3/82
Channel No. 3
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is 1.018 a.c.h.


Run-B02R03
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-18/3/82
Channel No. 4
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is .783 a.c.h.

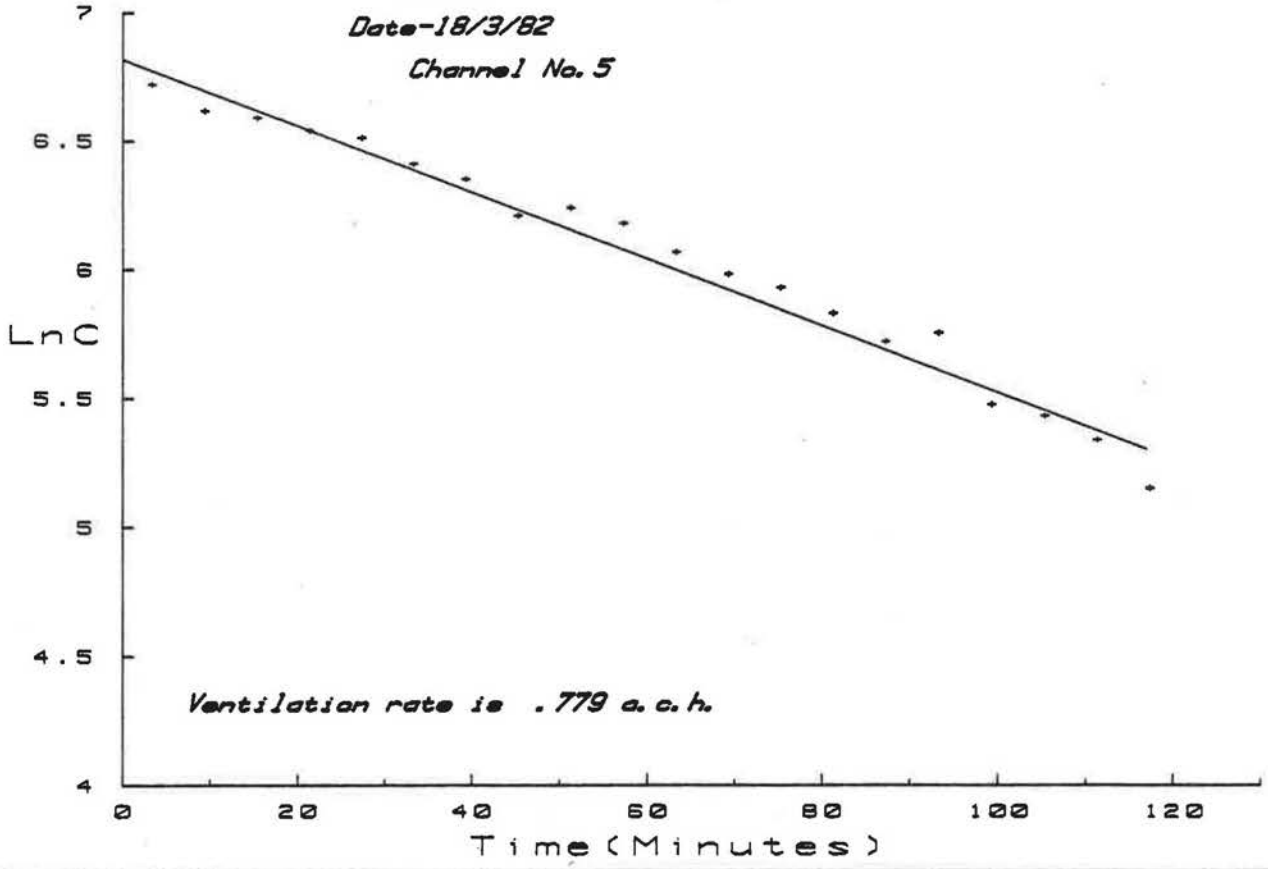
Run-B02R03

Location-Stag Industrial Estate, COVENTRY

Gas-N20

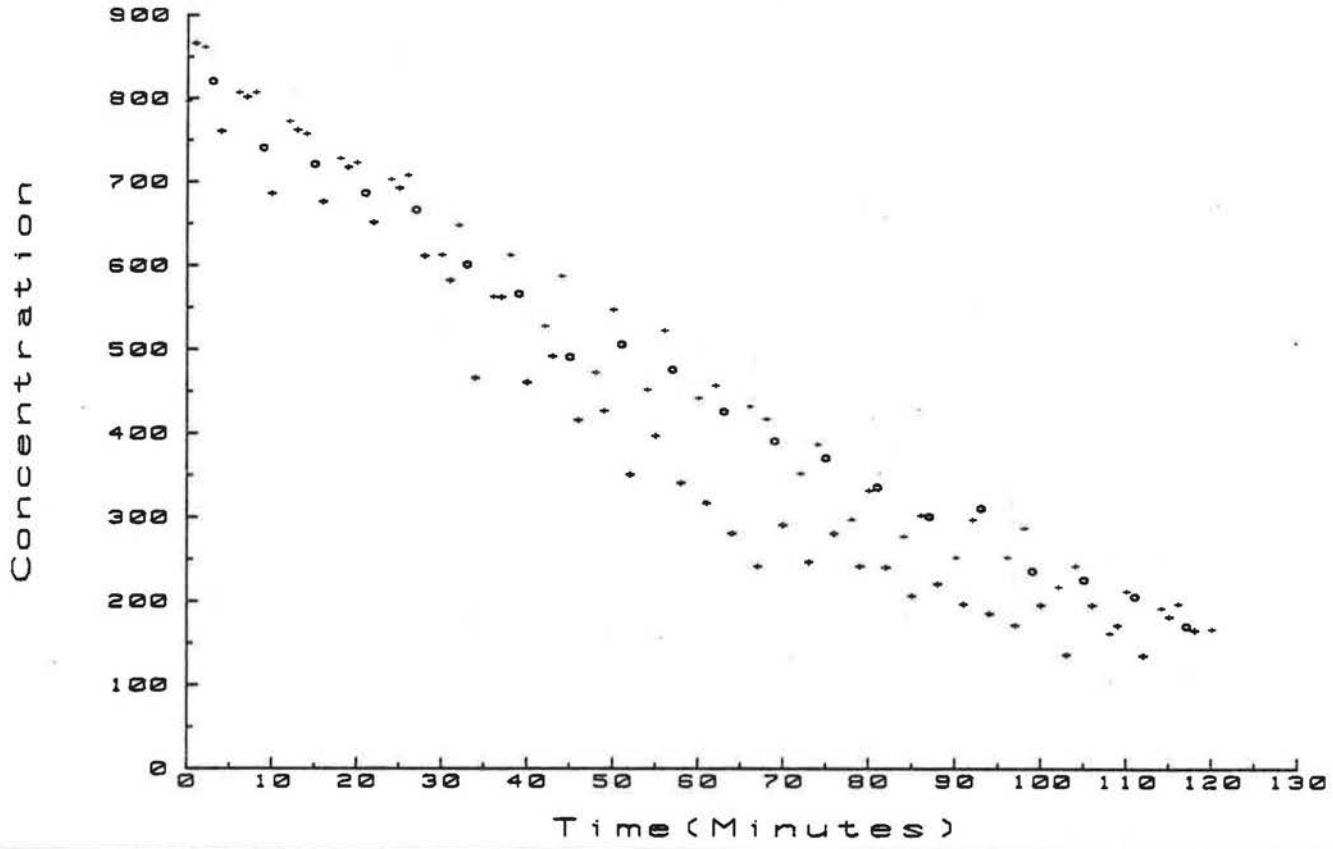
Date-18/3/82

Channel No. 5

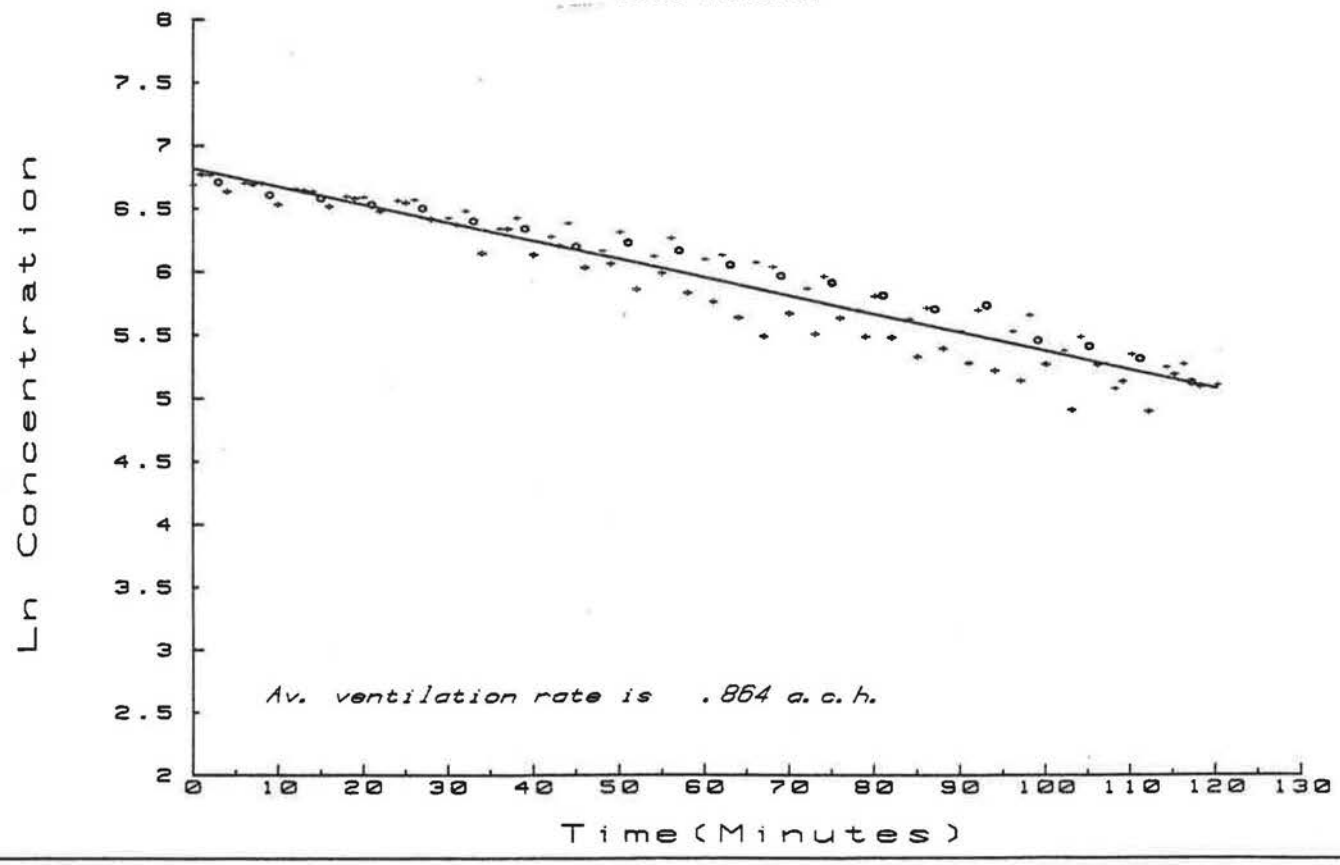


Ventilation rate is .779 a.c.h.

Run-B02R03
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-18/3/82



Run-B02R03
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-18/3/82



BO2 RO4

Date: 17th March, 1982

Time: 1430 hours to 1605 hours

Tracer Gas: Sulphur Hexaflouride

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1400 hrs	6.2	6.8
1500 hrs	4.6	7.2
1600 hrs	8.8	7.9

Wind direction: west north west

Internal conditions:

air velocity: 0.01 to 0.06 m/s
temperature: 7.5 to 8.5^{o}C

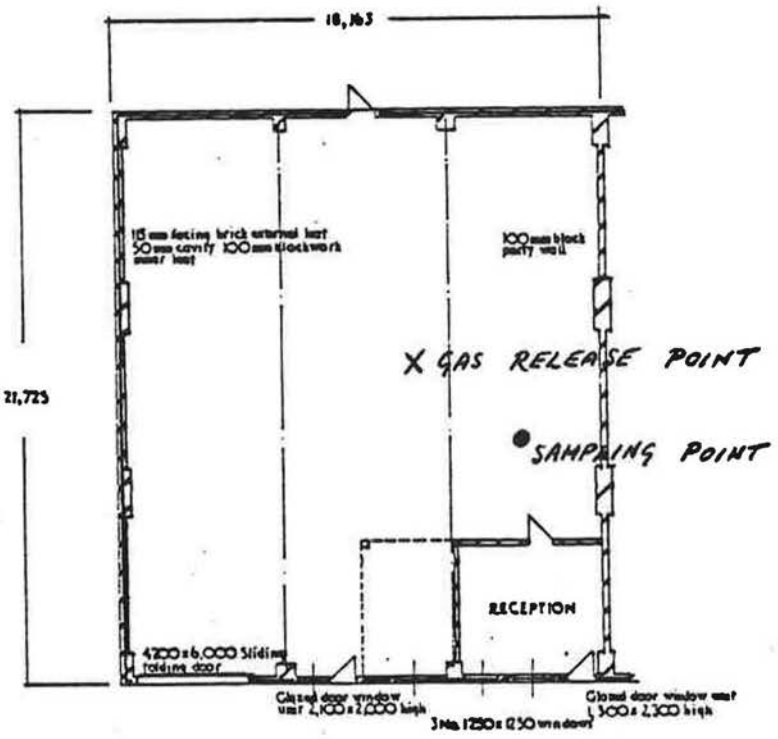
Gas Release:

Gas released into the path of a small fan at point shown on plan.

Sample Positions:

As shown on plan.

Comment: This run occurred simultaneously with run BO2 RO2.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B02R04
Location: Stag Industrial Estate,COVENTRY
Date: 17/3/82
Tracer gas: SF6

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt. ****	Channel 1 ********** T	C	LnC
1	1.5	800	6.685
2	4.4	640	6.461
3	7.4	440	6.087
4	10.0	480	6.174
5	12.9	530	6.273
6	16.0	550	6.310
7	19.3	475	6.163
8	22.0	450	6.109
9	25.1	450	6.109
10	28.1	415	6.028
11	31.1	410	6.016
12	34.0	400	5.991
13	37.0	395	5.979
14	40.0	395	5.979
15	43.0	390	5.966
16	46.0	380	5.940
17	49.0	380	5.940
18	52.0	355	5.872
19	55.1	350	5.858
20	58.1	355	5.872
21	61.1	335	5.814
22	64.2	325	5.784
23	67.1	335	5.814
24	70.2	310	5.737
25	73.0	305	5.720
26	79.0	295	5.687
27	82.0	300	5.704
28	88.0	290	5.670
29	91.0	265	5.580

STATISTICAL ANALYSIS FOR CHANNEL 1
********** ******** *** **********

Source	Df	SS	MS	F
******	**	*****	*****	*******
Regression	1	1.485	1.485	168.494
Residual	27	.238	.009	
Total	28	1.723		

INTERCEPT= 6.35664060834
GRADIENT= -8.69332835278E-03

Ventilation rate is .522 air changes per hour

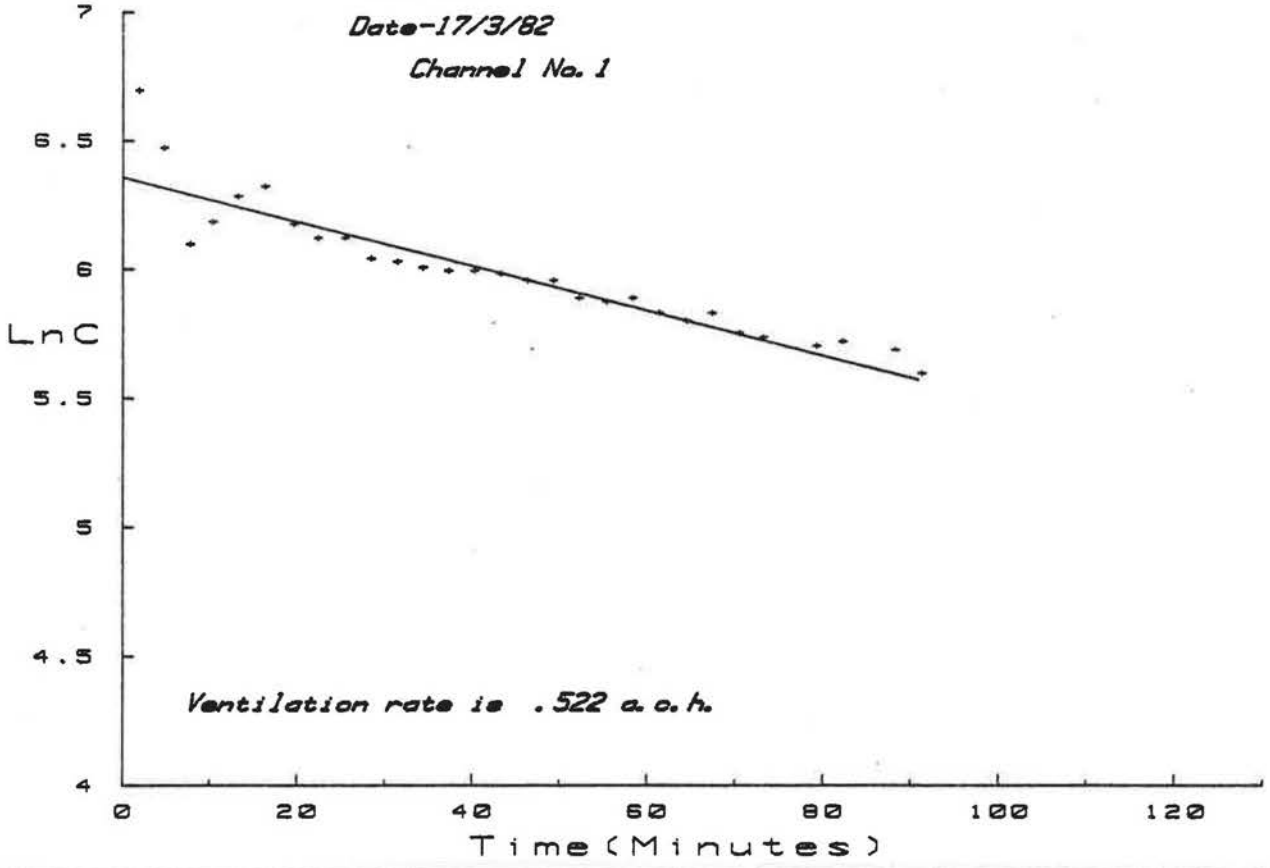
Run-B02R04

Location-Stag Industrial Estate, COVENTRY

Gas-SF6

Date-17/3/82

Channel No. 1



B02 R05

Date: 18th March, 1983.

Time: 1100 hours to 1230 hours

Tracer Gas: Sulphur Hexaflouride

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1100 hrs	6.7	6.9
1200 hrs	4.6	6.7
1300 hrs	4.11	7.2

Wind direction: west north west

Internal Conditions:

air velocity	0 to 0.08 m/s
temperature	7.5^{o}C

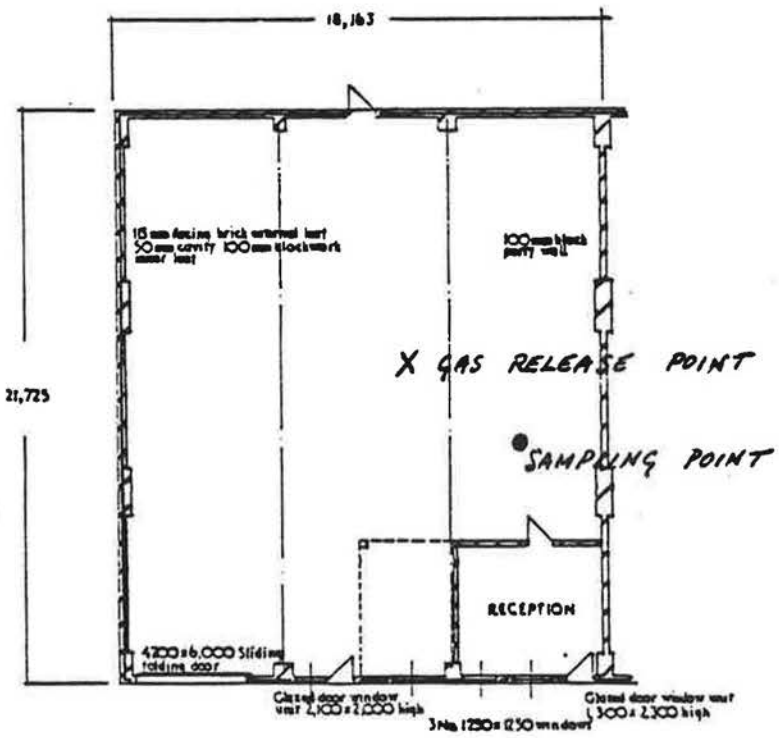
Gas Release:

Gas released into the path of a small fan at point shown on plan.

Sample Position:

As shown on plan.

Comment: This run occurred simultaneously with run B02 R03.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B02R05
Location: Stag Industrial Estate,COVENTRY
Date: 18/3/82
Tracer gas: SF6

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

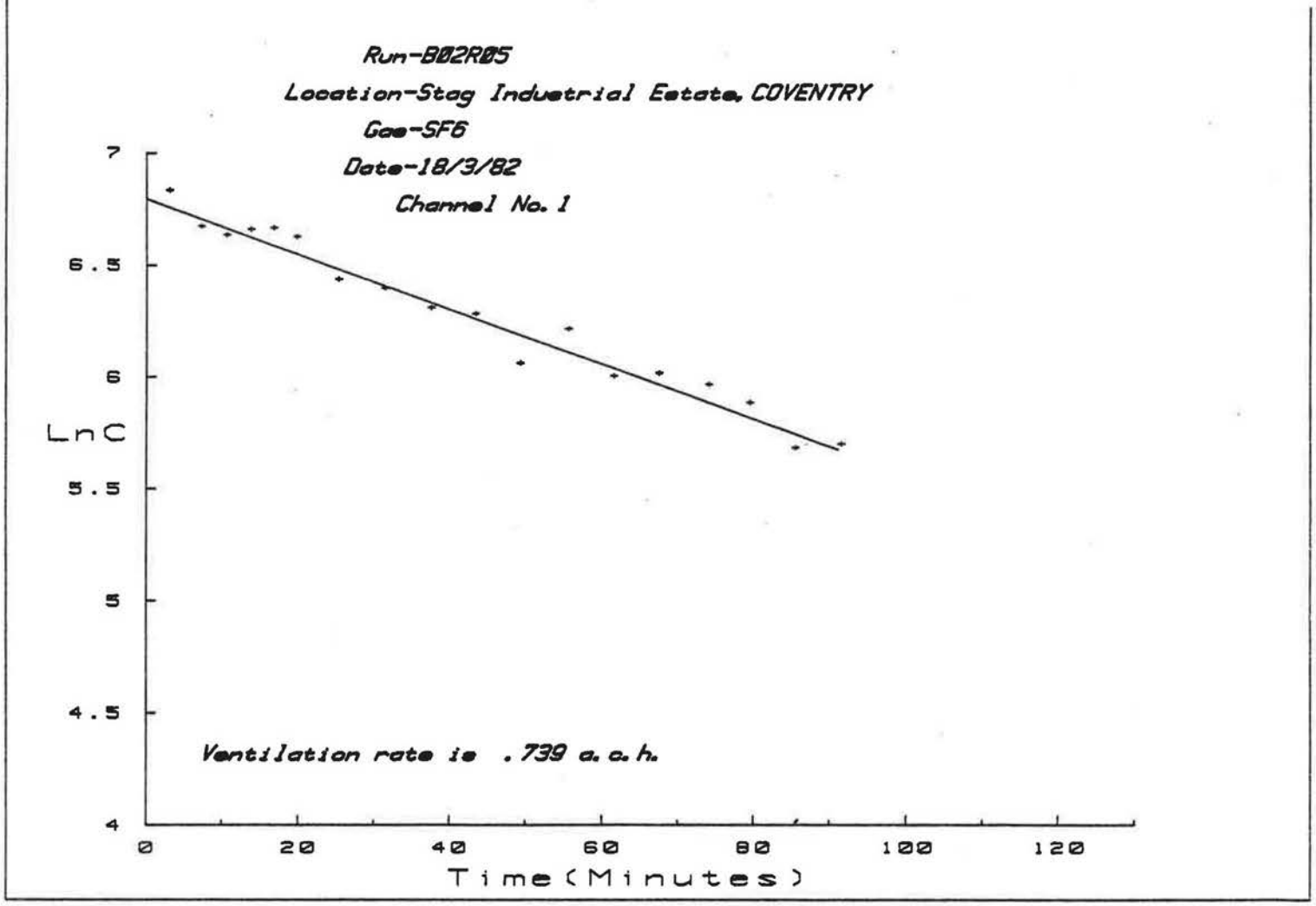
Data Pt.	Channel 1		
****	**********		
	T	C	LnC
1	2.7	920	6.824
2	6.9	784	6.664
3	10.2	755	6.627
4	13.4	775	6.653
5	16.4	780	6.659
6	19.4	750	6.620
7	24.9	620	6.430
8	31.1	595	6.389
9	37.2	545	6.301
10	43.1	530	6.273
11	49.0	425	6.052
12	55.3	495	6.205
13	61.2	400	5.991
14	67.2	405	6.004
15	73.8	385	5.953
16	79.2	355	5.872
17	85.2	290	5.670
18	91.2	295	5.687

STATISTICAL ANALYSIS FOR CHANNEL 1
********** ******** *** **********

Source	DF	SS	MS	F
******	**	*****	*****	*******
Regression	1	2.143	2.143	512.625
Residual	16	.067	.004	
Total	17	2.210		

INTERCEPT= 6.79618795154
GRADIENT= -1.23240720612E-02

Ventilation rate is .739 air changes per hour


Run-B02R05
Location-Stag Industrial Estate, COVENTRY
Gas-SF6
Date-18/3/82
Channel No. 1
7
6.5
6
5.5
5
4.5
4
LnC
Ventilation rate is .739 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)

B02 R06

Date: 17th March, 1982.

Time: 1110 hours to 1340 hours

Tracer Gas: Nitrous Oxide

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1100 hrs	5.1	7.3
1200 hrs	7.2	7.5
1300 hrs	4.6	6.8
1400 hrs	6.2	6.8

Wind Direction: west

Internal Conditions:

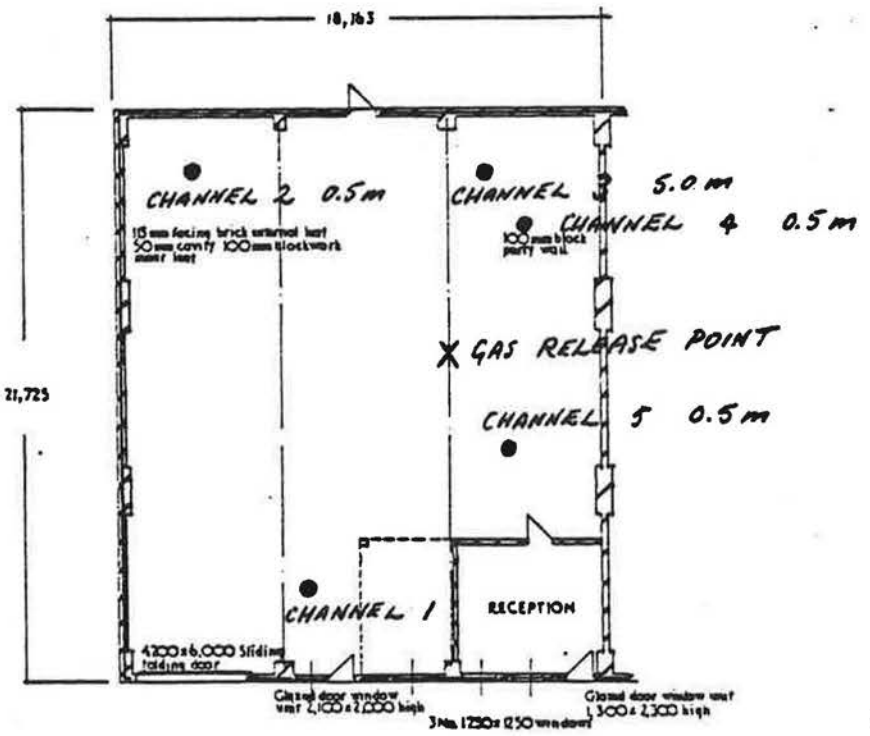
air velocity: 0.01 to 0.06 m/s
temperature: 7.5 to 8.5^{o}C

Gas Release:

Gas released into path of small fan at point shown on plan.

Sample Positions:

As shown on plan. Channel 6 positioned outside the building to monitor external air as a zero check.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B02R06
Location: Stag Industrial Estate, COVENTRY
Date: 17/3/82
Tracer gas: N2O

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt. ****	Channel 1 **********			Channel 2 **********			Channel 3 **********			Channel 4 **********			Channel 5 **********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	0.0	915	6.819	2.0	873	6.772	3.0	602	6.400	4.0	895	6.797	5.0	903	6.806
2	6.0	827	6.718	8.0	708	6.562	9.0	617	6.425	10.0	865	6.763	11.0	698	6.548
3	12.0	612	6.417	14.0	648	6.474	15.0	717	6.575	16.0	795	6.678	17.0	783	6.663
4	18.0	597	6.392	20.0	733	6.597	21.0	482	6.178	22.0	710	6.565	23.0	708	6.562
5	24.0	667	6.503	26.0	627	6.441	27.0	498	6.211	28.0	660	6.492	29.0	672	6.510
6	30.0	623	6.435	32.0	590	6.380	33.0	455	6.120	34.0	630	6.446	35.0	650	6.477
7	36.0	565	6.337	38.0	492	6.198	39.0	413	6.023	40.0	605	6.405	41.0	582	6.366
8	42.0	573	6.351	44.0	482	6.178	45.0	438	6.082	46.0	580	6.363	47.0	487	6.188
9	48.0	468	6.148	50.0	412	6.021	51.0	563	6.333	52.0	560	6.328	53.0	557	6.323
10	54.0	468	6.148	56.0	432	6.068	57.0	428	6.059	58.0	525	6.263	59.0	537	6.286
11	60.0	428	6.059	62.0	328	5.793	63.0	535	6.282	64.0	458	6.127	65.0	380	5.940
12	66.0	343	5.838	68.0	353	5.866	69.0	205	5.323	70.0	423	6.047	71.0	390	5.966
13	72.0	278	5.628	74.0	378	5.935	75.0	200	5.298	76.0	378	5.935	77.0	340	5.829
14	78.0	238	5.472	80.0	328	5.793	81.0	250	5.521	82.0	303	5.714	83.0	280	5.635
15	84.0	238	5.472	86.0	284	5.649	87.0	223	5.407	88.0	273	5.609	89.0	187	5.231
16	90.0	196	5.278	92.0	278	5.628	93.0	212	5.357	94.0	230	5.438	95.0	203	5.313
17	96.0	152	5.024	98.0	233	5.451	99.0	187	5.231	100.0	195	5.273	101.0	183	5.209
18	102.0	152	5.024	104.0	219	5.389	105.0	168	5.124	106.0	188	5.236	107.0	177	5.176
19	108.0	141	4.949	110.0	194	5.268	111.0	158	5.063	112.0	178	5.182	113.0	142	4.956
20	114.0	120	4.787	116.0	170	5.136	117.0	140	4.942	118.0	155	5.043	119.0	120	4.787
21	120.0	110	4.700	122.0	149	5.004	123.0	133	4.890	124.0	133	4.890	125.0	127	4.844
22	126.0	96	4.564												

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	Df	SS	MS	F
Regression	1	10.257	10.257	589.697
Residual	20	.348	.017	
Total	21	10.605		

INTERCEPT= 6.90568407151
GRADIENT= -1.79377451791E-02

Ventilation rate is 1.076 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	Df	SS	MS	F
Regression	1	5.001	5.001	708.489
Residual	19	.134	.007	
Total	20	5.135		

INTERCEPT= 6.76627851211
GRADIENT= -1.34314853719E-02

Ventilation rate is .806 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	Df	SS	MS	F
Regression	1	5.415	5.415	125.974
Residual	19	.817	.043	
Total	20	6.232		

INTERCEPT= 6.6351164551
GRADIENT= -1.39772184989E-02

Ventilation rate is .839 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	Df	SS	MS	F
Regression	1	7.169	7.169	583.843
Residual	19	.233	.012	
Total	20	7.403		

INTERCEPT= 7.01002363415
GRADIENT= -1.60821175299E-02

Ventilation rate is .965 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	Df	SS	MS	F
Regression	1	8.303	8.303	388.046
Residual	19	.407	.021	
Total	20	8.709		

INTERCEPT= 7.01148411472
GRADIENT= -1.73066738265E-02

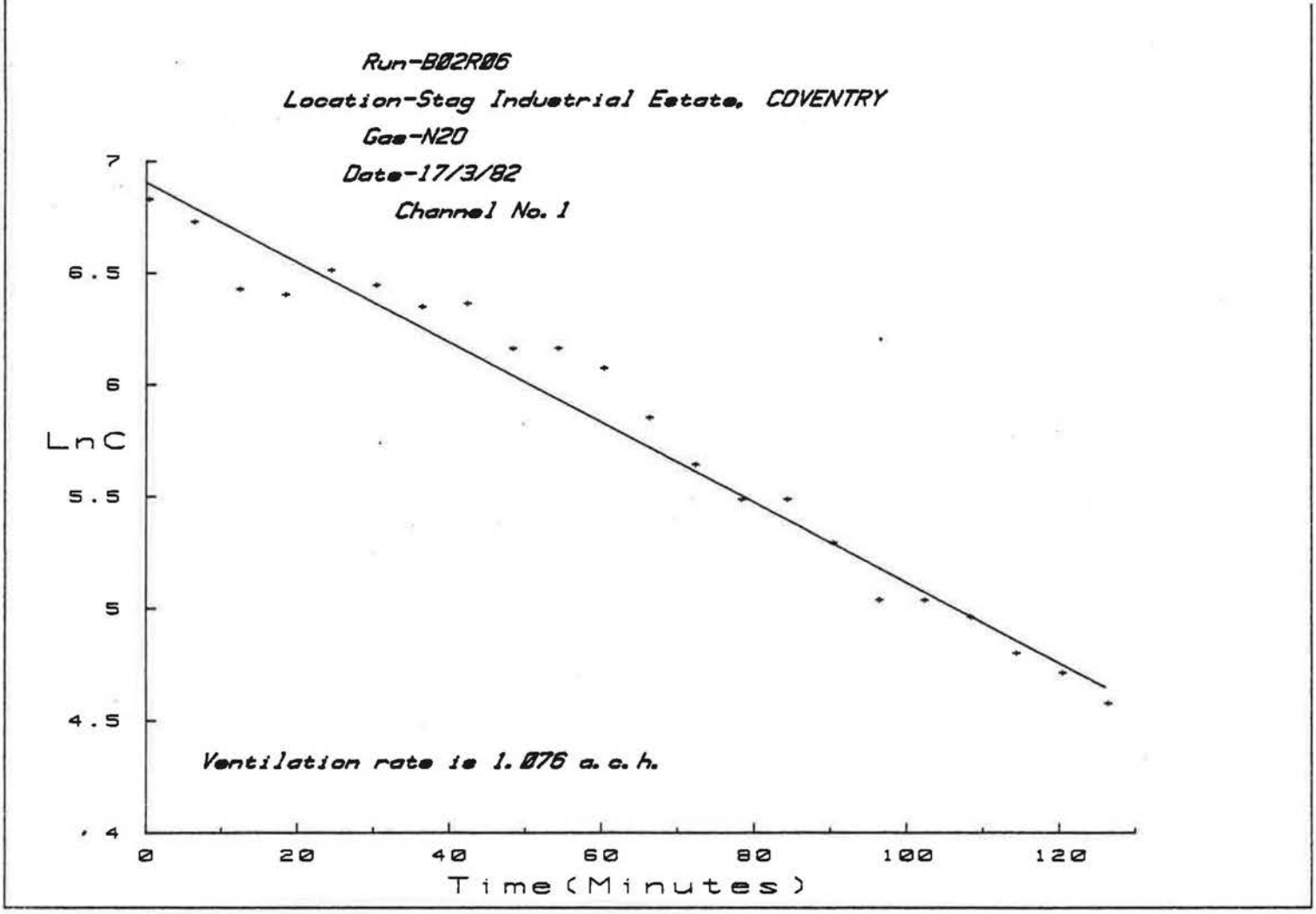
Ventilation rate is 1.038 air changes per hour

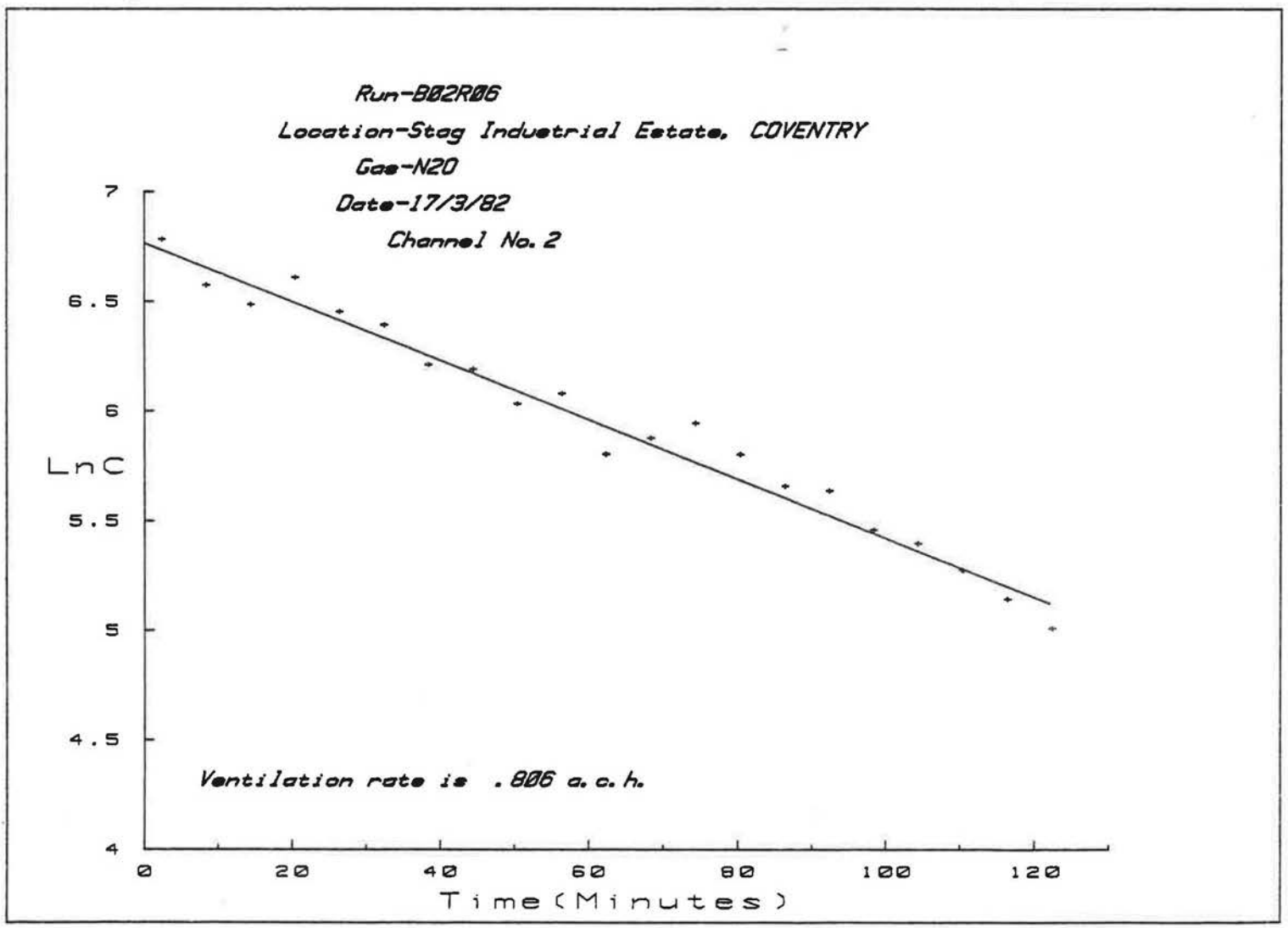
STATISTICAL ANALYSIS - ALL CHANNELS

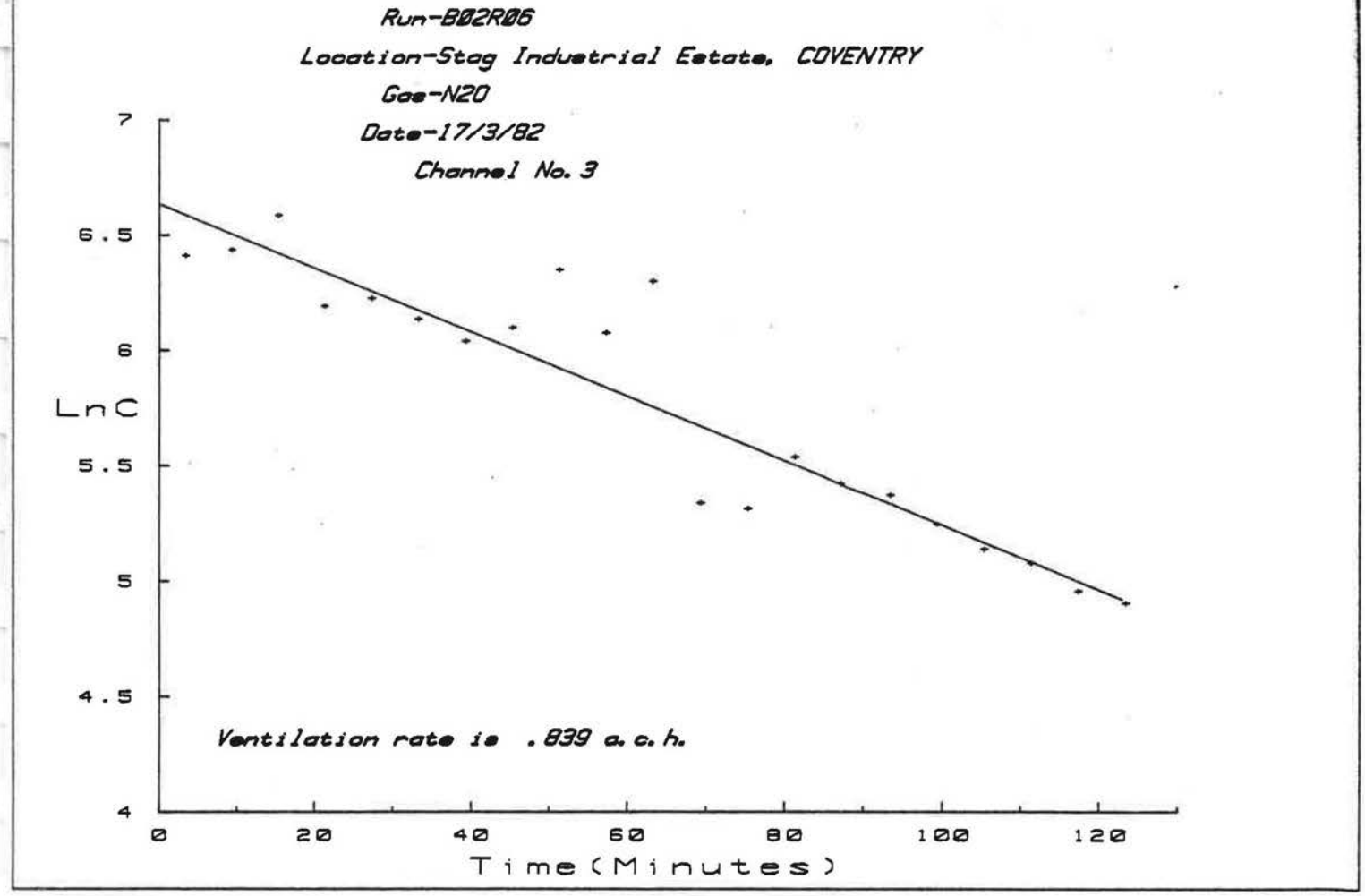
Source	Df	SS	MS	F
Regression	1	35.600	35.600	1120.054
Residual				
104 MDD				
	3.306	.032		
Total	105	38.906		

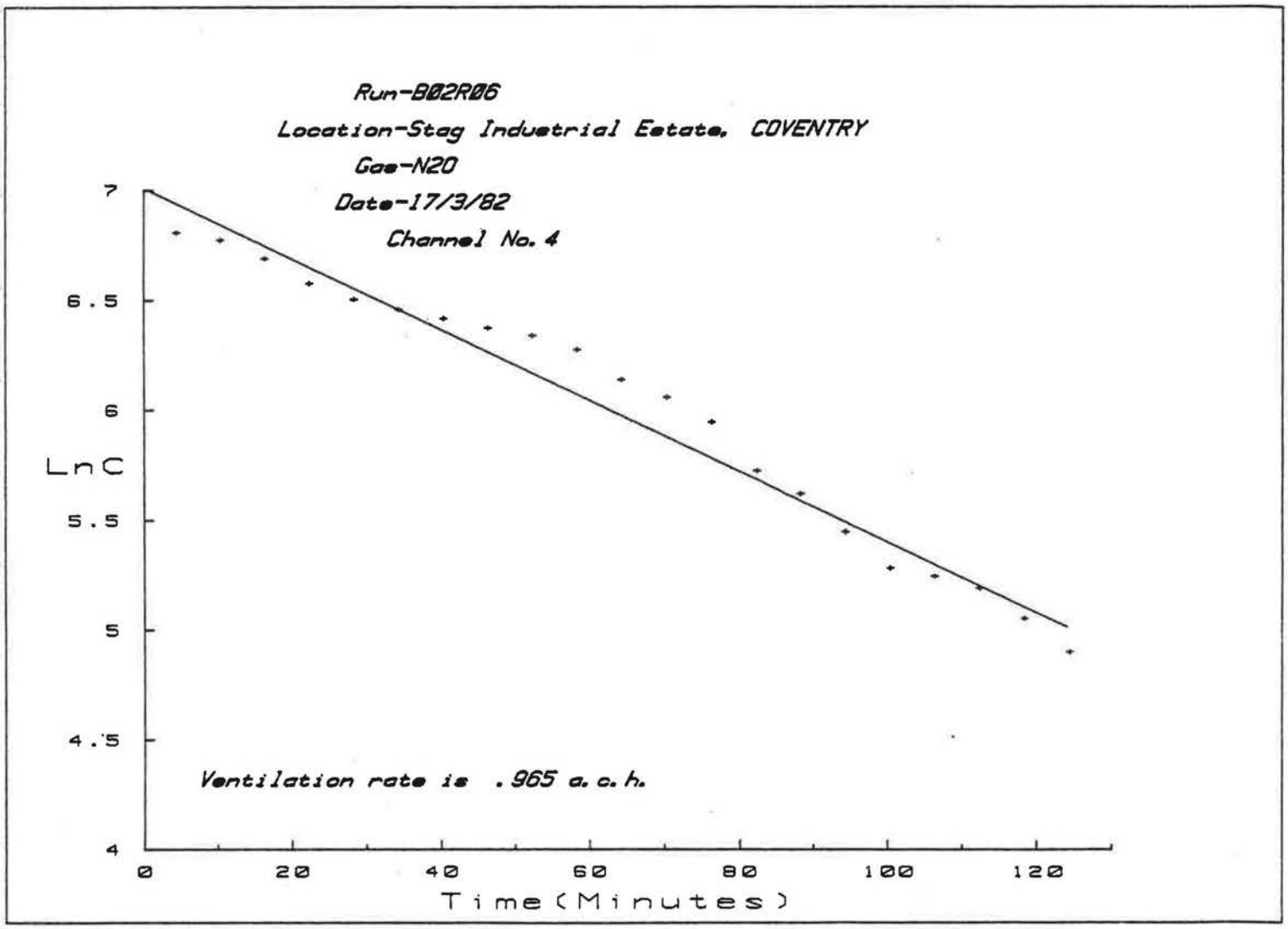
INTERCEPT= 6.86609173001
GRADIENT= -1.57655746051E-02

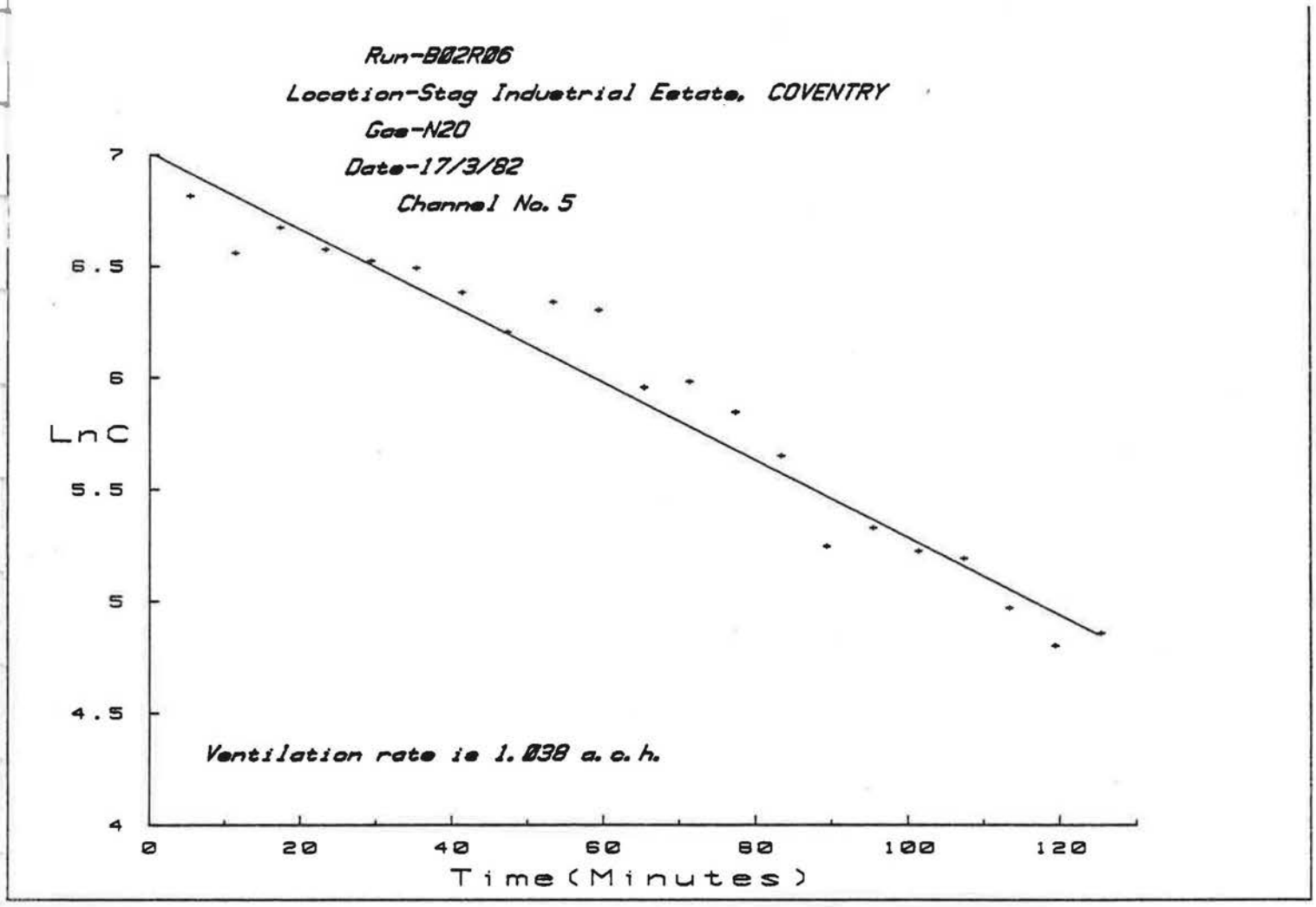
Ventilation rate is .947 air changes per hour


Run-B02R06
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82
Channel No. 1
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is 1.076 a.c.h.

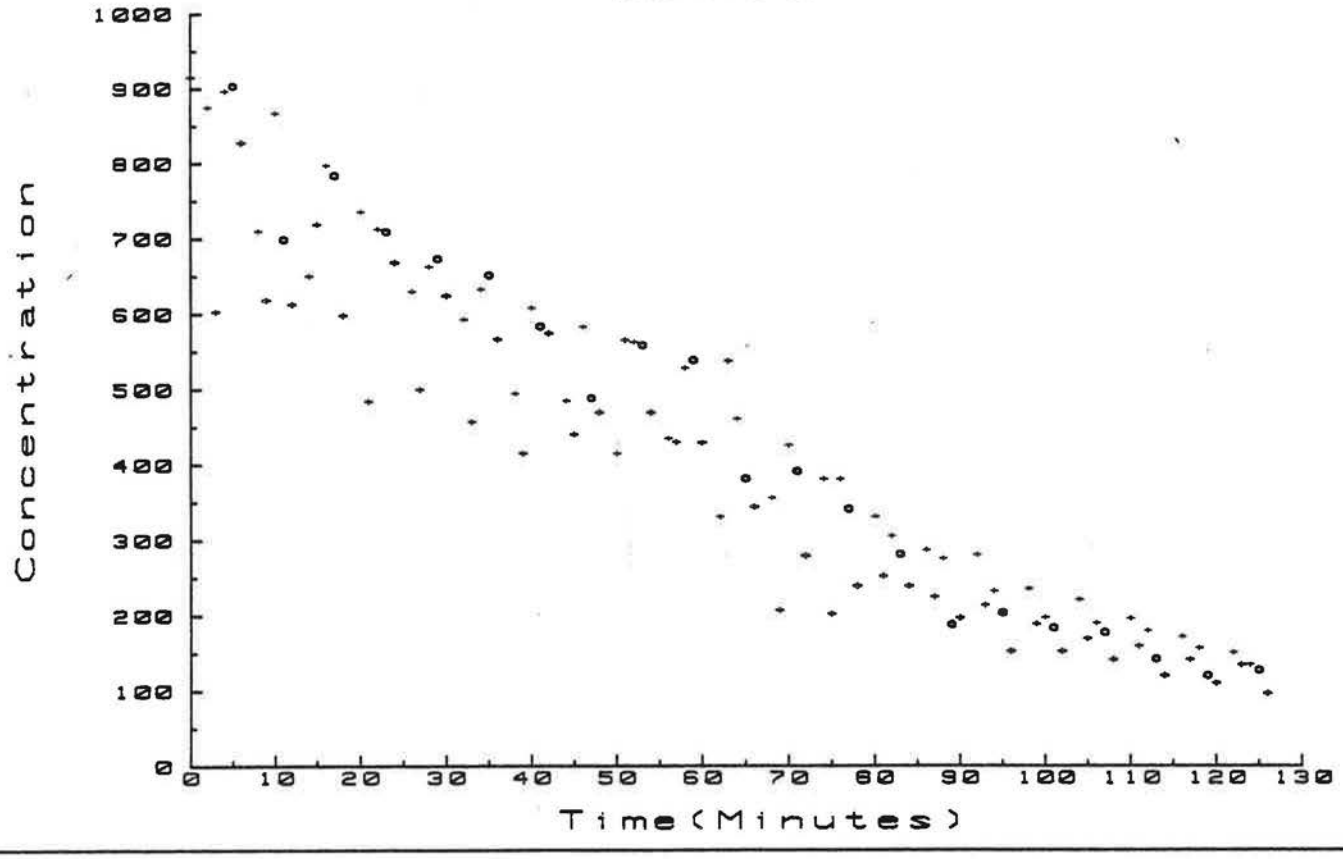

Run-B02R06
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82
Channel No. 2
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is .806 a.c.h.


Run-B02R06
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82
Channel No. 3
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is .839 a.c.h.

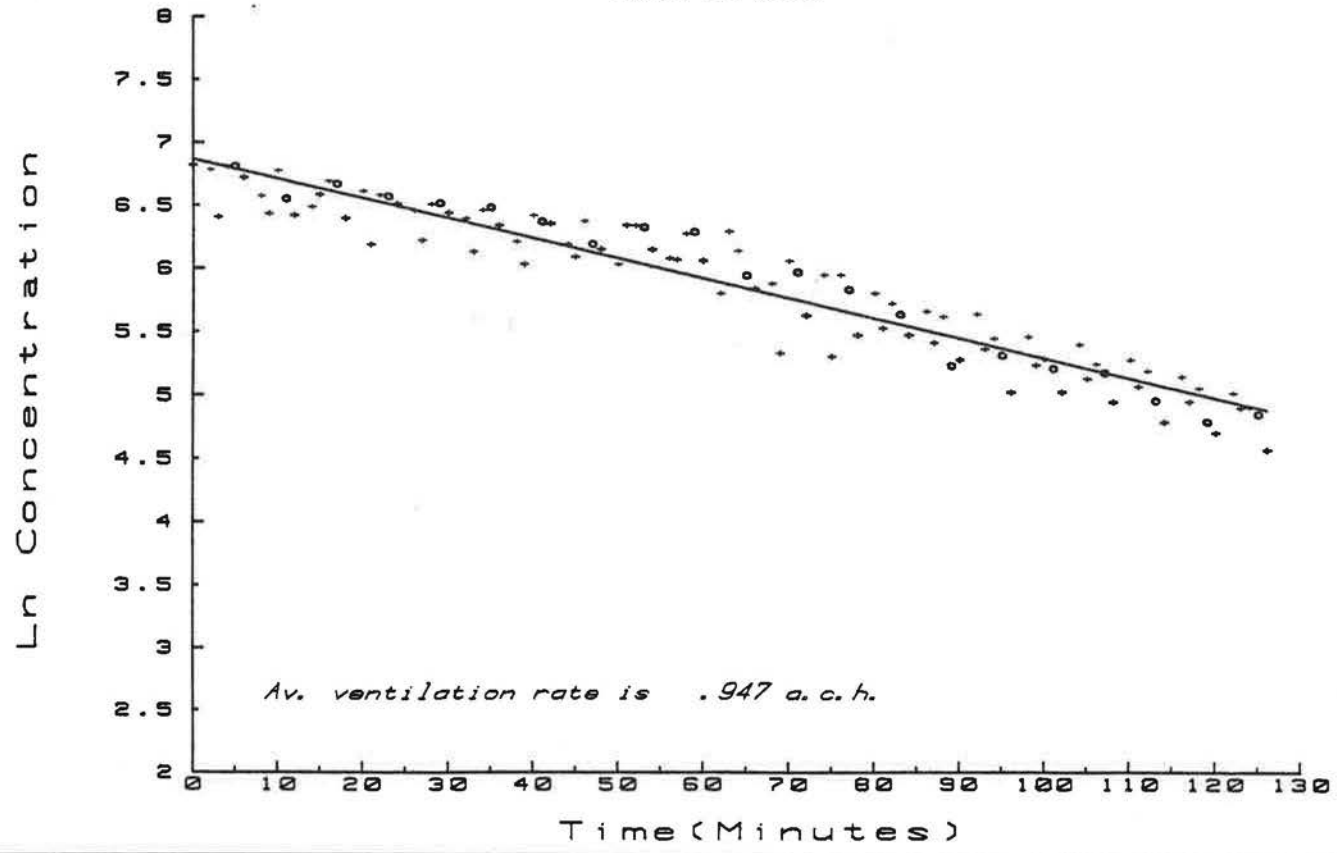

Run-B02R06
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82
Channel No. 4
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is .965 a.c.h.


Run-B02R06
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82
Channel No. 5
7
6.5
6
5.5
5
4.5
4
LnC
Ventilation rate is 1.038 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)

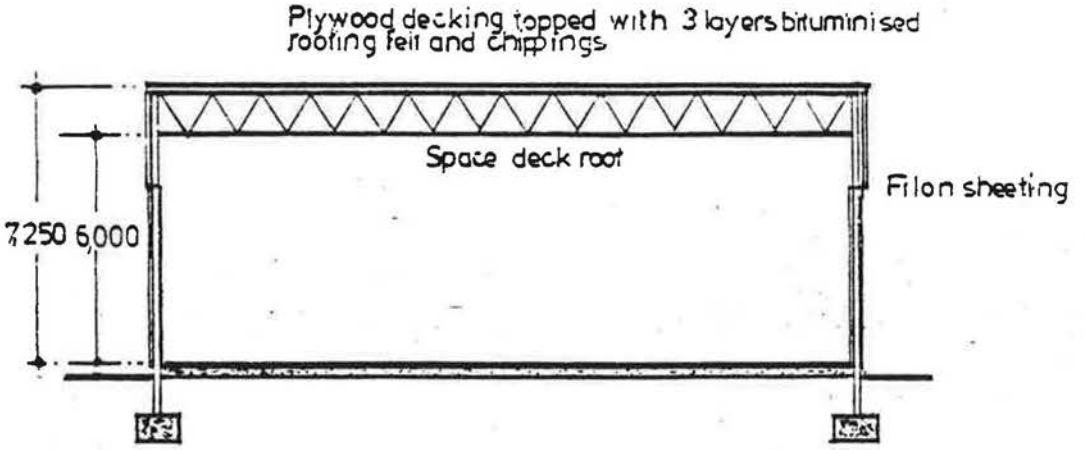
Run-B02R06
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82



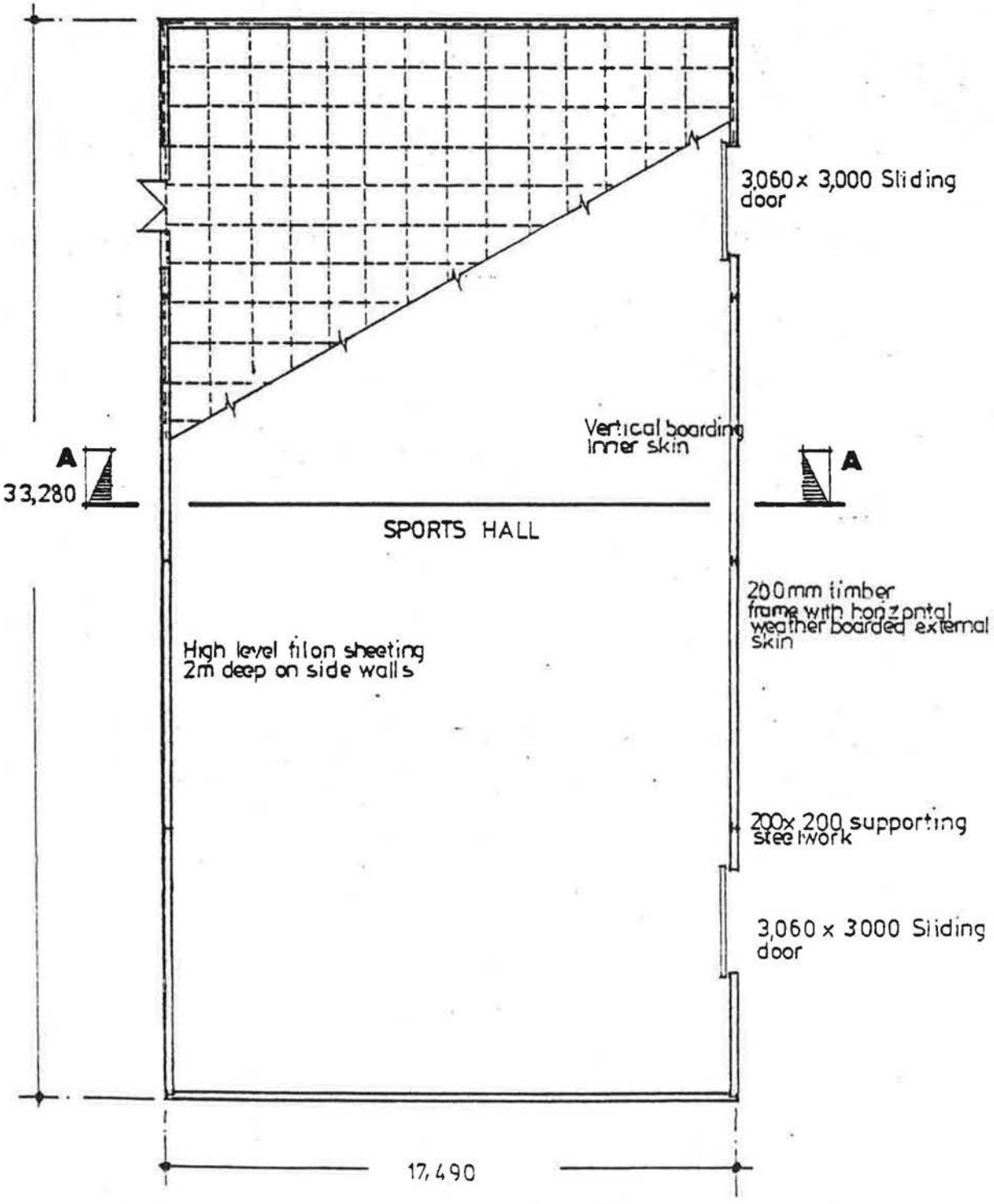
Run-B02R06
Location-Stag Industrial Estate, COVENTRY
Gas-N2O
Date-17/3/82



Building B03
Abbey School Sports Hall, Kenilworth.



SECTION THRO' 'A'-'A'



B03 R01

Date: 25th October, 1982

Time: 1300 hours to 1500 hours

Tracer Gas: Sulphur Hexaflouride

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1300 hrs	zero	12.2
1400 hrs	2 m/s	12.0
1500 hrs	zero	12.3

Wind Direction: at 1400 hours: south

Internal Conditions:

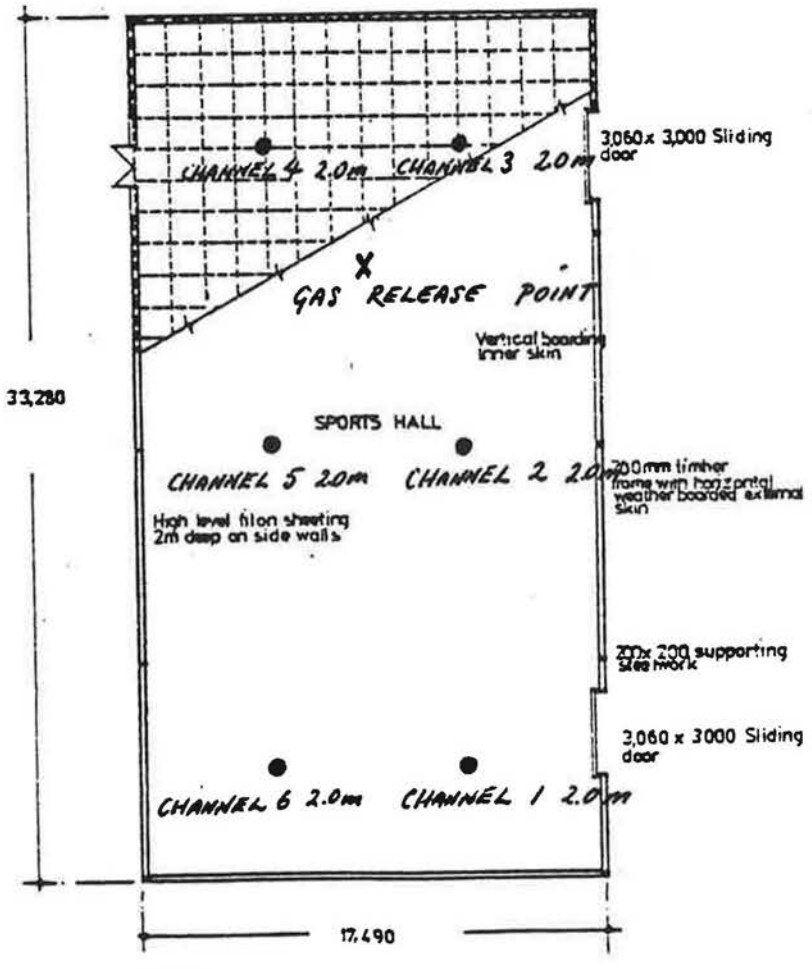
air velocity: 0.02 to 0.08 m/s
temperature: 15^{o}C

Gas Release:

Gas released into path of small fan at position shown on plan.

Sample Positions:

As shown on plan.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B03R01
Location: Abbey Sports Hall, KENILWORTH
Date: 25/10/82
Tracer gas: SF6

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5			Channel 6		
****	**********			**********			**********			**********			**********			**********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	1.2	809	6.696	2.7	796	6.680	4.2	826	6.717	5.6	1100	7.003	7.4	957	6.864	8.8	901	6.804
2	10.3	902	6.805	11.7	912	6.816	13.6	899	6.801	14.7	862	6.759	15.6	890	6.791	16.7	900	6.802
3	17.7	890	6.791	18.7	848	6.743	19.7	836	6.729	20.6	741	6.608	21.6	800	6.685	22.6	805	6.691
4	23.7	835	6.727	24.6	835	6.727	25.6	809	6.696	26.6	578	6.360	27.6	668	6.504	28.6	698	6.548
5	29.6	768	6.644	30.6	748	6.617	31.6	768	6.644	32.6	582	6.366	33.6	546	6.303	34.6	505	6.225
6	35.6	708	6.562	36.6	590	6.380	37.6	555	6.319	38.6	522	6.258	39.7	580	6.363	40.6	690	6.537
7	41.6	626	6.439	42.6	606	6.407	43.6	540	6.292	44.6	600	6.397	45.6	569	6.344	46.6	633	6.450
8	47.6	589	6.378	48.6	589	6.378	49.5	554	6.317	50.7	663	6.497	51.7	598	6.394	52.7	607	6.409
9	53.7	584	6.370	54.7	580	6.363	55.6	620	6.430	56.6	512	6.238	57.6	495	6.205	58.7	532	6.277
10	59.6	578	6.360	60.7	586	6.373	61.6	592	6.384	62.6	583	6.368	63.6	591	6.382	64.6	601	6.399
11	65.6	564	6.335	66.6	500	6.215	67.6	499	6.213	68.6	531	6.275	69.6	492	6.198	70.6	450	6.109
12	71.6	507	6.229	72.7	490	6.194	73.7	496	6.207	74.6	348	5.852	75.6	400	5.991	76.6	375	5.927
13	77.6	504	6.223	78.6	555	6.319	79.6	347	5.849	80.6	388	5.961	81.6	407	6.009	82.6	360	5.886
14	83.6	470	6.153	84.6	472	6.157	85.6	320	5.768	86.6	375	5.927	87.6	352	5.864	88.6	367	5.905
15	89.6	401	5.994	90.6	342	5.835	91.6	285	5.652	92.6	362	5.892	93.6	342	5.835	94.6	351	5.861
16	95.6	358	5.881	96.6	358	5.881	97.6	307	5.727	98.6	347	5.849	99.6	322	5.775	100.6	326	5.787
17	101.6	335	5.814	102.6	350	5.858	103.6	330	5.799	104.6	304	5.717	105.7	314	5.749	106.6	342	5.835
18	107.7	325	5.784	108.7	361	5.889	109.7	321	5.771	110.7	298	5.697	111.7	365	5.900	112.7	296	5.690
19	113.7	324	5.781	114.7	361	5.889	115.7	282	5.642	116.7	300	5.704	117.7	316	5.756	118.7	306	5.724

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	DF	SS	MS	F
Regression	1	2.036	2.036	376.531
Residual	17	.092	.005	
Total	18	2.128		

INTERCEPT= 6.89616881757
GRADIENT= -9.41421914019E-03

Ventilation rate is .589 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	DF	SS	MS	F
Regression	1	1.720	1.720	174.966
Residual	17	.168	.010	
Total	18	1.888		

INTERCEPT= 6.84686786606
GRADIENT= -9.03919541114E-03

Ventilation rate is .542 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	DF	SS	MS	F
Regression	1	2.679	2.679	161.610
Residual	17	.282	.017	
Total	18	2.961		

INTERCEPT= 6.90354412921
GRADIENT= -1.13161784947E-02

Ventilation rate is .679 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	DF	SS	MS	F
Regression	1	2.255	2.255	132.116
Residual	17	.290	.017	
Total	18	2.546		

INTERCEPT= 6.84570384208
GRADIENT= -.010396007047

Ventilation rate is .624 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	DF	SS	MS	F
Regression	1	2.054	2.054	184.383
Residual	17	.189	.011	
Total	18	2.243		

INTERCEPT= 6.83716652229
GRADIENT= -9.94113255952E-03

Ventilation rate is .586 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 6

Source	DF	SS	MS	F
Regression	1	2.317	2.317	186.650
Residual	17	.211	.012	
Total	18	2.528		

INTERCEPT= 6.88578196372
GRADIENT= -1.05744473206E-02

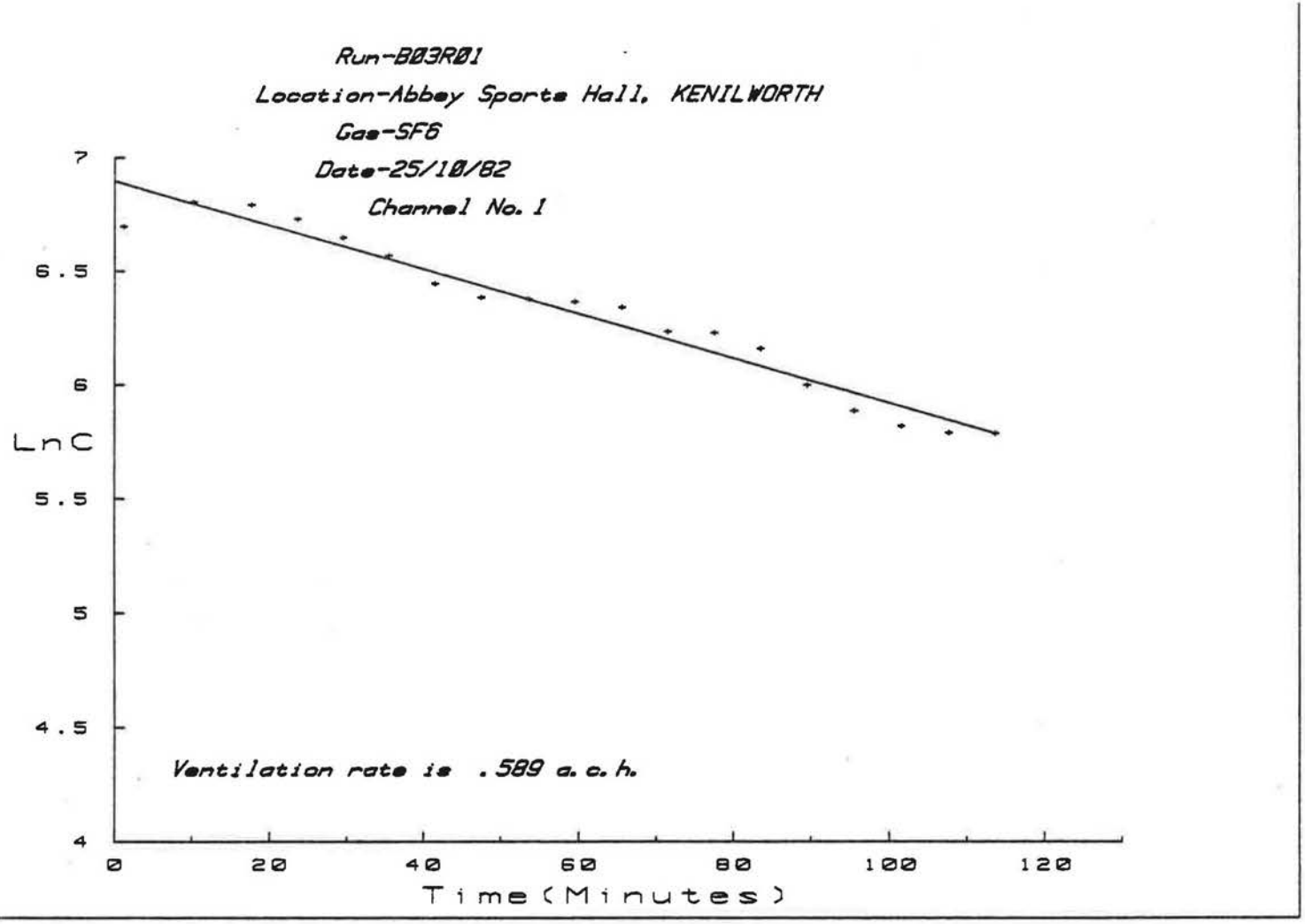
Ventilation rate is .634 air changes per hour

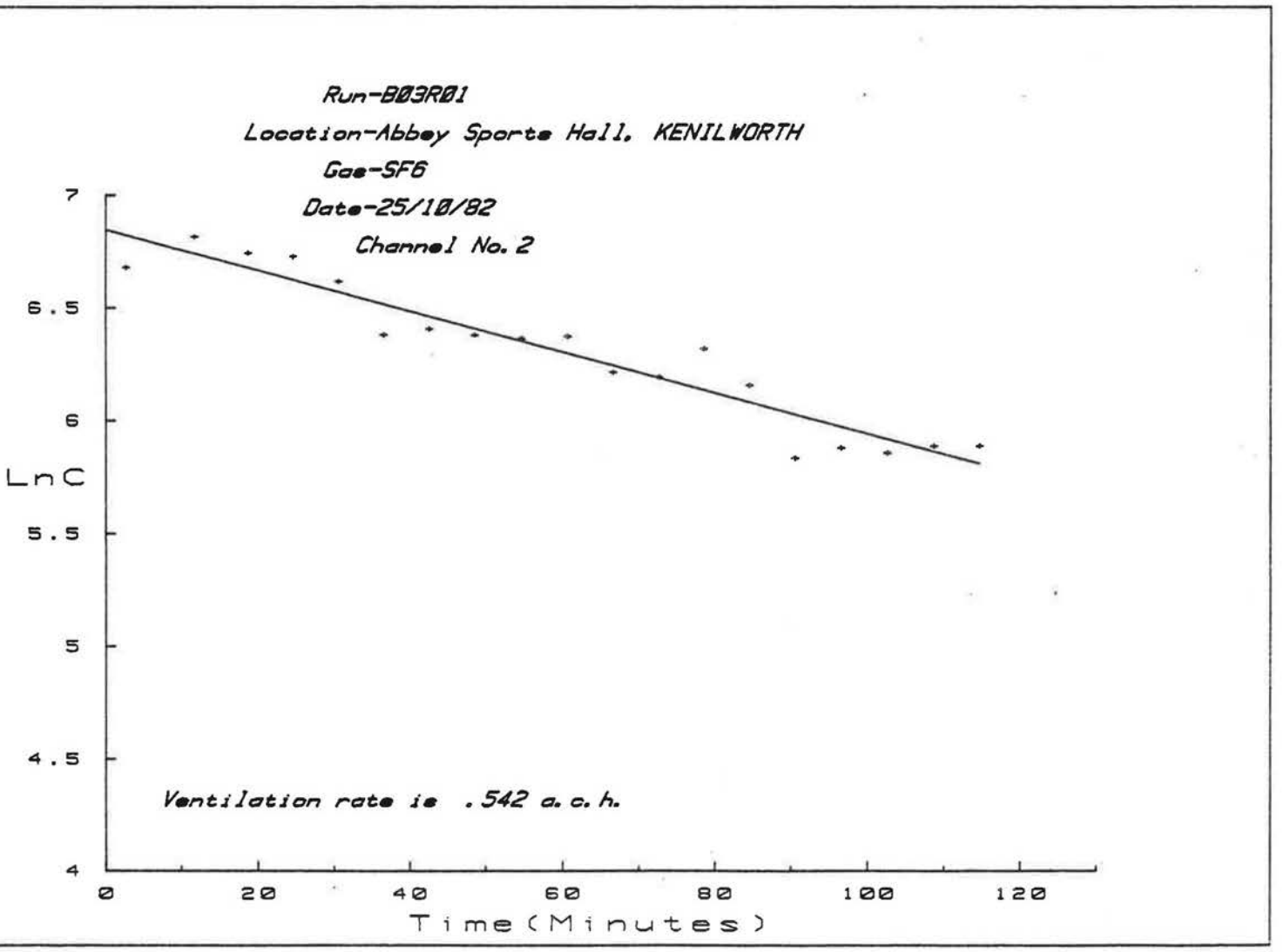
STATISTICAL ANALYSIS - ALL CHANNELS

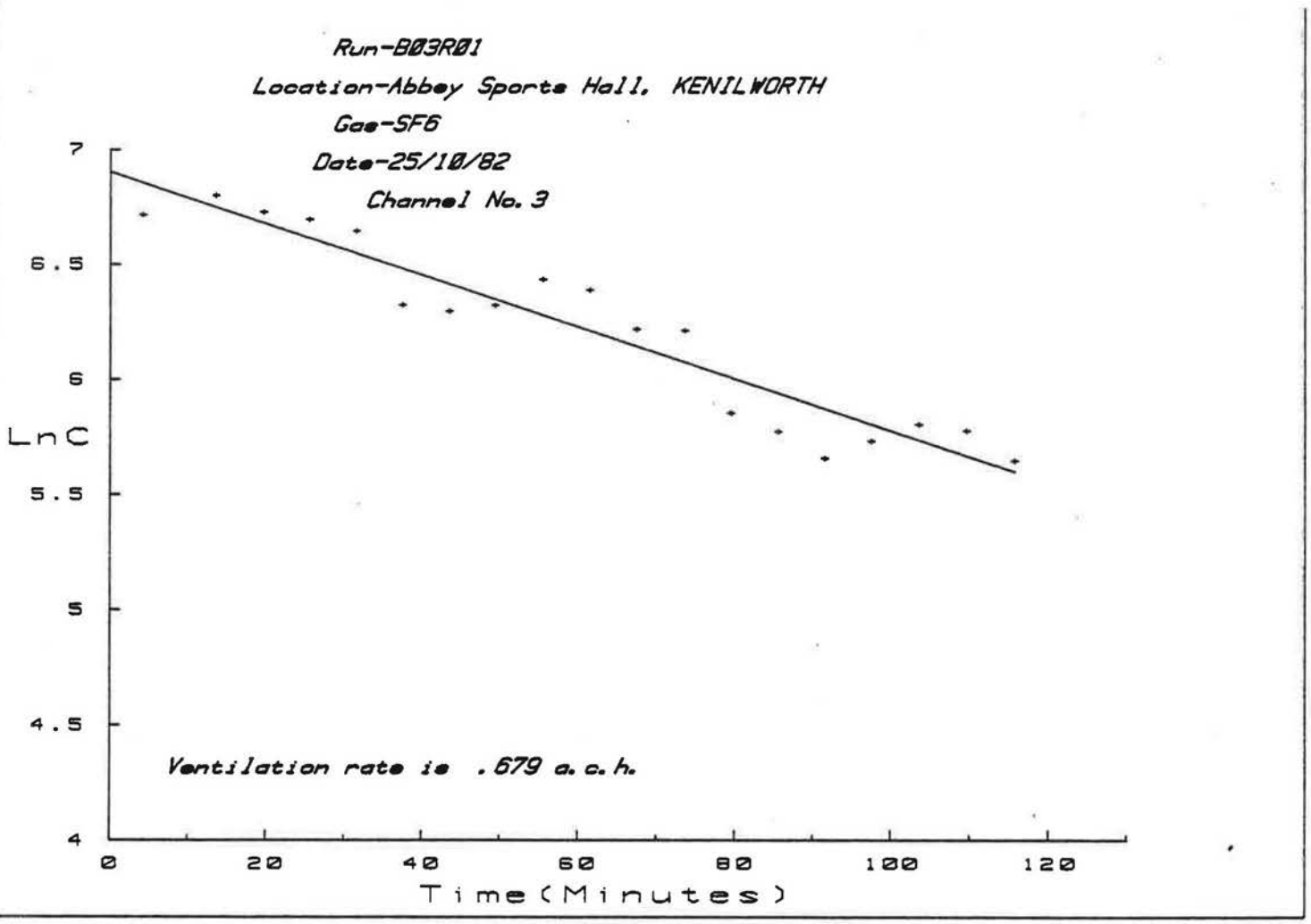
Source	DF	SS	MS	F
Regression	1	13.135	13.135	1023.155
Residual				
112 MISS				
	1.438	.013		
Total	113	14.573		

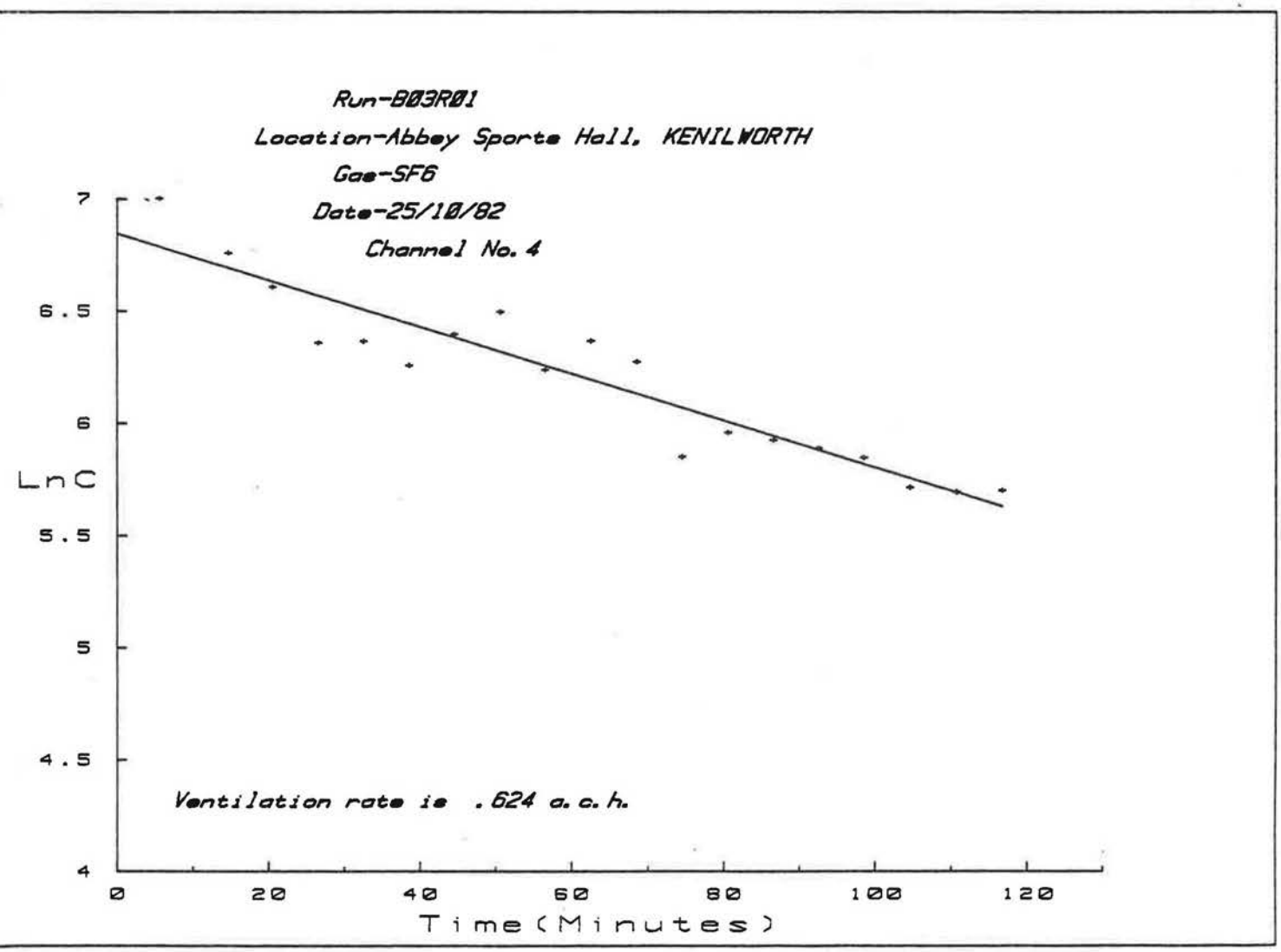
INTERCEPT= 6.87091630357
GRADIENT= -1.02163540338E-02

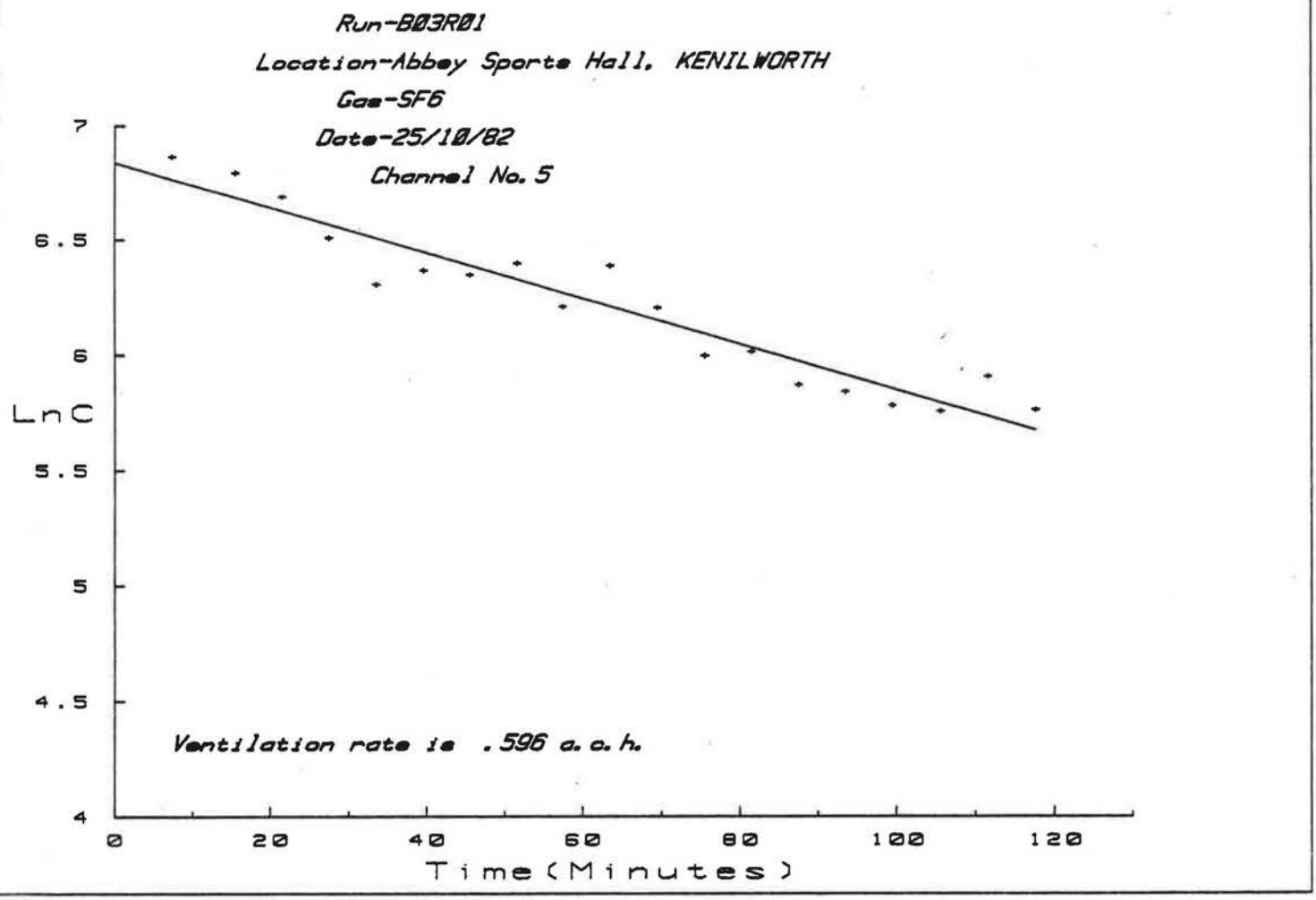
Ventilation rate is .613 air changes per hour

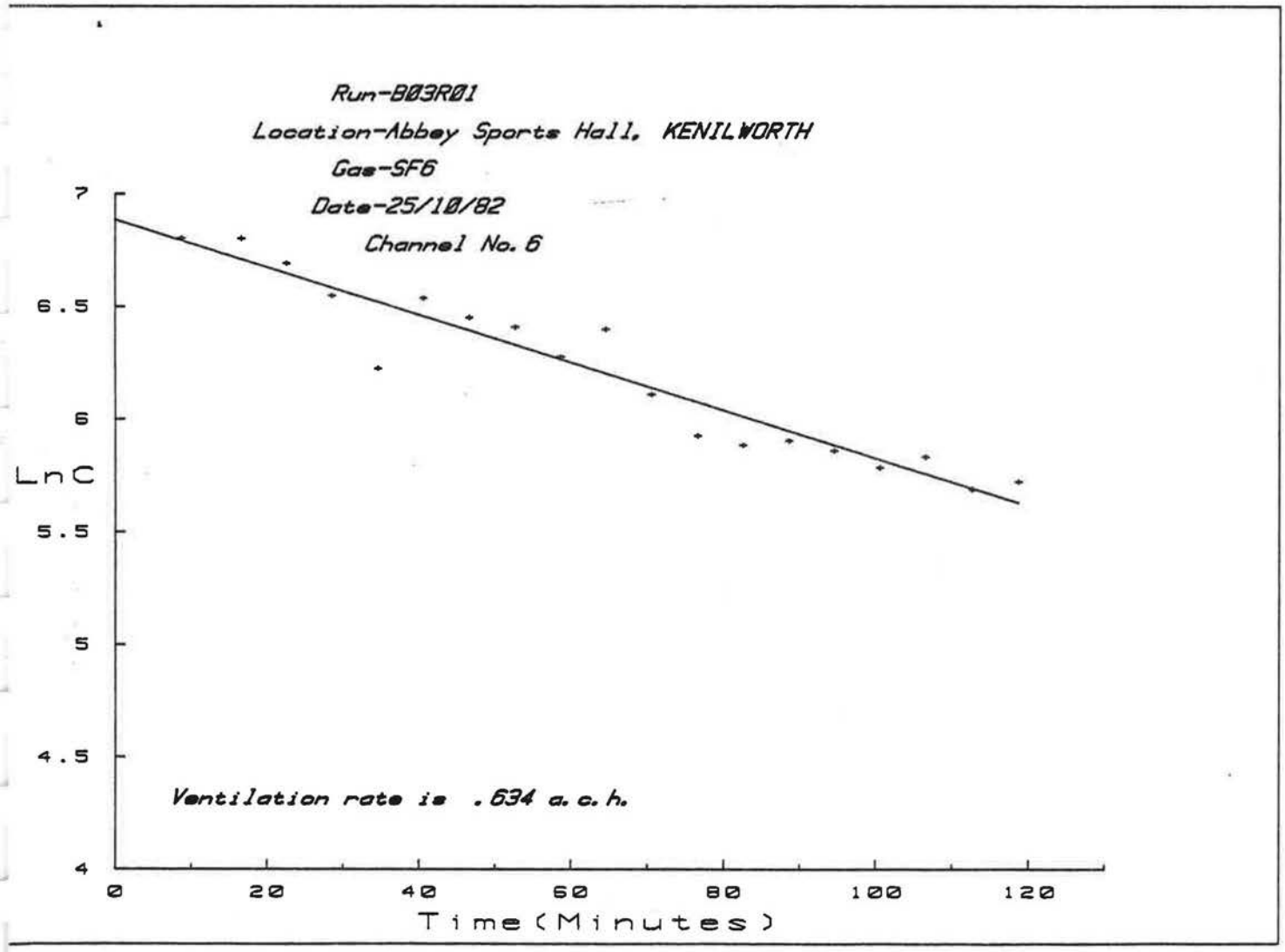

Run-B03R01
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-25/10/82
Channel No. 1
LnC
7
6.5
6
5.5
5
4.5
4
Ventilation rate is .589 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)


Run-B03R01
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-25/10/82
Channel No. 2
LnC
7
6.5
6
5.5
5
4.5
4
Ventilation rate is .542 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)


Run-B03R01
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-25/10/82
Channel No. 3
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is .679 a.c.h.


Run-B03R01
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-25/10/82
Channel No. 4
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is .624 a.c.h.


Run-B03R01
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-25/10/82
Channel No. 5
7
6.5
6
5.5
5
4.5
4
LnC
Ventilation rate is .596 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)

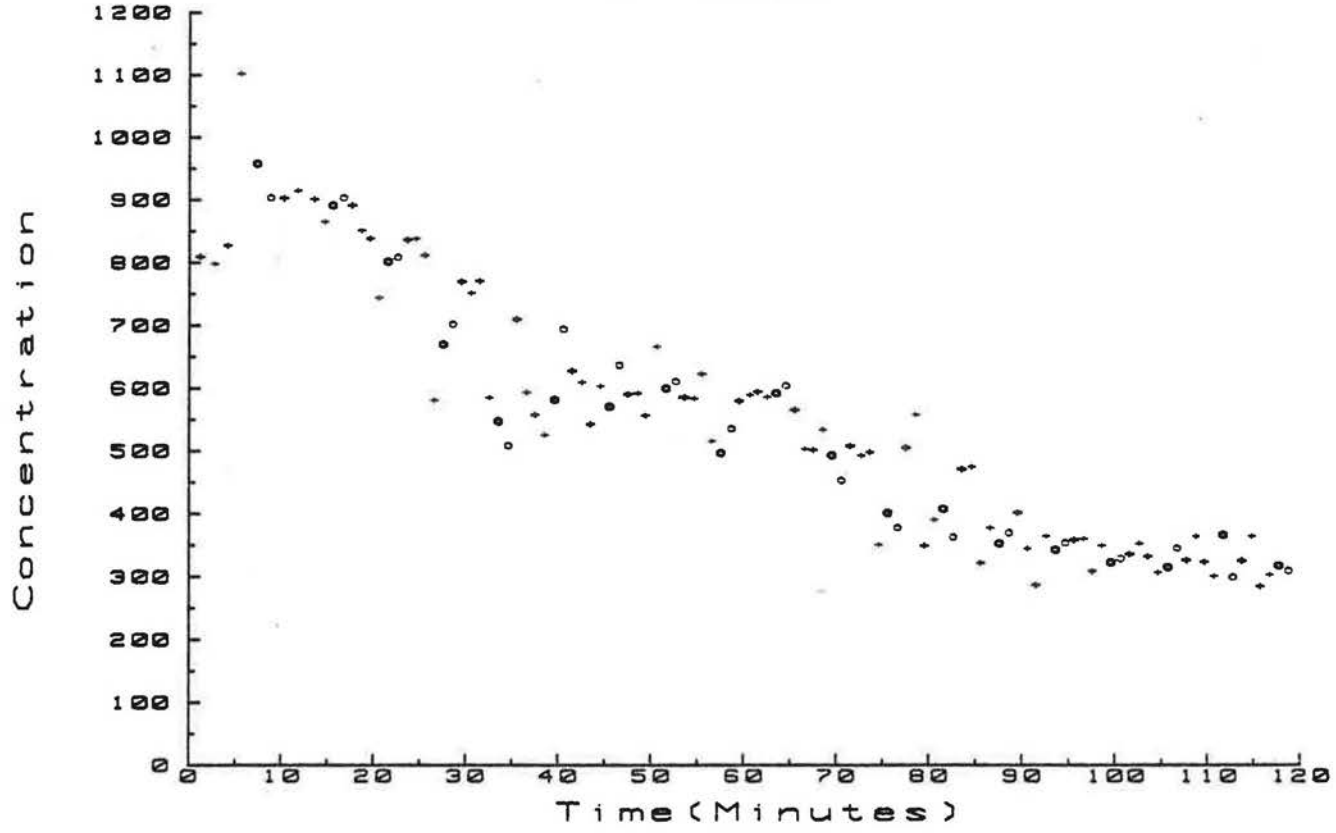

Run-B03R01
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-25/10/82
Channel No. 6
7
6.5
6
5.5
5
4.5
4
LnC
Ventilation rate is .634 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)

Run-B03R01

Location-Abbey Sports Hall. KENILWORTH

Gas-SF6

Date-25/10/82

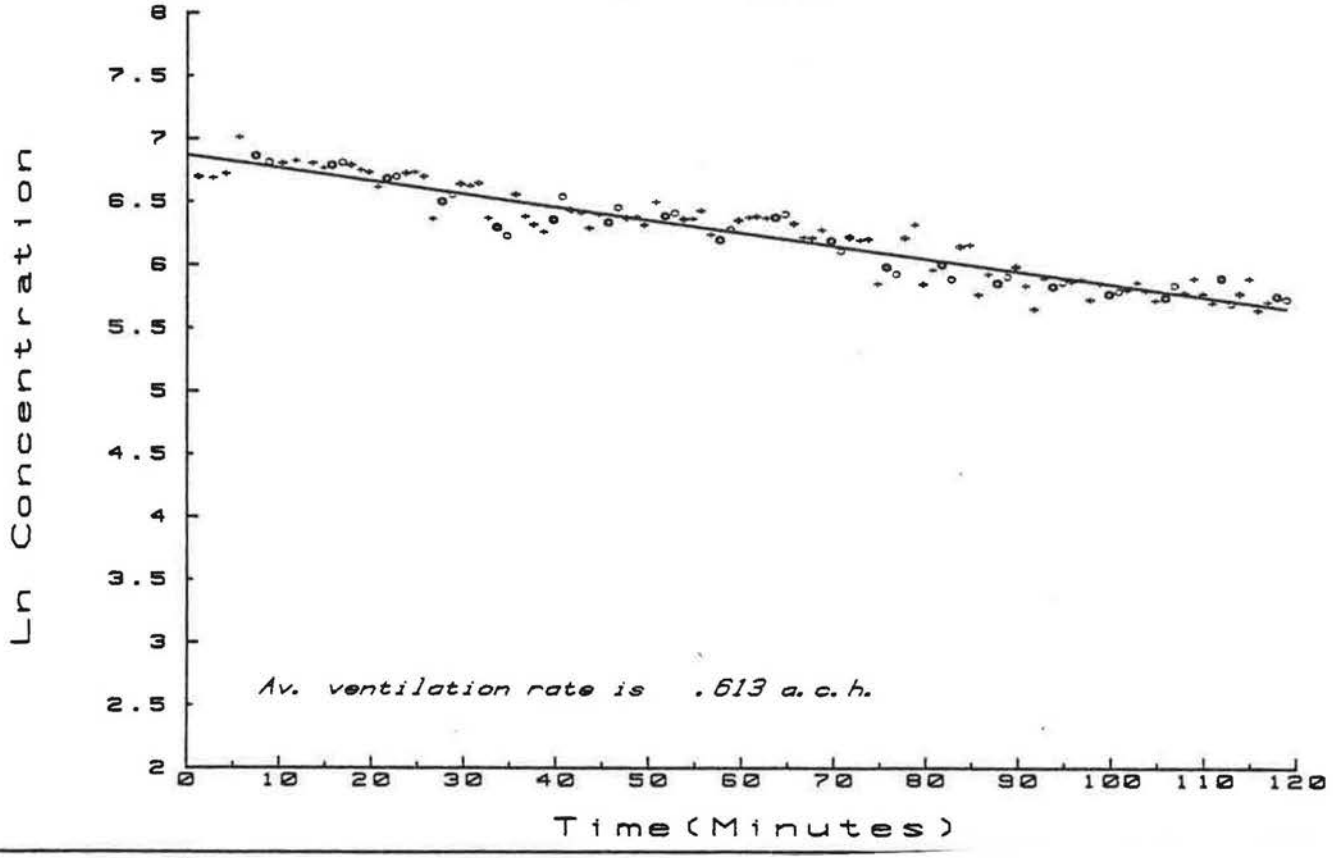


Run-B03R01

Location-Abbey Sports Hall. KENILWORTH

Gas-SF6

Date-25/10/82



B03 R02

Date: 26th October, 1982

Time: 0930 hours to 1040 hours

Tracer Gas: Sulphur Hexaflouride

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
0900 hrs	6.7	13.4
1000 hrs	7.2	13.8
1100 hrs	5.7	14.4

Wind Direction: south south west

Internal Conditions:

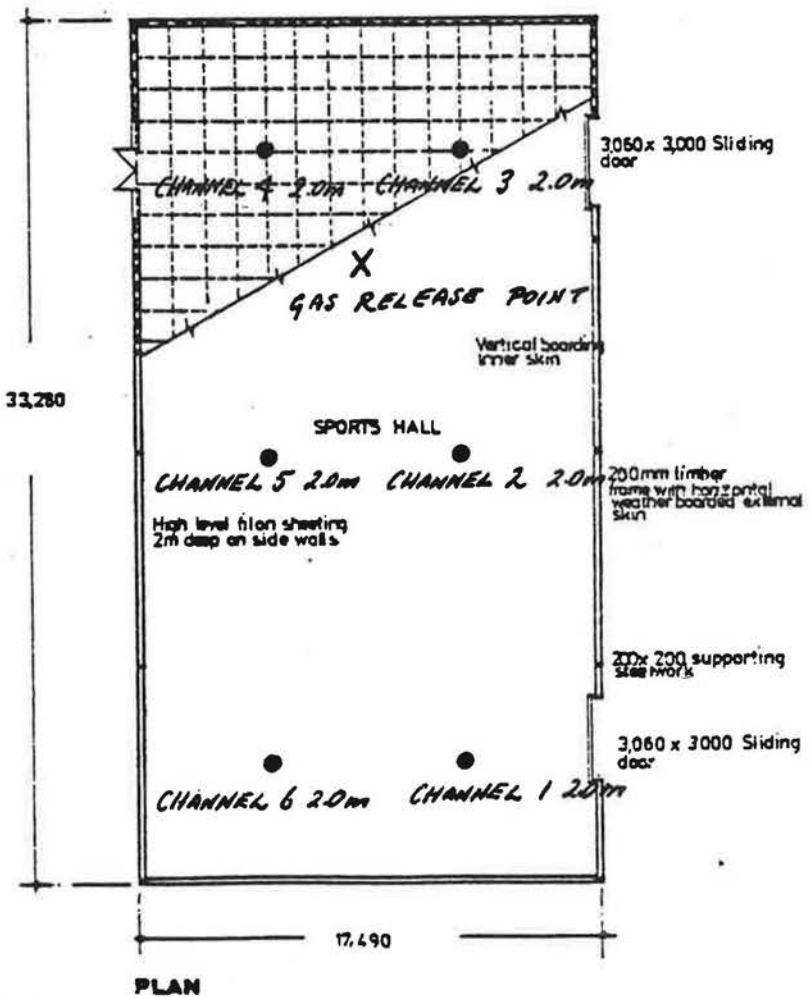
air velocity: 0.01 to 0.10 m/s
temperature: 14 to 15^{o}C

Gas Release:

Gas released into path of small fan at position shown on plan.

Sample Positions:

As shown on plan.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B03R02
Location: Abbey Sports Hall, KENILWORTH
Date: 26/10/82
Tracer gas: SF6

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5			Channel 6		
****	**********			**********			**********			**********			**********			**********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	.9	987	6.895	2.4	978	6.886	4.2	677	6.518	5.8	655	6.485	7.3	681	6.524	9.4	630	6.446
2	11.3	624	6.436	12.7	583	6.368	14.0	394	5.976	15.2	448	6.105	16.5	379	5.938	17.7	410	6.016
3	19.0	386	5.956	20.3	349	5.855	21.6	289	5.666	22.9	266	5.583	24.3	249	5.517	25.6	218	5.384
4	27.0	201	5.303	28.3	183	5.209	29.6	116	4.754	30.8	118	4.771	32.1	125	4.828	33.3	136	4.913
5	34.7	122	4.804	36.0	85	4.443	37.4	81	4.394	38.6	73	4.290	40.0	68	4.220	41.3	68	4.220
6	42.6	62	4.127	43.9	49	3.892	45.1	27	3.296	46.2	37	3.611	47.5	36	3.584	48.9	38	3.638
7	50.3	36	3.584	51.4	26	3.258	52.6	21	3.045	53.9	20	2.996	55.1	21	3.045	56.5	24	3.178

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	DF	SS	MS	F
Regression	1	8.760	8.760	669.896
Residual	5	.072	.014	
Total	6	8.832		

INTERCEPT= 7.13420367135
SLOPE= -6.907852584328-02

Ventilation rate is 4.145 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	DF	SS	MS	F
Regression	1	10.570	10.570	609.385
Residual	5	.087	.017	
Total	6	10.657		

INTERCEPT= 7.25710073442
SLOPE= -7.635134162538-02

Ventilation rate is 4.581 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	DF	SS	MS	F
Regression	1	10.343	10.343	205.044
Residual	5	.252	.050	
Total	6	10.595		

INTERCEPT= 7.01398561139
SLOPE= -.076194825332

Ventilation rate is 4.572 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	DF	SS	MS	F
Regression	1	9.973	9.973	494.915
Residual	5	.103	.021	
Total	6	10.076		

INTERCEPT= 7.12813434133
SLOPE= -7.524802184628-02

Ventilation rate is 4.514 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	DF	SS	MS	F
Regression	1	9.637	9.637	1158.665
Residual	5	.041	.008	
Total	6	9.678		

INTERCEPT= 7.17159781014
SLOPE= -7.436727183398-02

Ventilation rate is 4.496 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 6

Source	DF	SS	MS	F
Regression	1	8.828	8.828	1598.426
Residual	5	.028	.006	
Total	6	8.856		

INTERCEPT= 7.28965461288
SLOPE= -7.165194866628-02

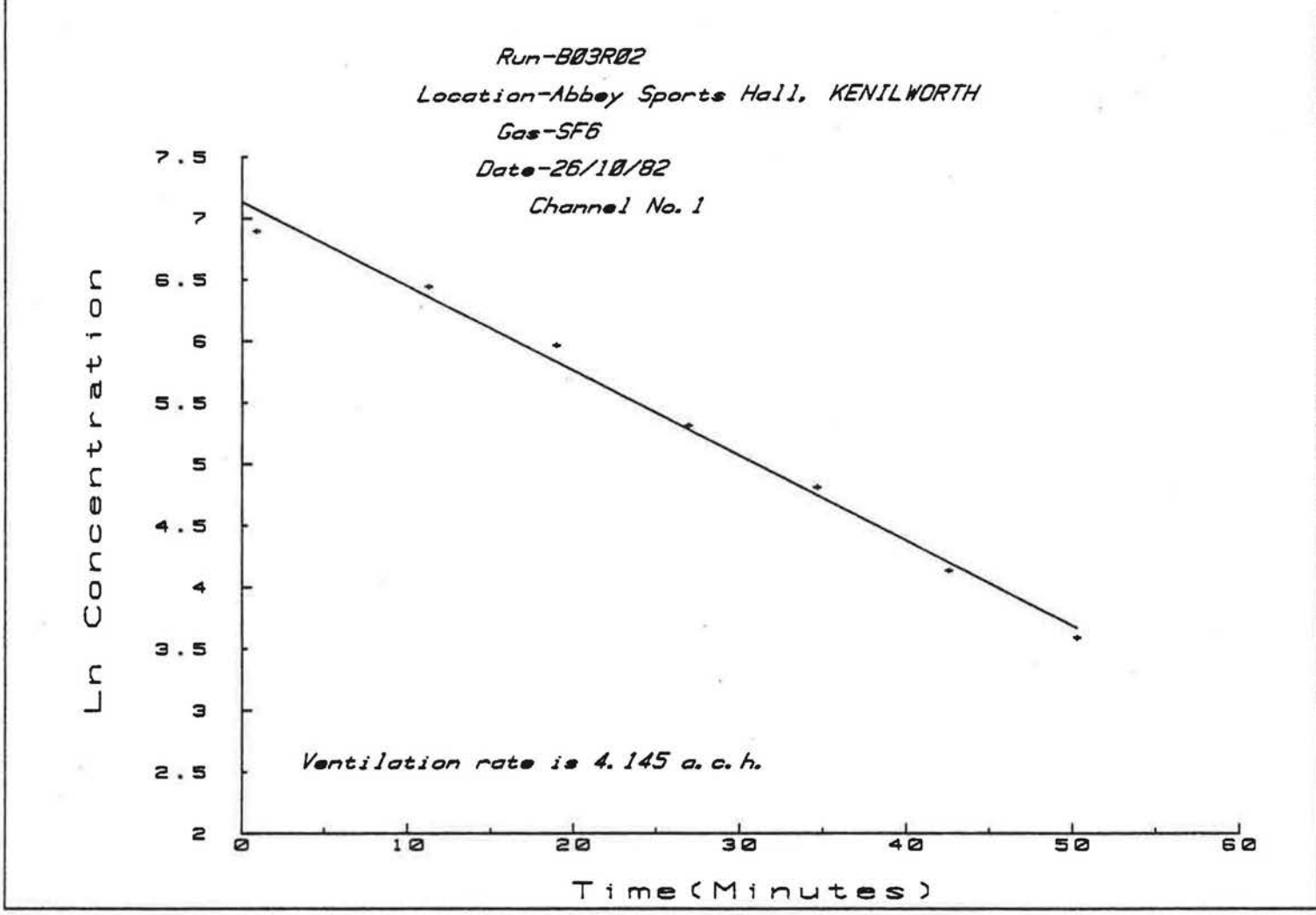
Ventilation rate is 4.299 air changes per hour

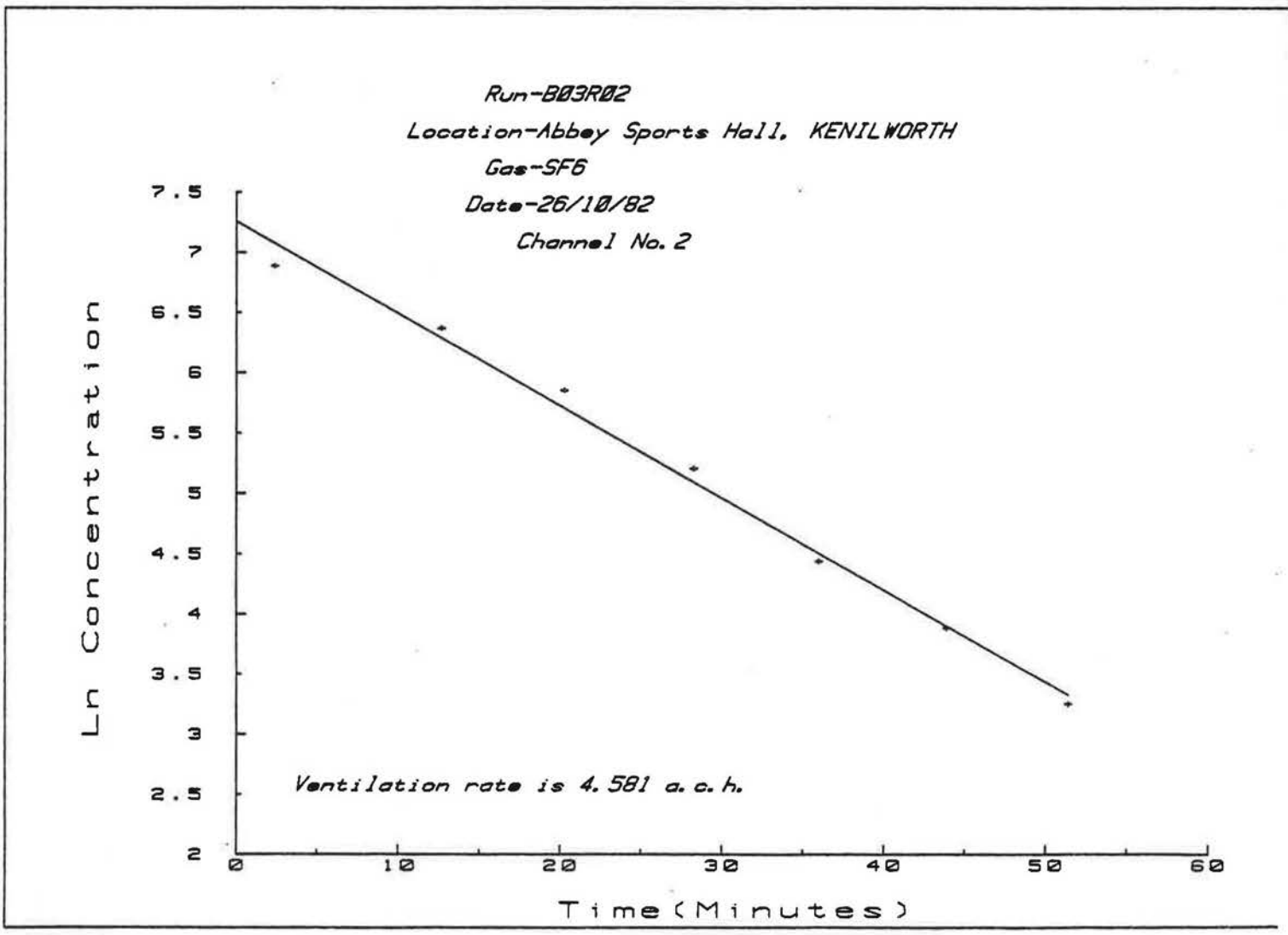
STATISTICAL ANALYSIS - ALL CHANNELS

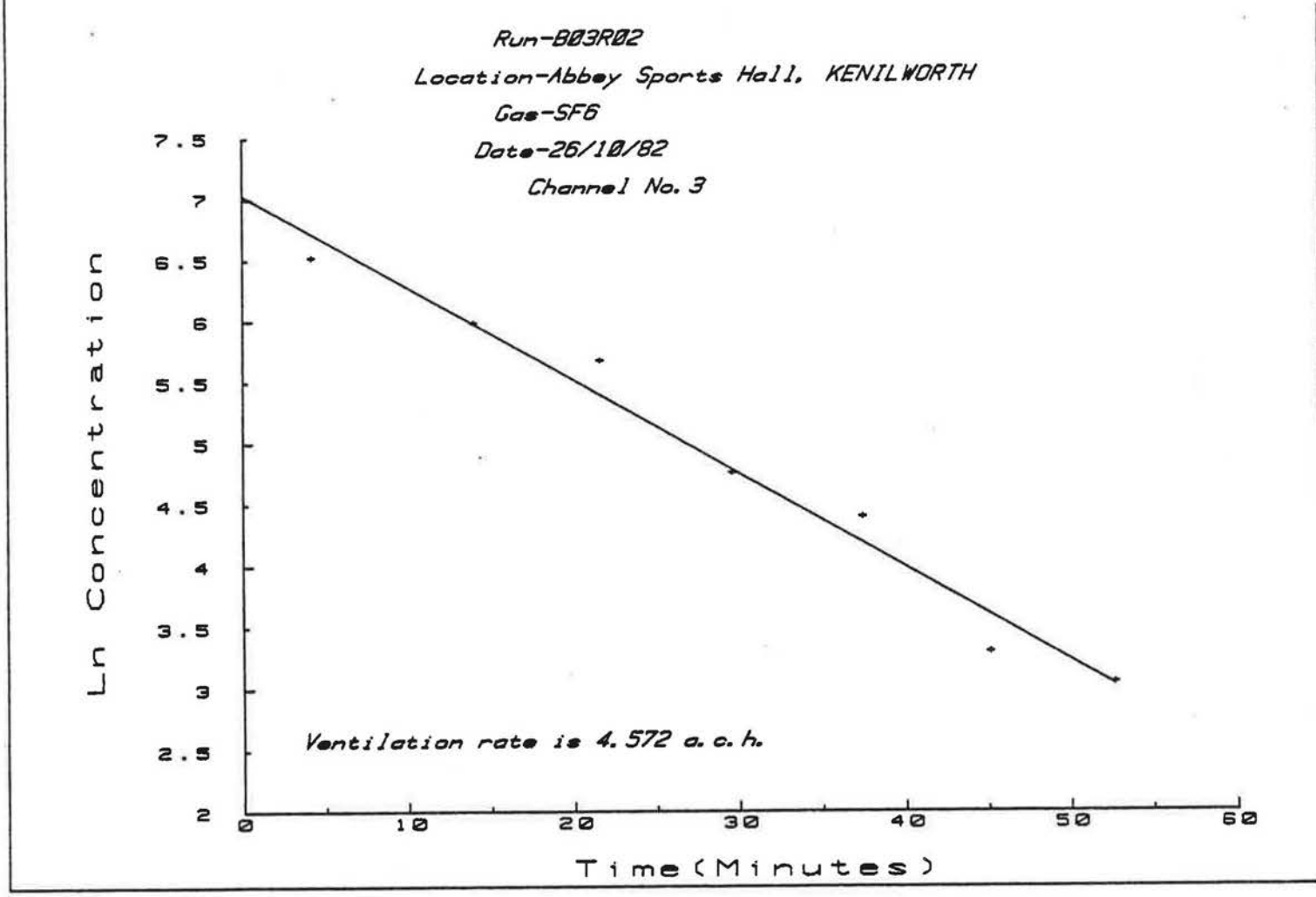
Source	DF	SS	MS	F
Regression	1	59.119	59.119	2866.130
Residual	40	1.145	.029	
Total	41	60.264		

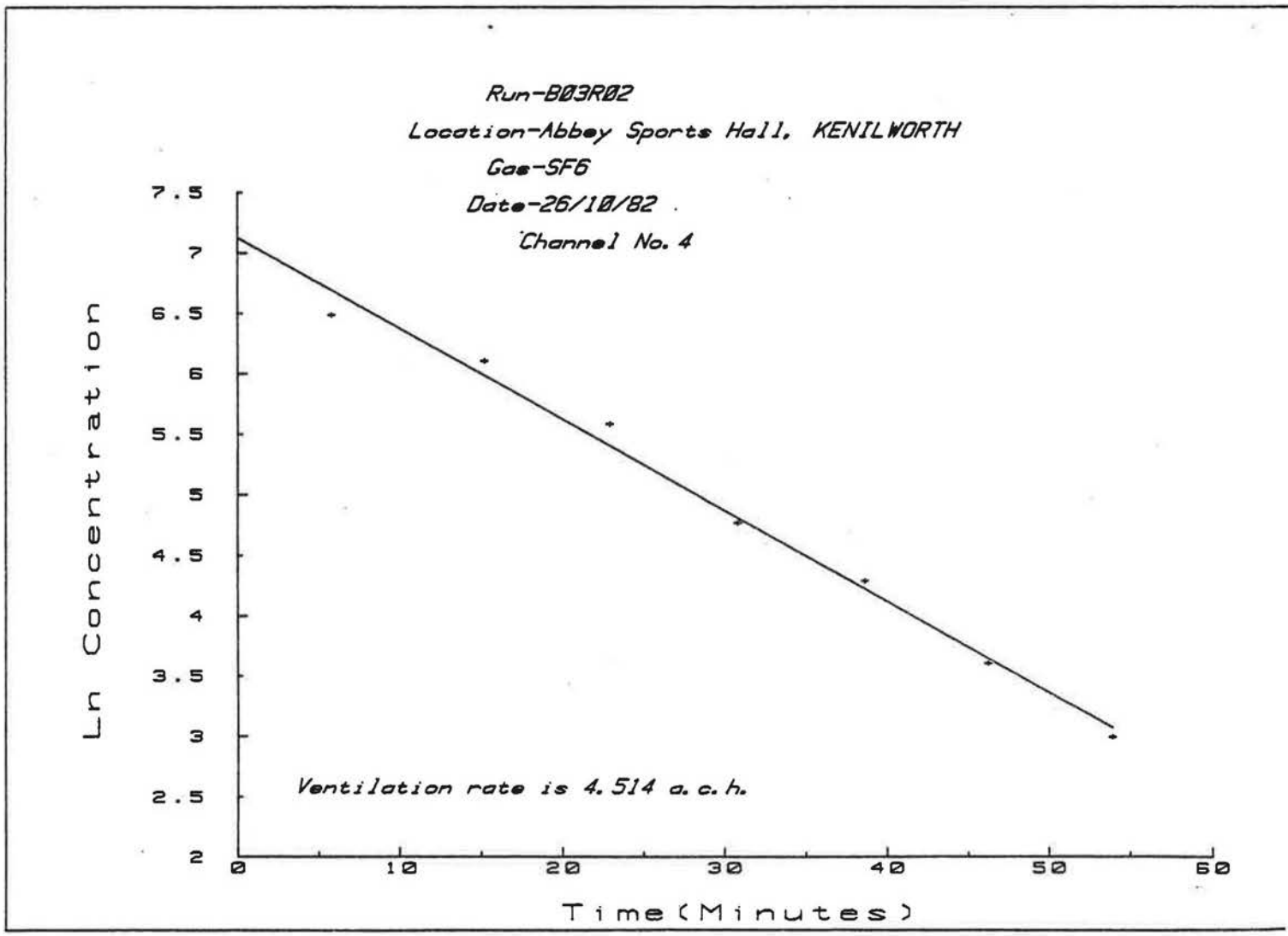
INTERCEPT= 7.15284141679
SLOPE= -7.372486366228-02

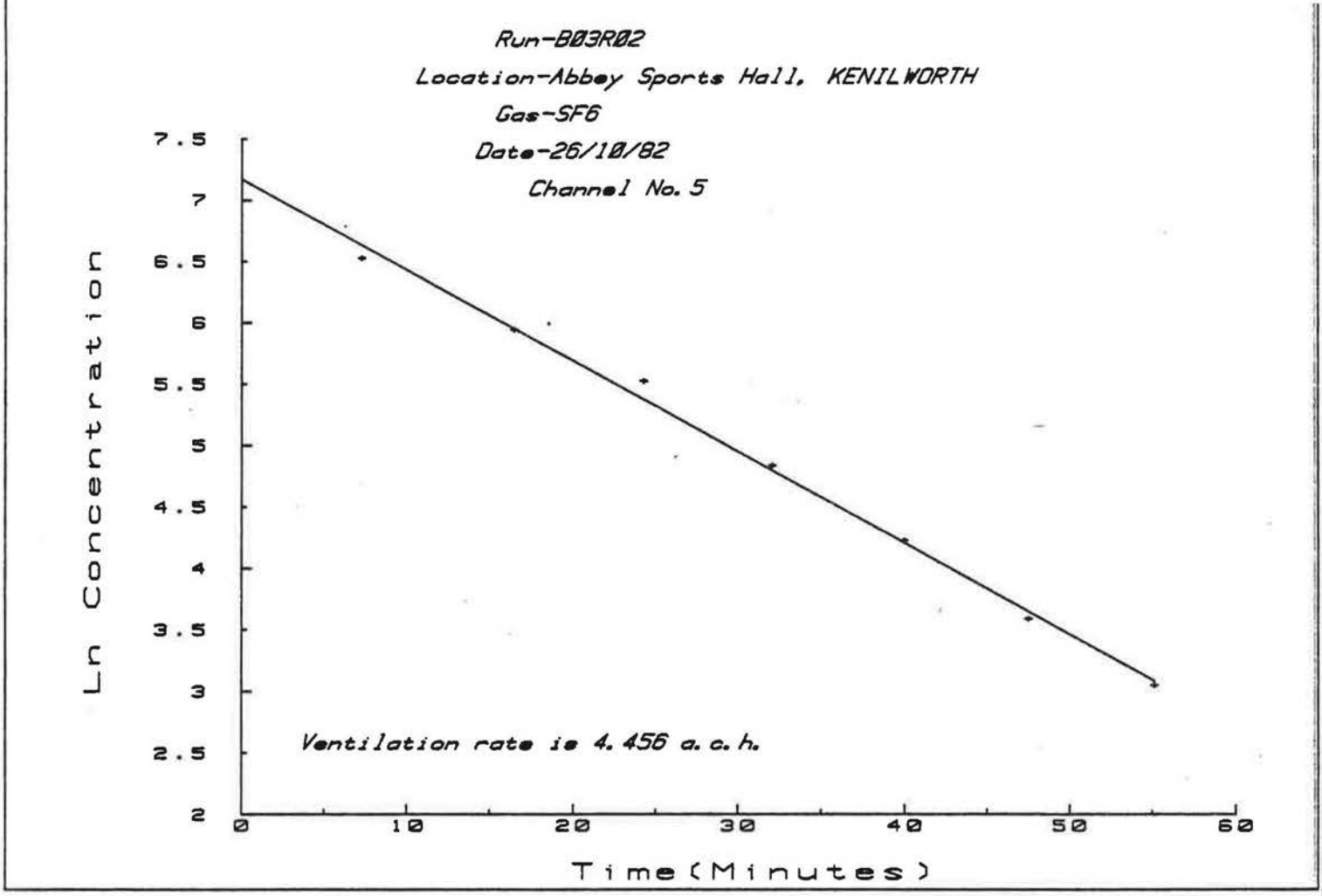
Ventilation rate is 4.423 air changes per hour

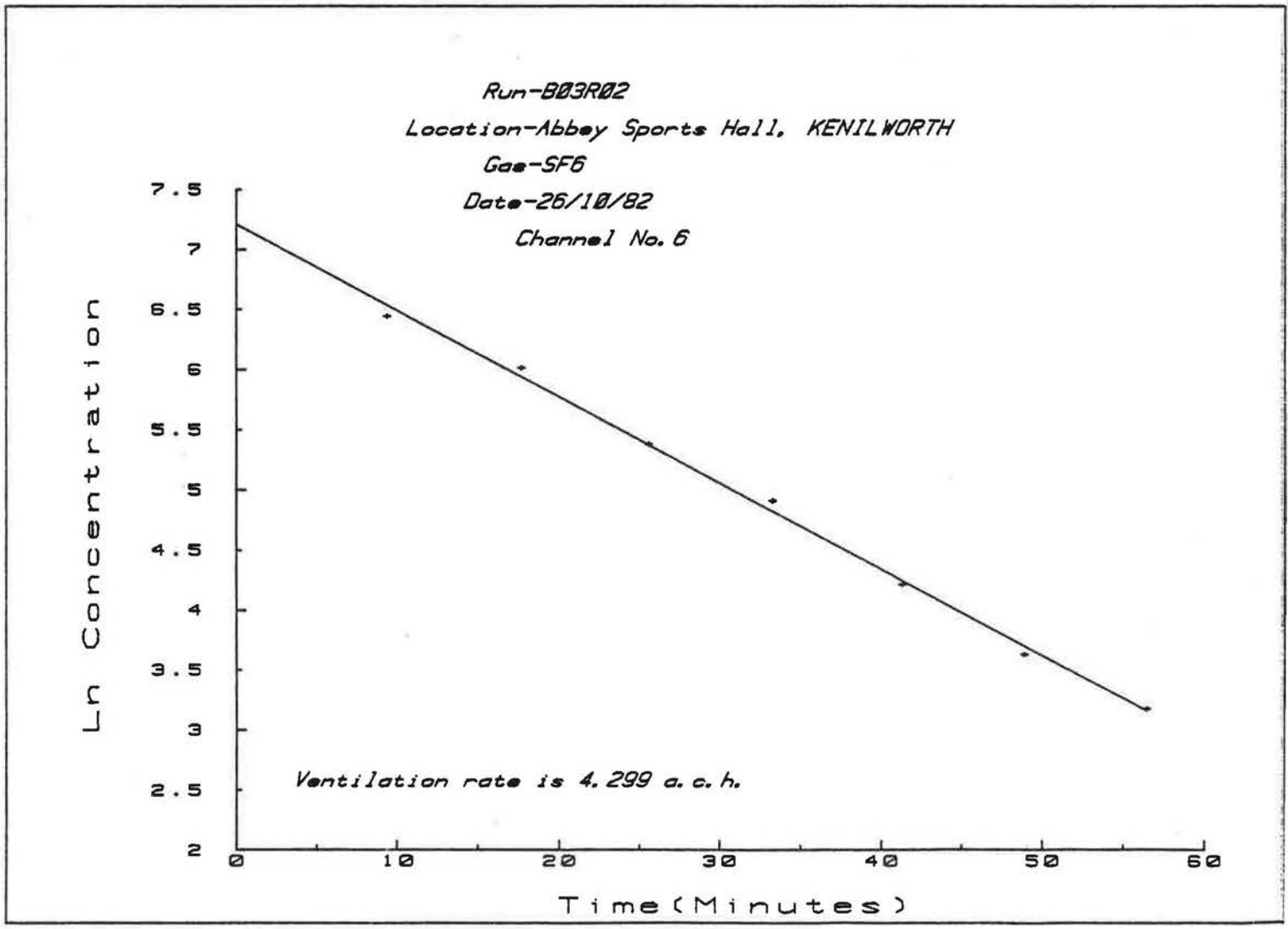

Run-B03R02
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 1
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0
10
20
30
40
50
60
Time(Minutes)
Ventilation rate is 4.145 a.c.h.


Run-B03R02
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 2
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0
10
20
30
40
50
60
Time(Minutes)
Ventilation rate is 4.581 a.c.h.

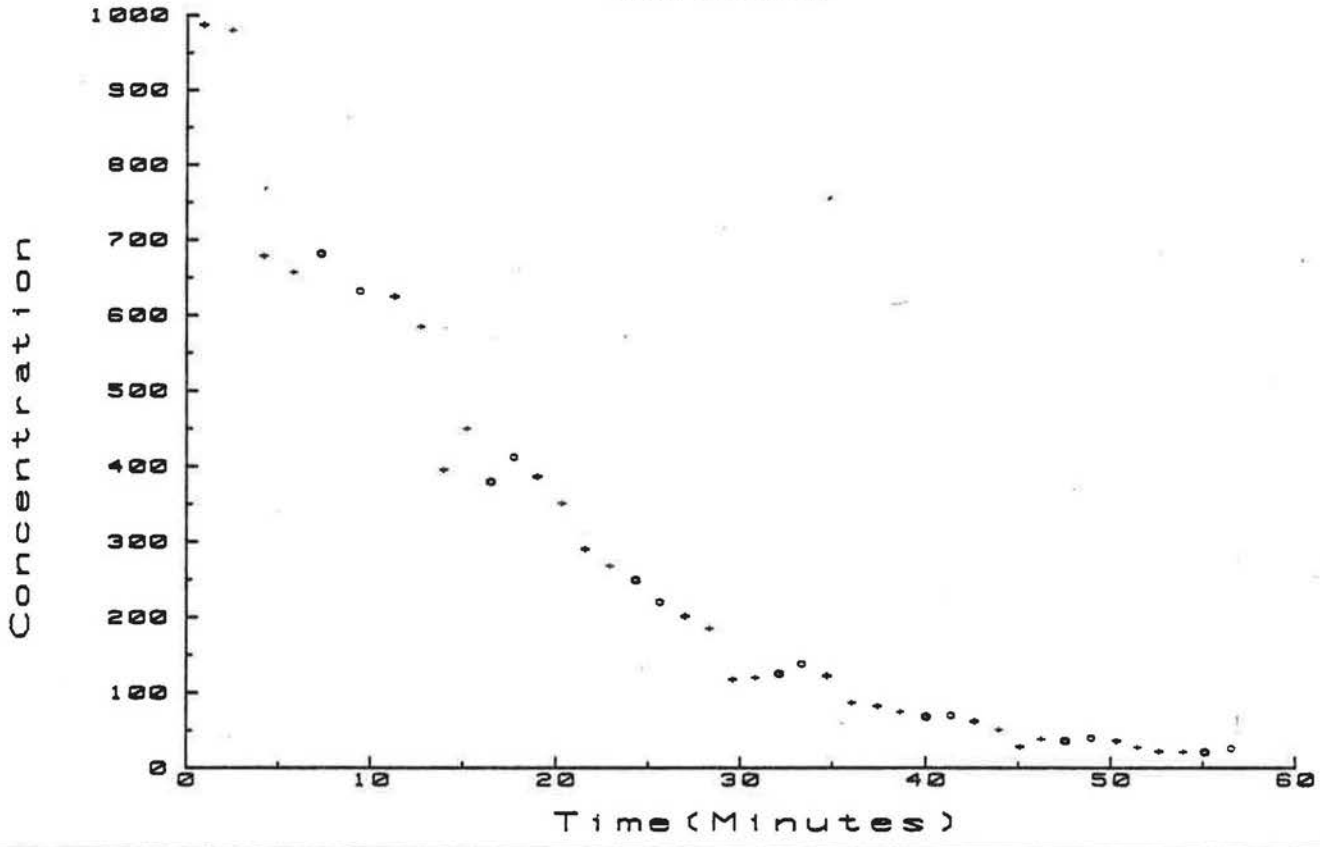

Run-B03R02
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 3
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0
10
20
30
40
50
60
Time(Minutes)
Ventilation rate is 4.572 a.c.h.


Run-B03R02
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 4
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0
10
20
30
40
50
60
Time(Minutes)
Ventilation rate is 4.514 a.c.h.

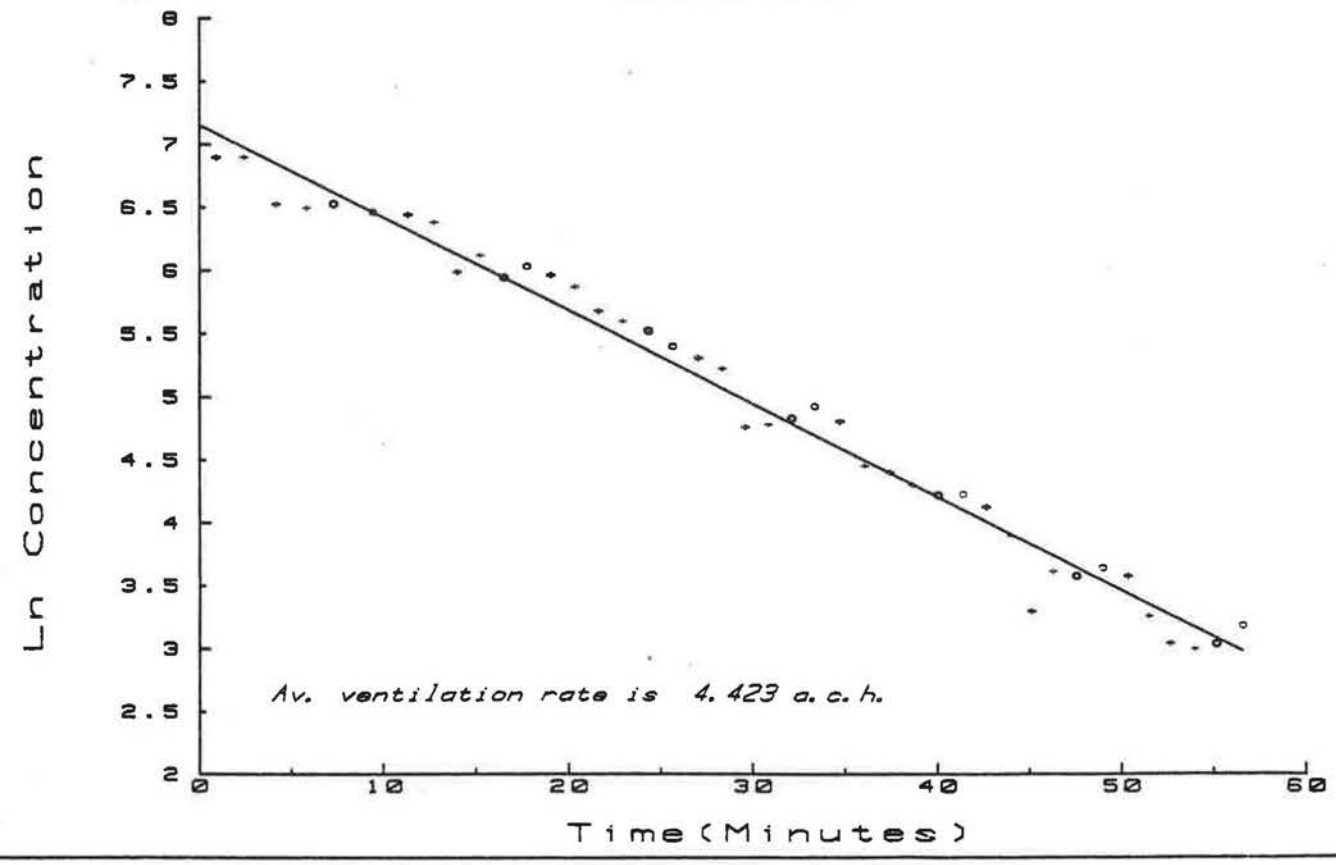

Run-B03R02
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 5
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0
10
20
30
40
50
60
Time(Minutes)
Ventilation rate is 4.456 a.c.h.


Run-B03R02
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 6
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0
10
20
30
40
50
60
Time(Minutes)
Ventilation rate is 4.299 a.c.h.

Run-B03R02
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82



Run-B03R02
Location-Abbey Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82



B03 R03

Date: 26th October, 1982

Time: 1055 hours to 1200 hours

Tracer Gas: Sulphur Hexaflouride

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1100 hrs	5.7	14.4
1200 hrs	7.7	15.4

Wind Direction: south south west

Internal Conditions:

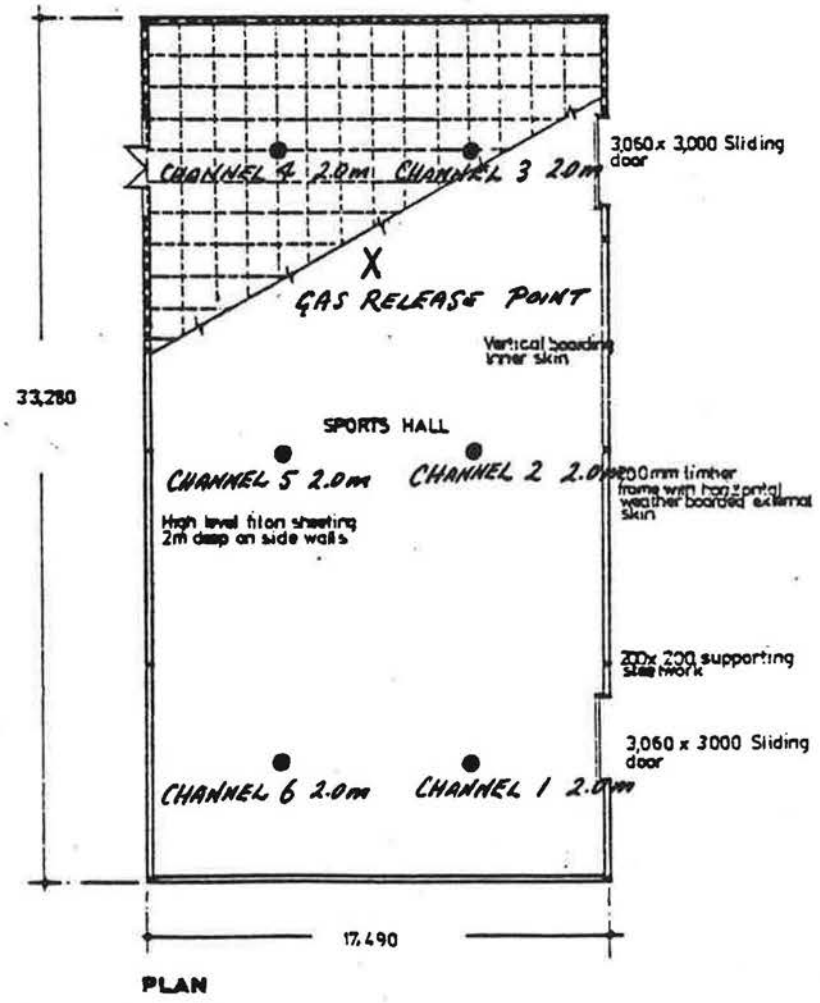
air velocity: 0.01 to 0.10 m/s
temperature: 14 to 15 ^{o}C

Gas Release:

Gas released into path of small fan at position shown on plan.

Sample Positions:

As shown on plan.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B03R03
Location: Abbey School Sports Hall, KENILWORTH.
Date: 26/10/82
Tracer gas: SF6

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5			Channel 6		
****	**********			**********			**********			**********			**********			**********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	.7	1296	7.167	2.0	1011	6.919	3.5	730	6.593	5.1	784	6.664	6.6	772	6.649	8.0	778	6.657
2	9.2	759	6.632	10.6	537	6.286	11.8	408	6.011	13.0	434	6.073	14.3	432	6.068	15.5	459	6.129
3	16.8	442	6.091	18.0	360	5.886	19.1	264	5.576	20.3	306	5.724	21.5	250	5.521	22.8	268	5.591
4	23.9	255	5.541	25.2	200	5.298	26.4	128	4.852	27.6	182	5.204	28.8	137	4.920	30.0	151	5.017
5	31.3	151	5.017	32.5	113	4.727	33.8	82	4.407	35.2	100	4.605	36.6	84	4.431	37.9	88	4.477
6	39.2	98	4.585	40.4	70	4.248	42.0	46	3.829	43.4	43	3.761	44.8	41	3.714	46.1	54	3.989
7	47.5	48	3.871	48.9	38	3.638	50.1	23	3.135	51.4	27	3.296	52.6	23	3.135	54.0	25	3.219

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	DF	SS	MS	F
Regression	1	8.098	8.098	2888.986
Residual	5	.014	.003	
Total	6	8.112		

INTERCEPT= 7.24502493176
GRADIENT= -7.00481204881E-02

Ventilation rate is 4.203 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	DF	SS	MS	F
Regression	1	8.120	8.120	3394.975
Residual	5	.012	.002	
Total	6	8.132		

INTERCEPT= 7.06640518393
GRADIENT= -7.01703384098E-02

Ventilation rate is 4.210 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	DF	SS	MS	F
Regression	1	9.040	9.040	1951.972
Residual	5	.023	.005	
Total	6	9.064		

INTERCEPT= 6.88888129123
GRADIENT= -7.40172635428E-02

Ventilation rate is 4.441 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	DF	SS	MS	F
Regression	1	8.986	8.986	636.462
Residual	5	.071	.014	
Total	6	9.056		

INTERCEPT= 7.11709671035
GRADIENT= -7.39395125579E-02

Ventilation rate is 4.436 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	DF	SS	MS	F
Regression	1	9.543	9.543	7097.066
Residual	5	.007	.001	
Total	6	9.549		

INTERCEPT= 7.15740427366
GRADIENT= -7.63288715913E-02

Ventilation rate is 4.360 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 6

Source	DF	SS	MS	F
Regression	1	8.815	8.815	2133.131
Residual	5	.021	.004	
Total	6	8.836		

INTERCEPT= 7.25509682491
GRADIENT= -7.32914957388E-02

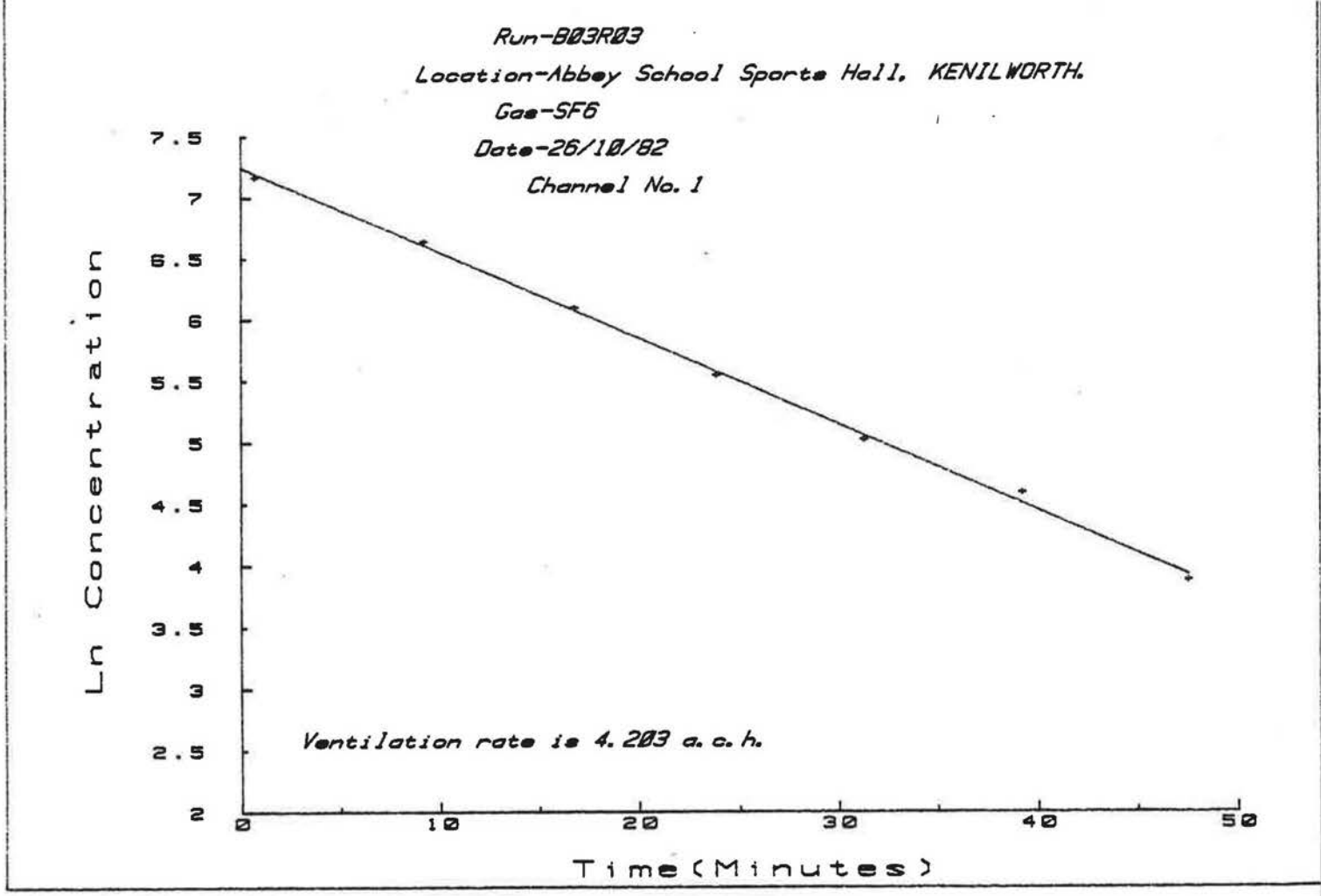
Ventilation rate is 4.397 air changes per hour

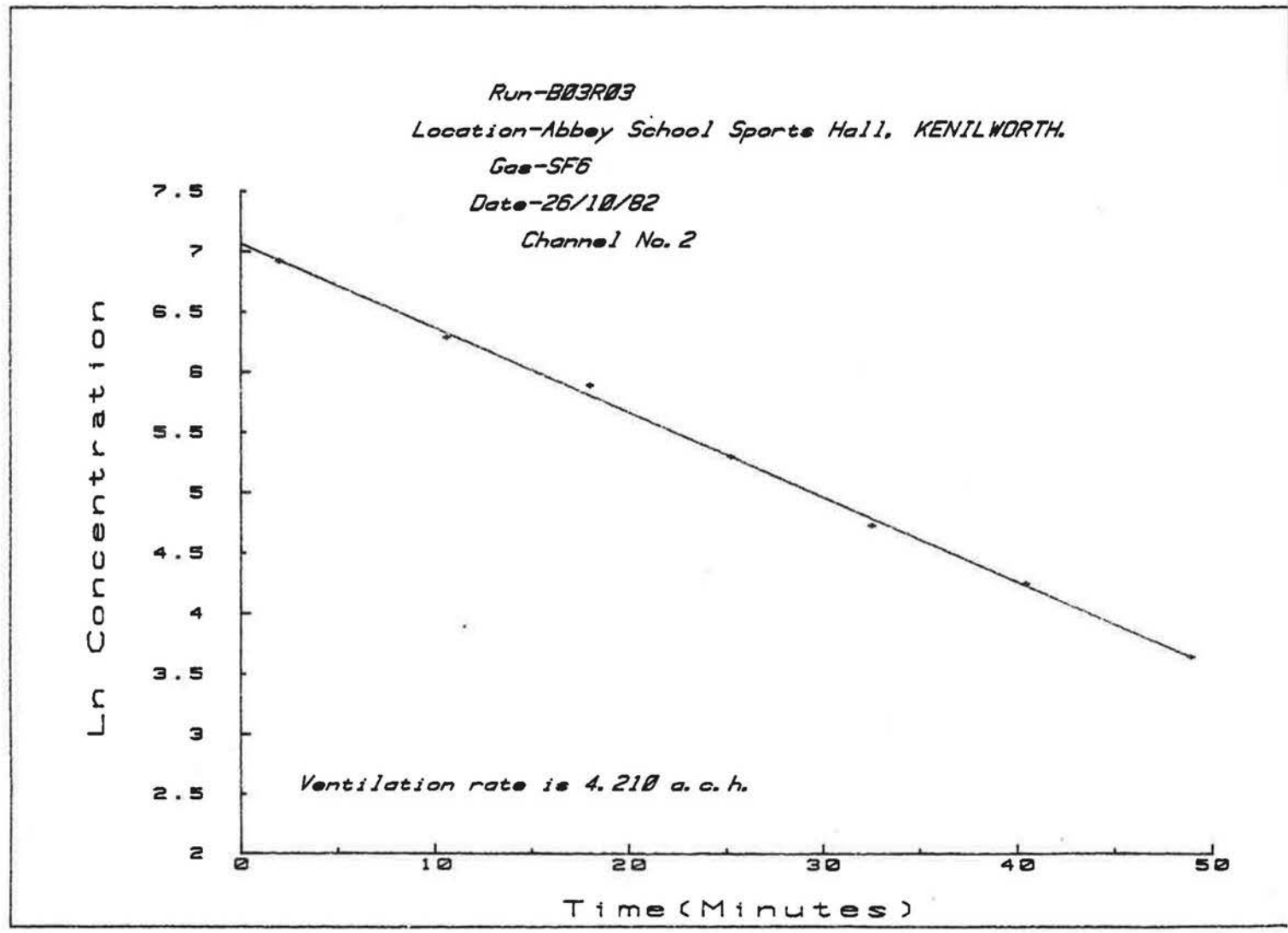
STATISTICAL ANALYSIS - ALL CHANNELS

Source	DF	SS	MS	F
Regression	1	53.912	53.912	2801.610
Residual	40	1.077	.027	
Total	41	54.989		

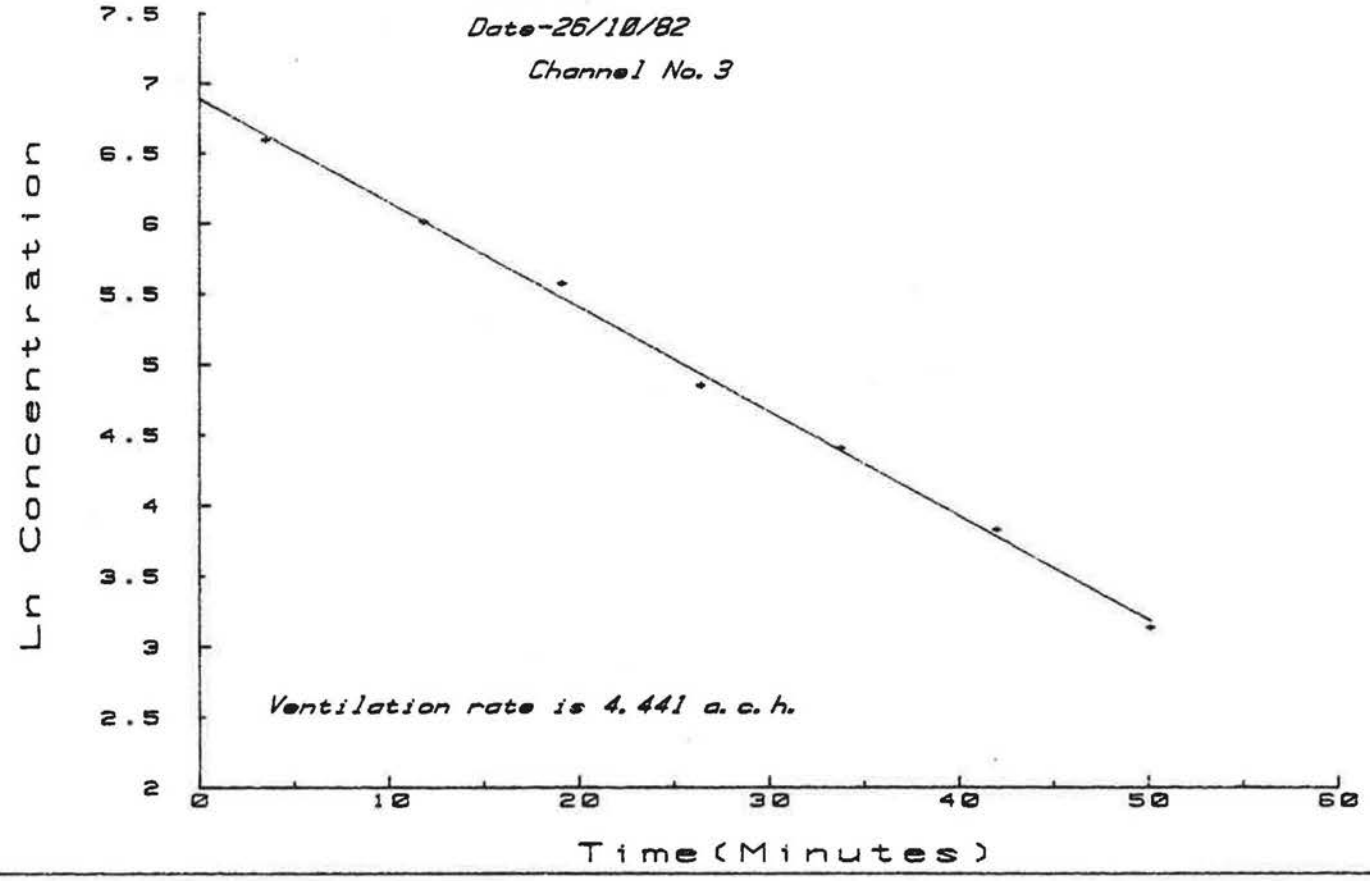
INTERCEPT= 7.12206144579
GRADIENT= -7.31194113134E-02

Ventilation rate is 4.387 air changes per hour

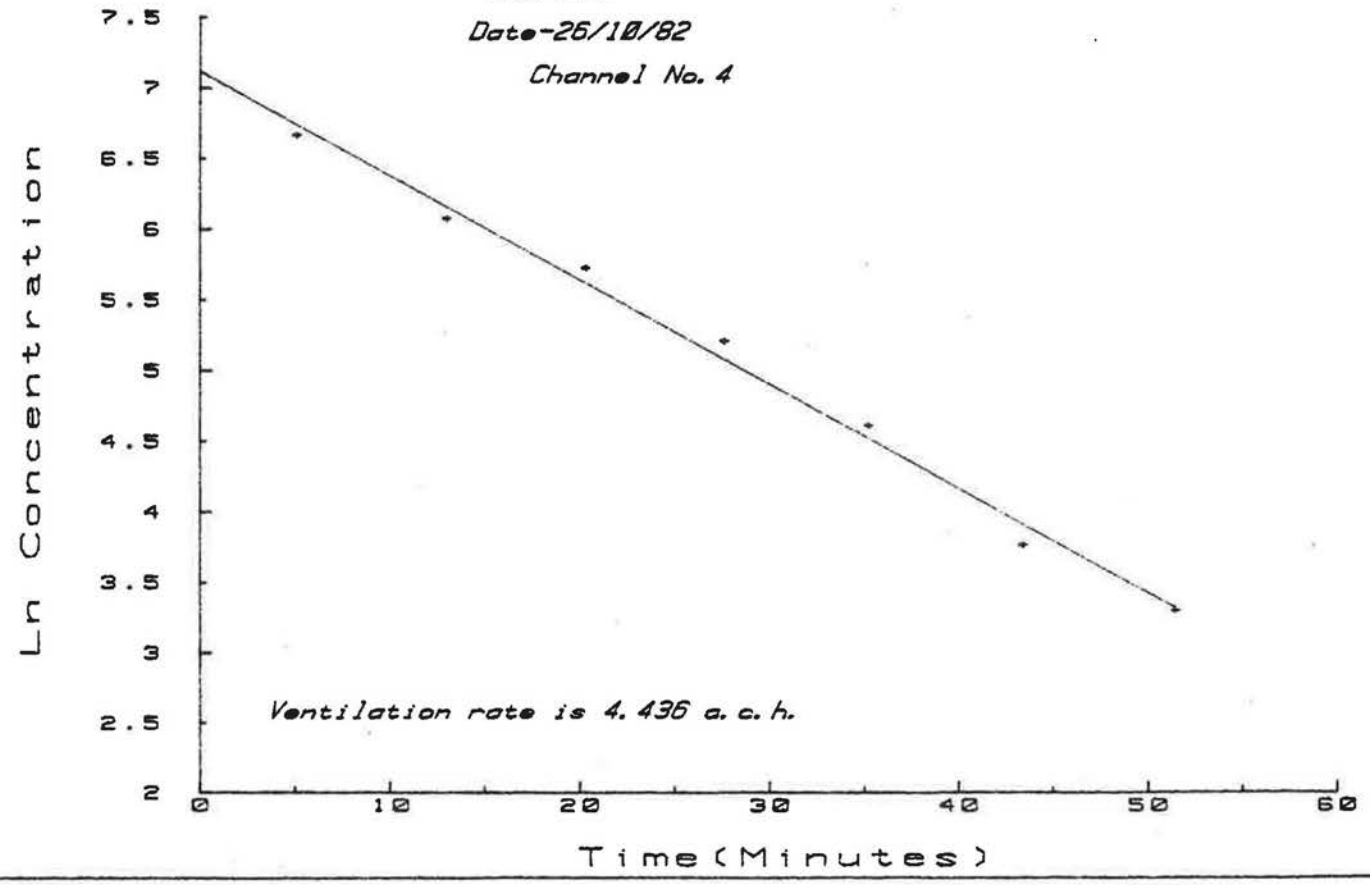

Run-B03R03
Location-Abbey School Sports Hall, KENILWORTH.
Gas-SF6
Date-26/10/82
Channel No. 1
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
Ventilation rate is 4.203 a.c.h.
0
10
20
30
40
50
Time(Minutes)

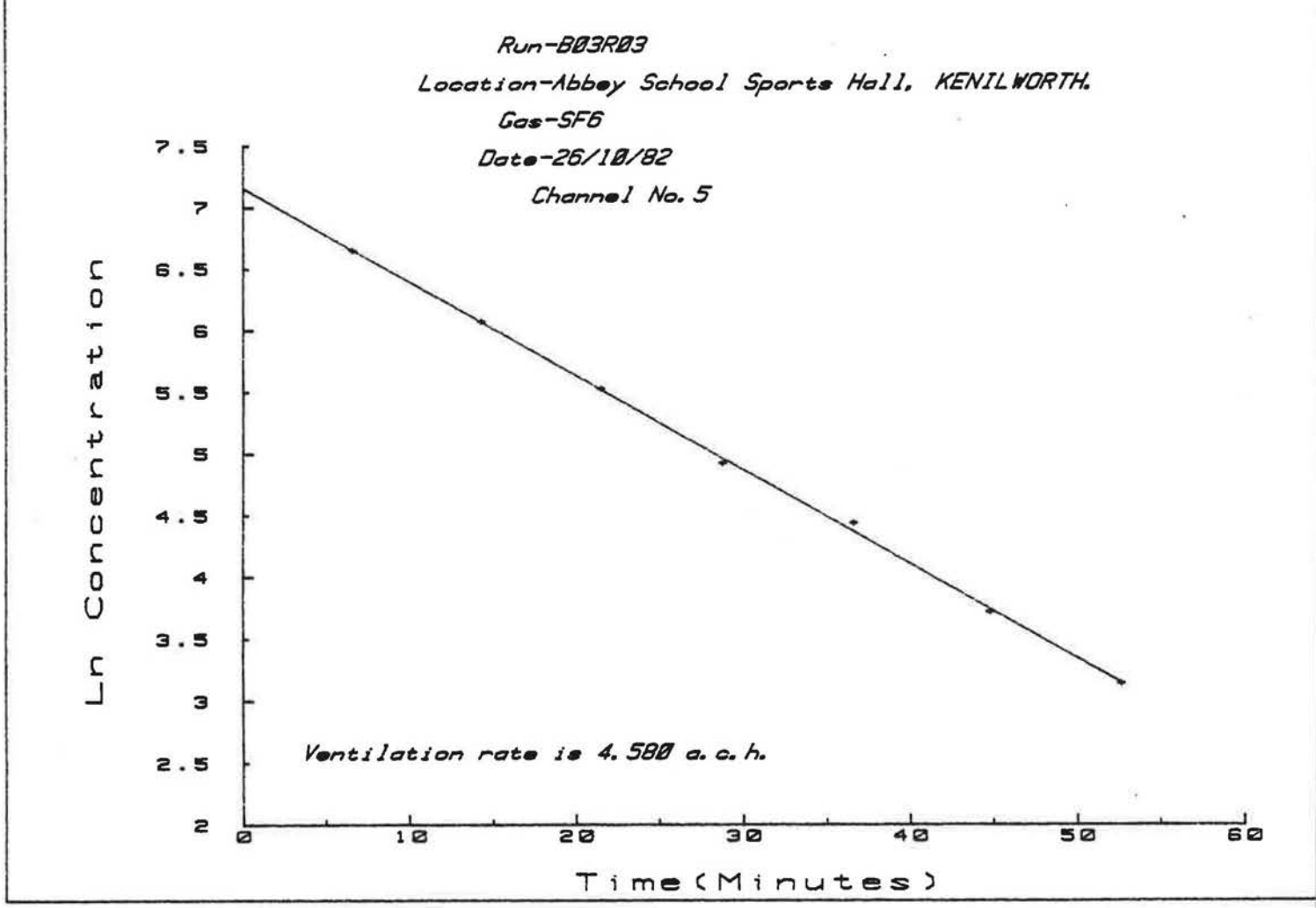

Run-B03R03
Location-Abbey School Sports Hall, KENILWORTH.
Gas-SF6
Date-26/10/82
Channel No. 2
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
Ventilation rate is 4.210 a.c.h.
0
10
20
30
40
50
Time(Minutes)

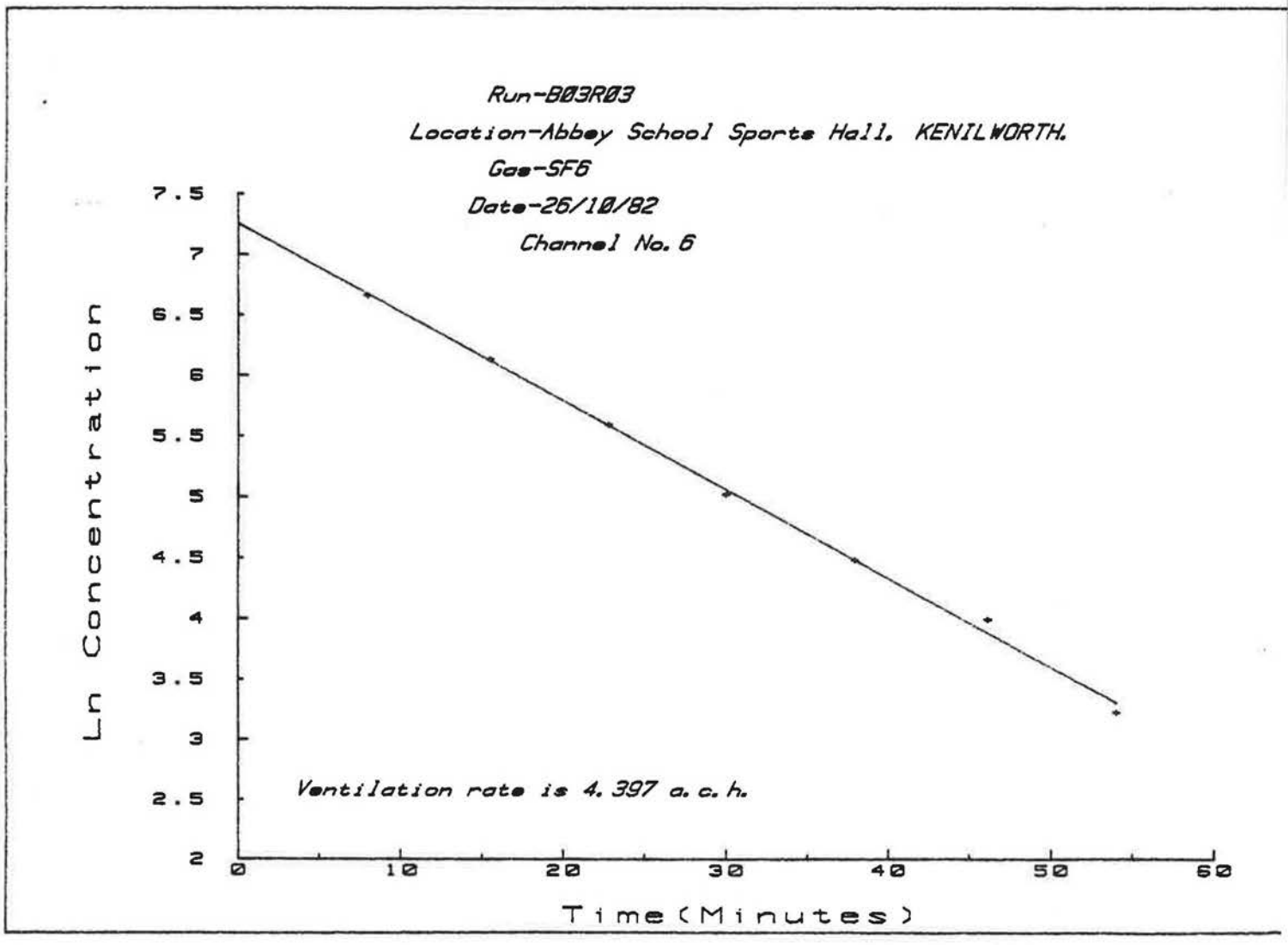
Run-B03R03
Location-Abbey School Sports Hall. KENILWORTH.
Gas-SF6
Date-26/10/82
Channel No. 3



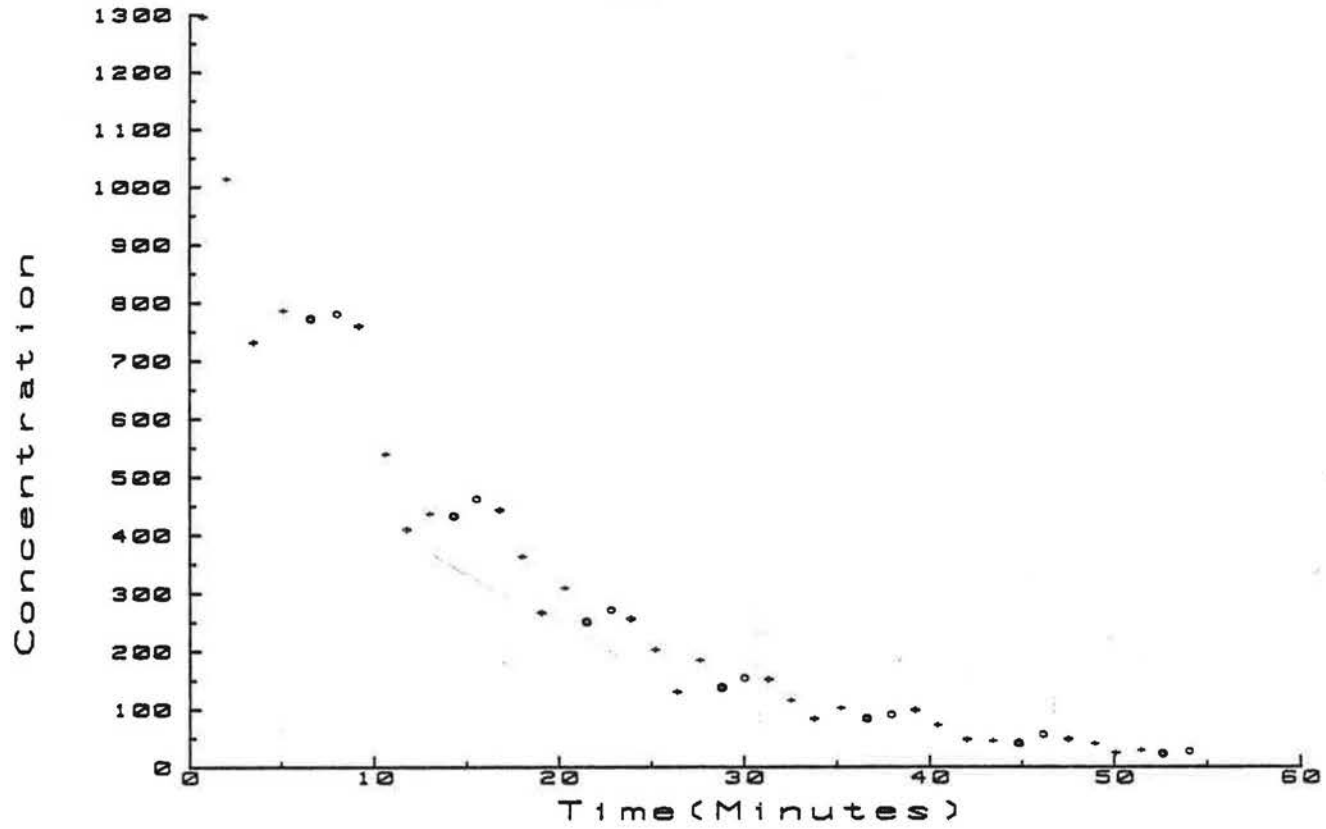
Run-B03R03
Location-Abbey School Sports Hall. KENILWORTH.
Gas-SF6
Date-26/10/82
Channel No. 4



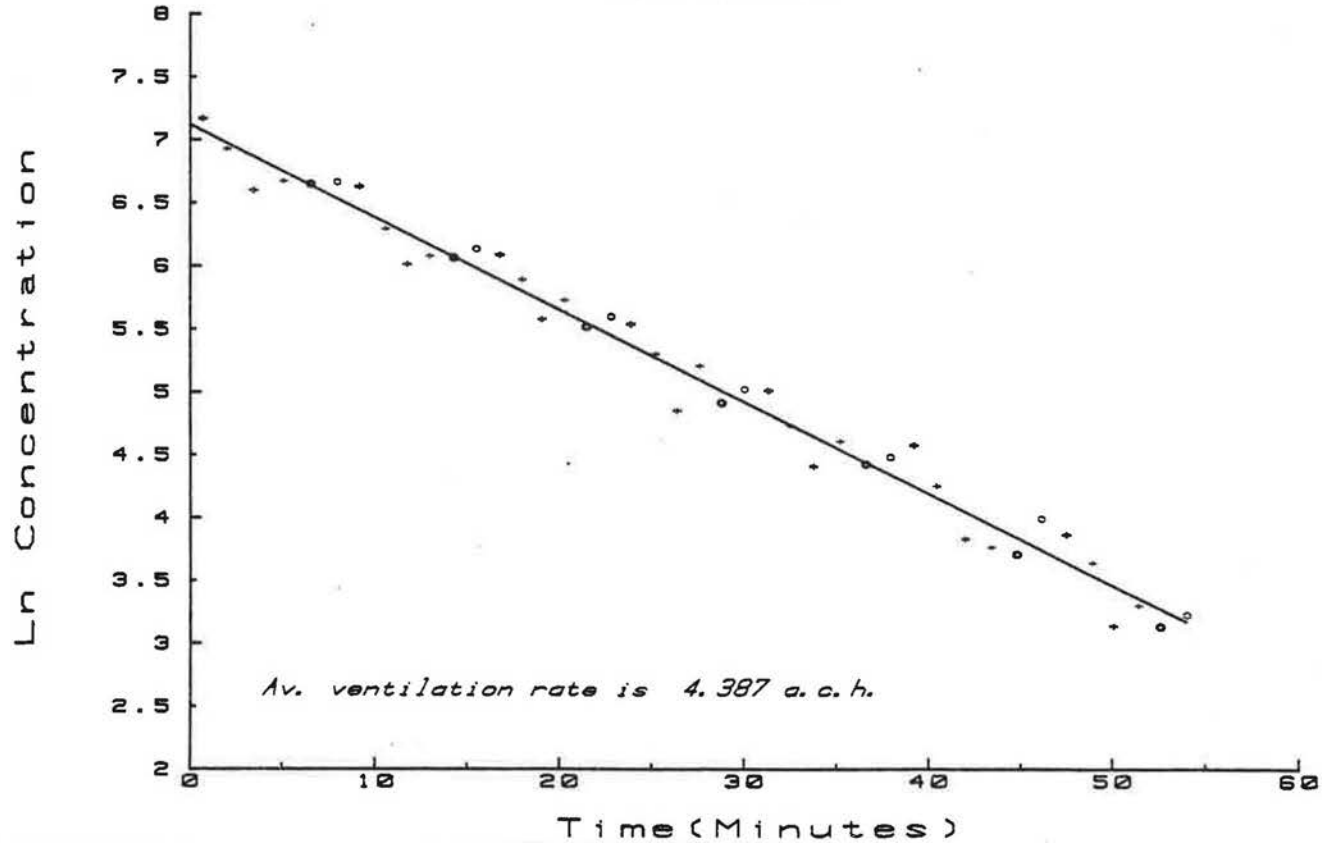

Run-B03R03
Location-Abbey School Sports Hall, KENILWORTH.
Gas-SF6
Date-26/10/82
Channel No. 5
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0
10
20
30
40
50
60
Time(Minutes)
Ventilation rate is 4.580 a.c.h.


Run-B03R03
Location-Abbey School Sports Hall, KENILWORTH.
Gas-SF6
Date-26/10/82
Channel No. 6
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0
10
20
30
40
50
60
Time(Minutes)
Ventilation rate is 4.397 a.c.h.

Run-B03R03
Location-Abbey School Sports Hall, KENILWORTH.
Gas-SF6
Date-26/10/82



Run-B03R03
Location-Abbey School Sports Hall, KENILWORTH.
Gas-SF6
Date-26/10/82



B03 R04

Date: 26th October 1982

Time: 1440 hours to 1550 hours

Tracer Gas: Sulphur Hexaflouride

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1400 hrs	5.7	14.3
1500 hrs	4.6	13.8
1600 hrs	4.1	13.8

Wind Direction: west south west

Internal Conditions:

air velocity: 0.01 to 0.10 m/s
temperature: 14 to 15^{o}C

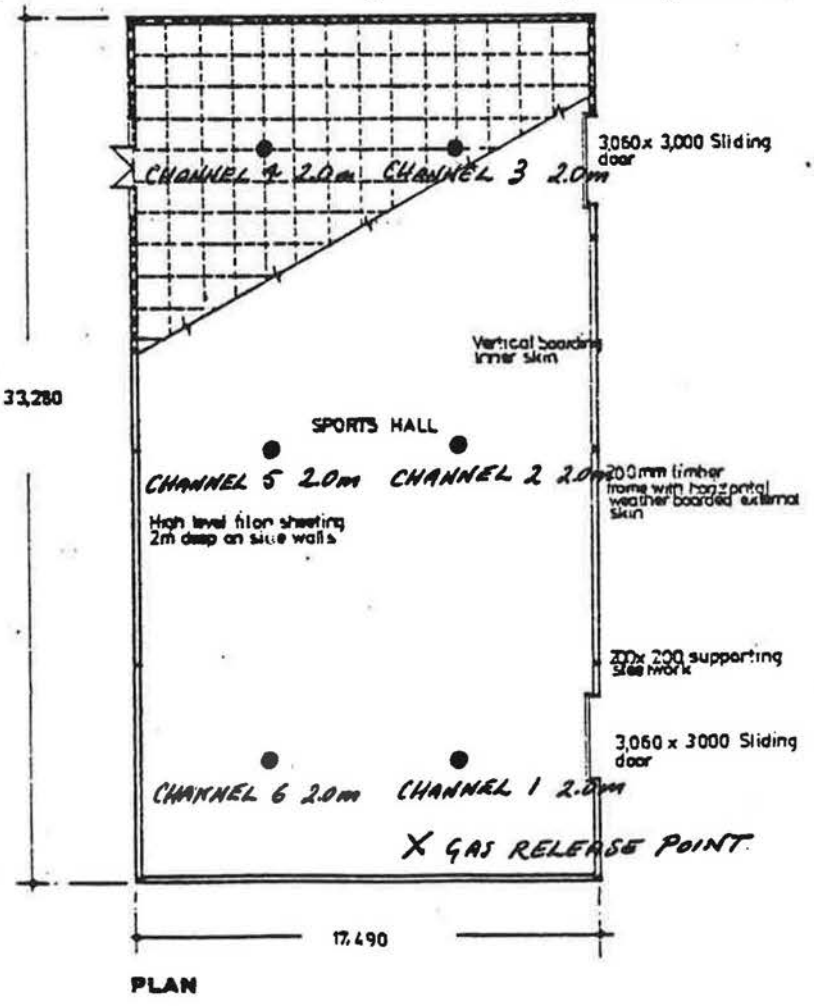
Gas Release:

Gas bled into room without fan or any other mixing at point shown on plan.

Sample Positions:

As shown on plan.

Comment: Gas bled in over a period of about 10 minutes and readings commenced approximately 10 minutes after completion of gas injection.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B03R04
Location: Abbey School Sports Hall, KENILWORTH
Date: 26/10/82
Tracer gas: SF6

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5			Channel 6		
****	**********			**********			**********			**********			**********			**********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	1.1	1364	7.218	2.8	825	6.715	4.3	756	6.628	5.6	895	6.797	7.2	1149	7.047	8.7	1100	7.003
2	10.0	944	6.850	11.7	972	6.879	13.2	765	6.640	14.7	680	6.522	16.1	785	6.666	17.5	817	6.706
3	18.8	760	6.633	20.3	662	6.495	21.7	377	5.932	23.0	388	5.961	24.3	455	6.120	25.7	564	6.335
4	26.6	491	6.196	28.4	415	6.028	29.9	320	5.768	31.2	341	5.832	32.5	315	5.753	33.8	349	5.855
5	35.2	300	5.704	36.4	273	5.609	37.8	200	5.298	39.0	220	5.394	40.3	247	5.509	42.0	238	5.472
6	43.4	202	5.308	44.5	211	5.352	46.2	125	4.828	47.6	165	5.106	48.8	186	5.226	49.9	179	5.187
7	51.1	141	4.949	52.4	122	4.804	53.5	80	4.382	54.9	100	4.605	56.1	100	4.605	57.3	103	4.635
8	59.1	92	4.522	60.5	75	4.317	61.9	55	4.007	63.2	60	4.094	64.4	70	4.248	65.8	75	4.317

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	DF	SS	MS	F
Regression	1	6.409	6.409	846.945
Residual	6	.045	.008	
Total	7	6.455		

INTERCEPT= 7.3722892651S
GRADIENT= -4.727945138638E-02

Ventilation rate is 2.837 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	DF	SS	MS	F
Regression	1	5.685	5.685	123.803
Residual	6	.276	.046	
Total	7	5.960		

INTERCEPT= 7.21791521748
GRADIENT= -4.491128165768-02

Ventilation rate is 2.695 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	DF	SS	MS	F
Regression	1	6.623	6.623	276.864
Residual	6	.144	.024	
Total	7	6.767		

INTERCEPT= 7.06698375867
GRADIENT= -4.866855028658-02

Ventilation rate is 2.917 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	DF	SS	MS	F
Regression	1	5.893	5.893	406.237
Residual	6	.087	.015	
Total	7	5.980		

INTERCEPT= 7.13973435026
GRADIENT= -4.547028187628-02

Ventilation rate is 2.752 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	DF	SS	MS	F
Regression	1	6.405	6.405	596.624
Residual	6	.064	.011	
Total	7	6.470		

INTERCEPT= 7.38894368192
GRADIENT= -4.811138406558-02

Ventilation rate is 2.887 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 6

Source	DF	SS	MS	F
Regression	1	6.463	6.463	1164.659
Residual	6	.033	.006	
Total	7	6.496		

INTERCEPT= 7.51129511146
GRADIENT= -4.846572192688-02

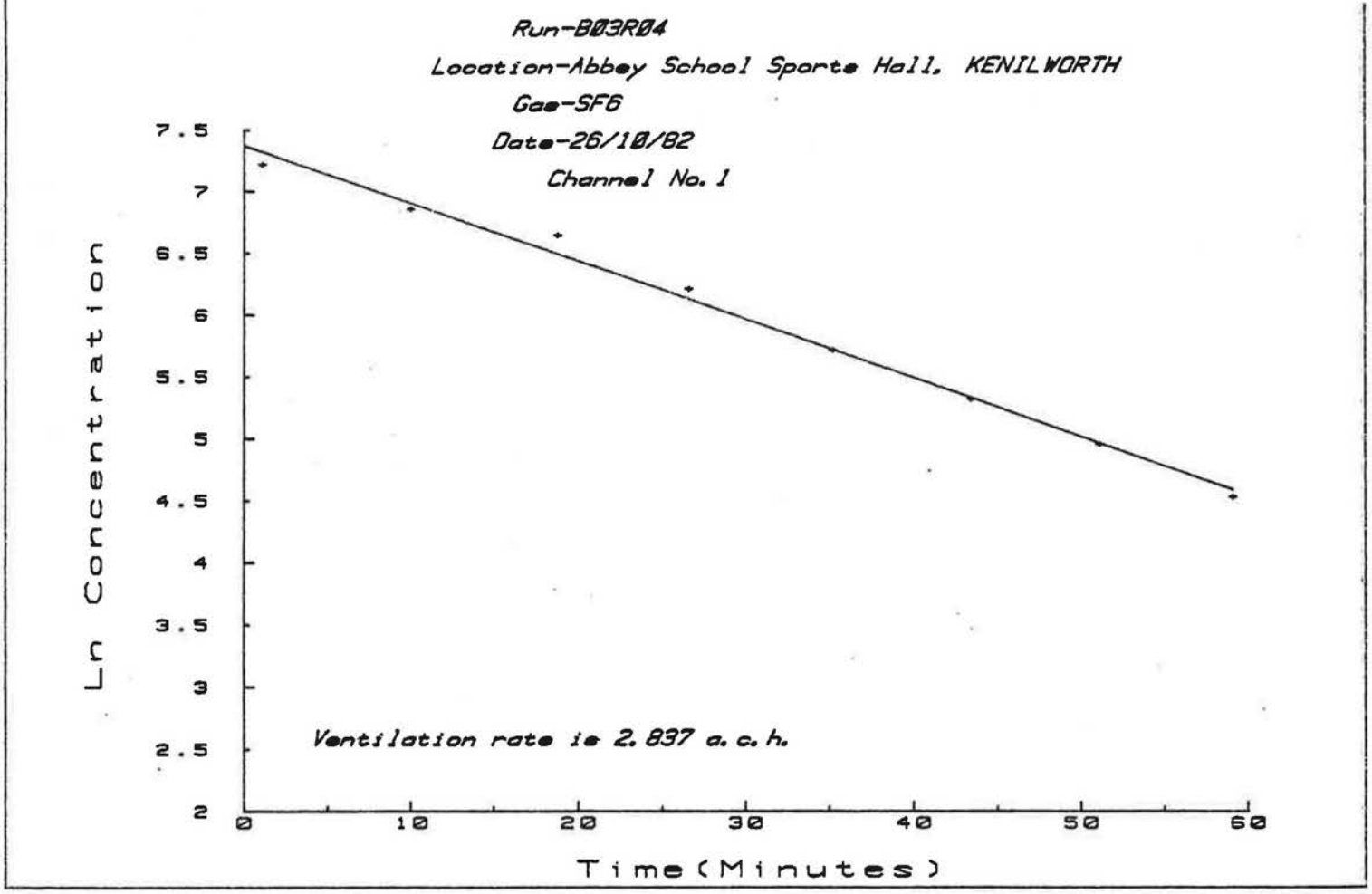
Ventilation rate is 2.909 air changes per hour

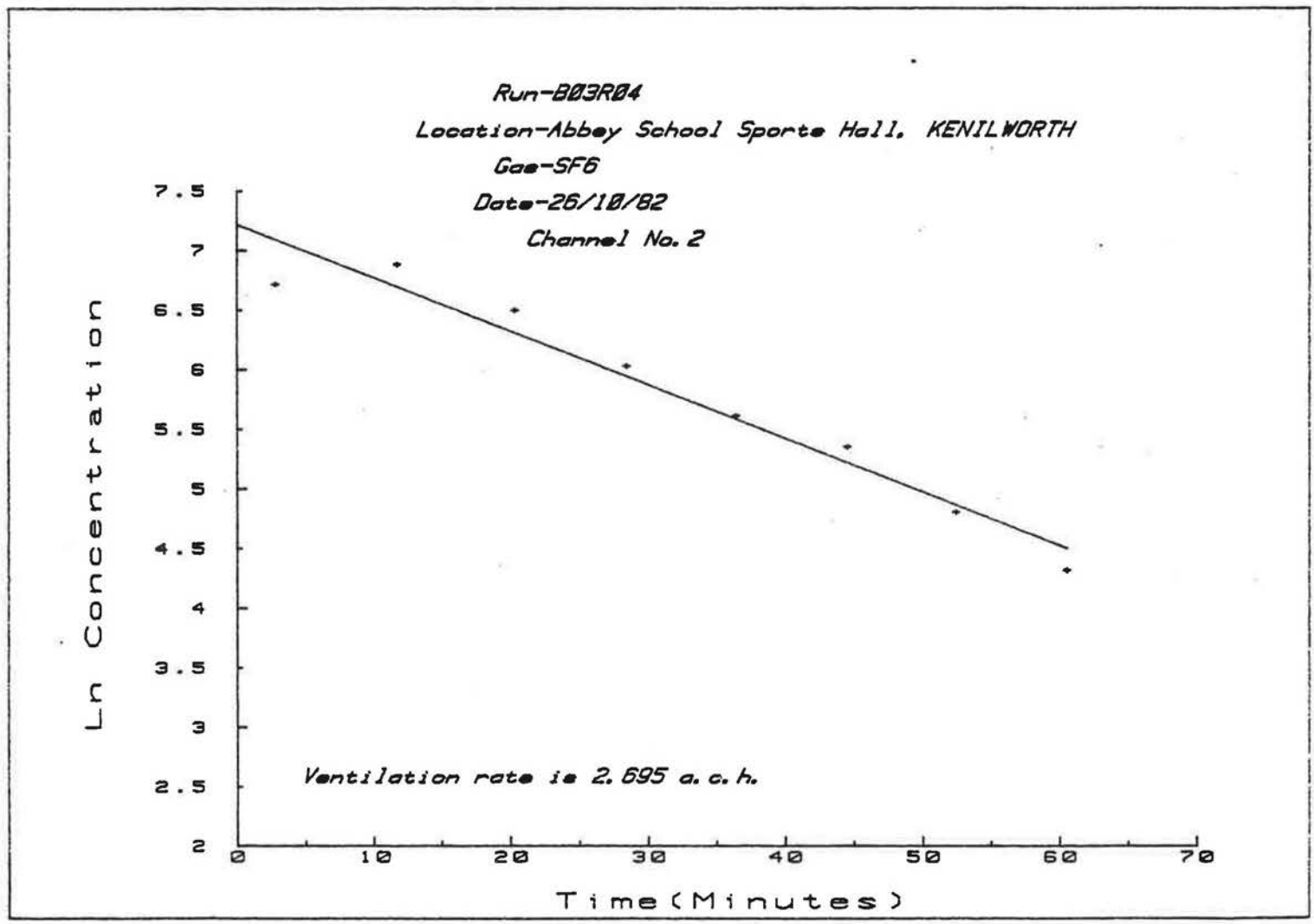
STATISTICAL ANALYSIS - ALL CHANNELS

Source	DF	SS	MS	F
Regression	1	37.639	37.639	1035.166
Residual	46	1.673	.036	
Total	47	39.312		

INTERCEPT= 7.27261974345
GRADIENT= -.046954333642

Ventilation rate is 2.817 air changes per hour


Run-B03R04
Location-Abbey School Sports Hall. KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 1
Ln Concentration
Time(Minutes)
Ventilation rate is 2.837 a.c.h.
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0
10
20
30
40
50
60


Run-B03R04
Location-Abbey School Sports Hall. KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 2
Ln Concentration
Time(Minutes)
Ventilation rate is 2.695 a.c.h.
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0
10
20
30
40
50
60
70

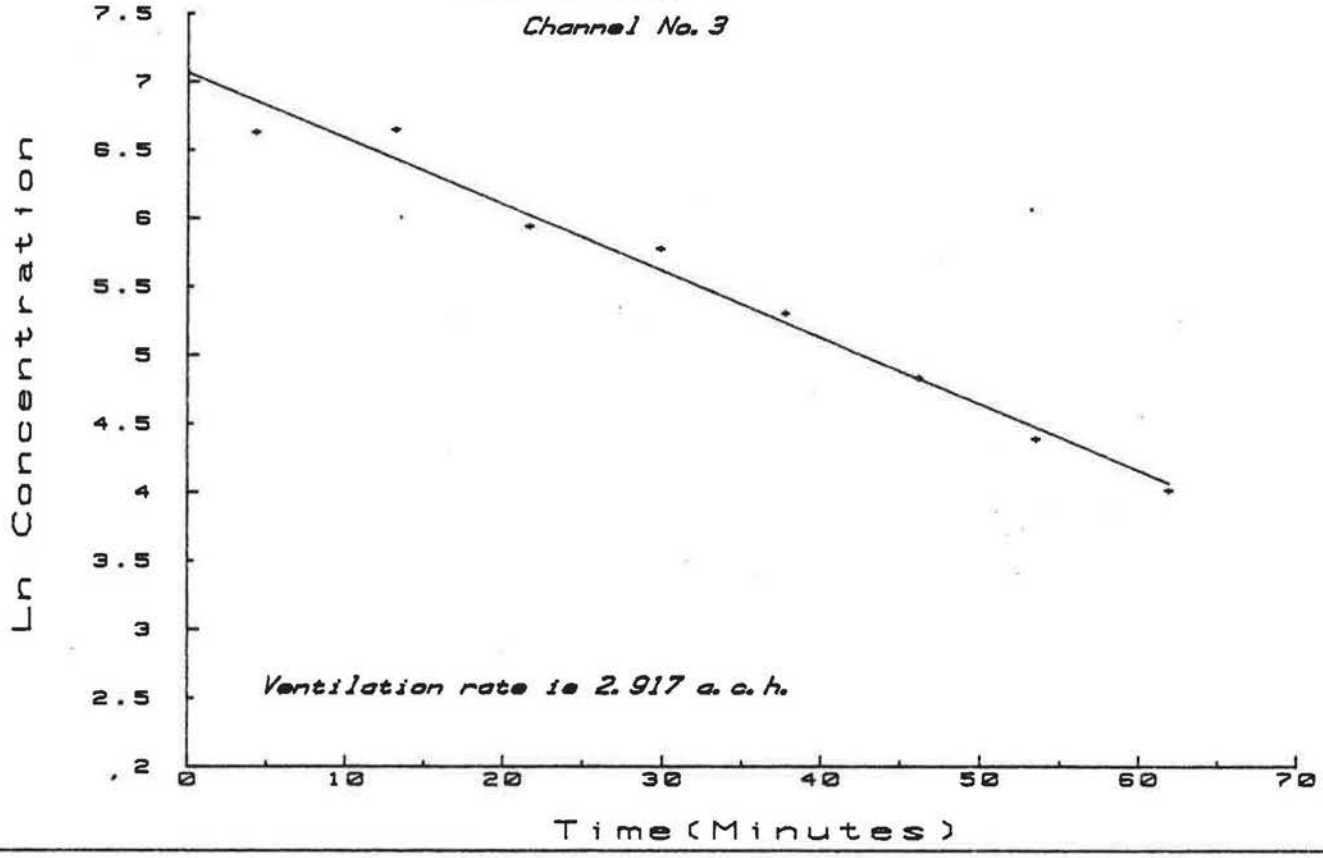
Run-B03R04

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-26/10/82

Channel No. 3



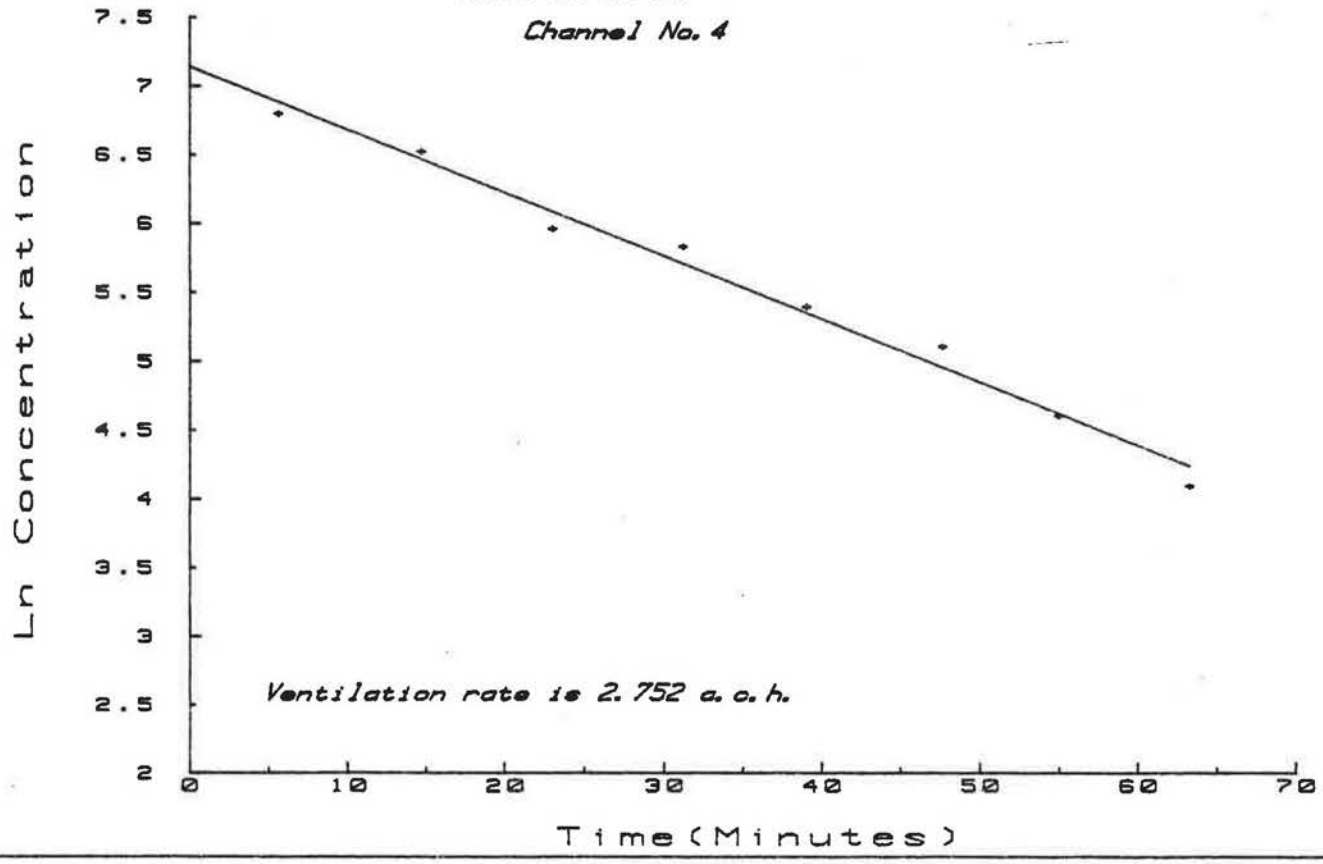
Run-B03R04

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-26/10/82

Channel No. 4



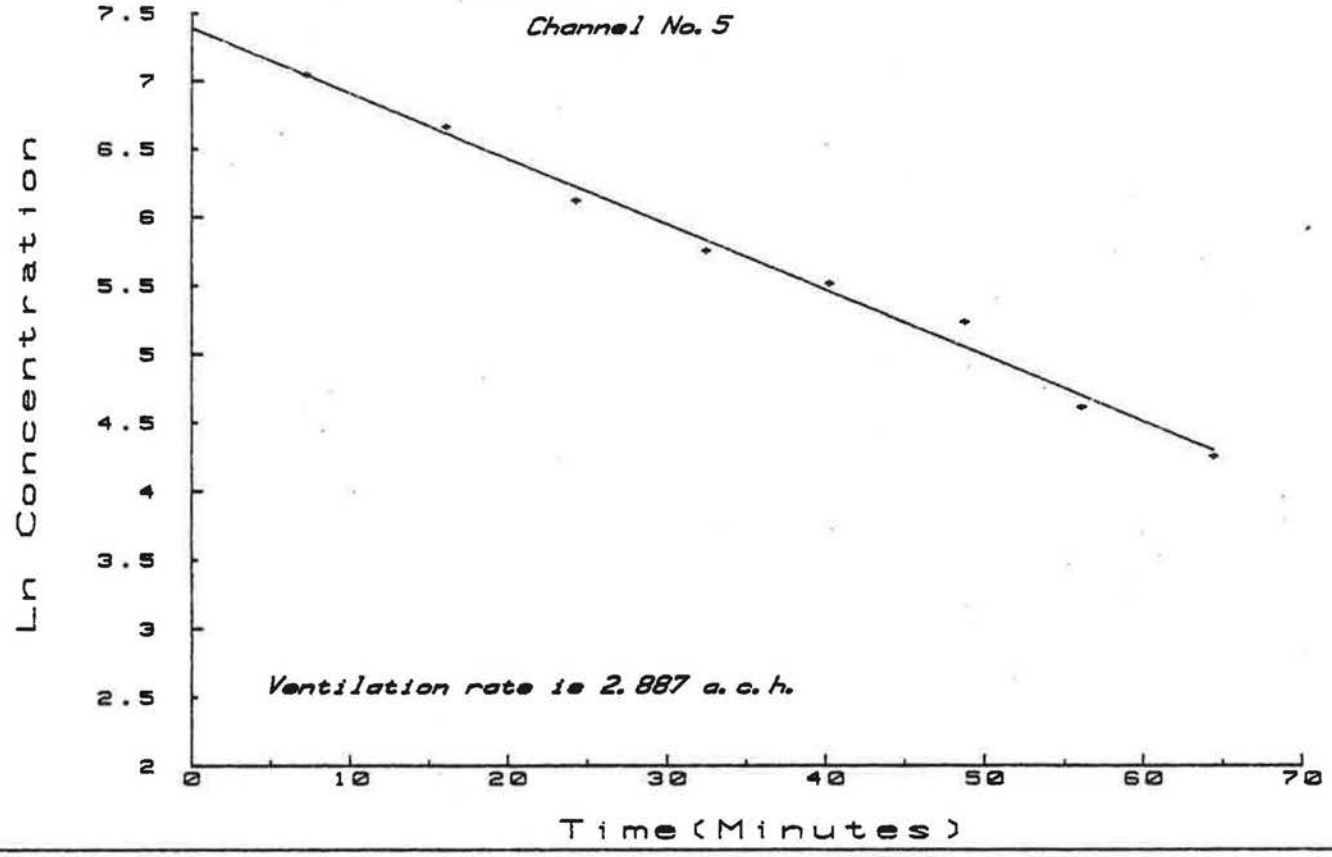
Run-B03R04

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-26/10/82

Channel No. 5



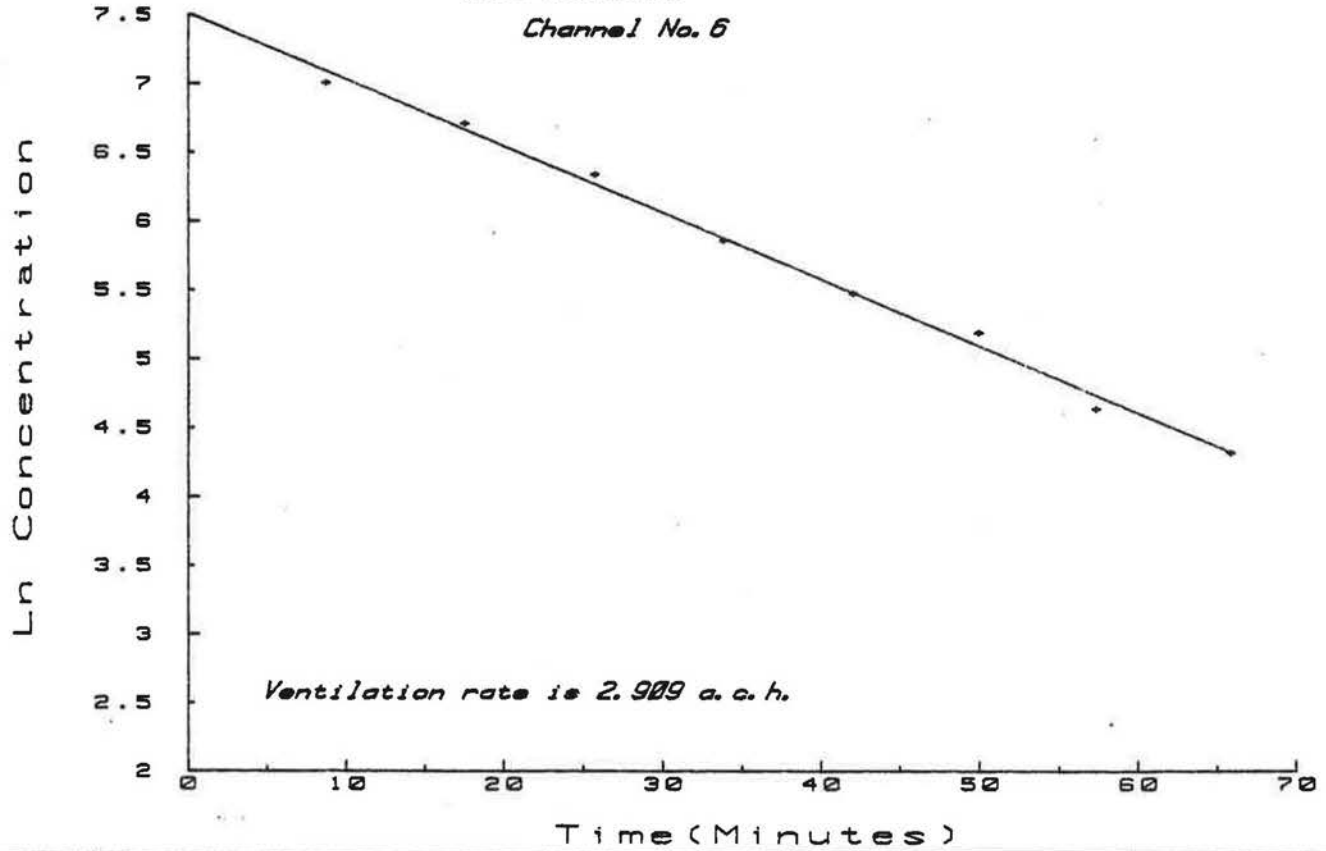
Run-B03R04

Location-Abbey School Sports Hall, KENILWORTH

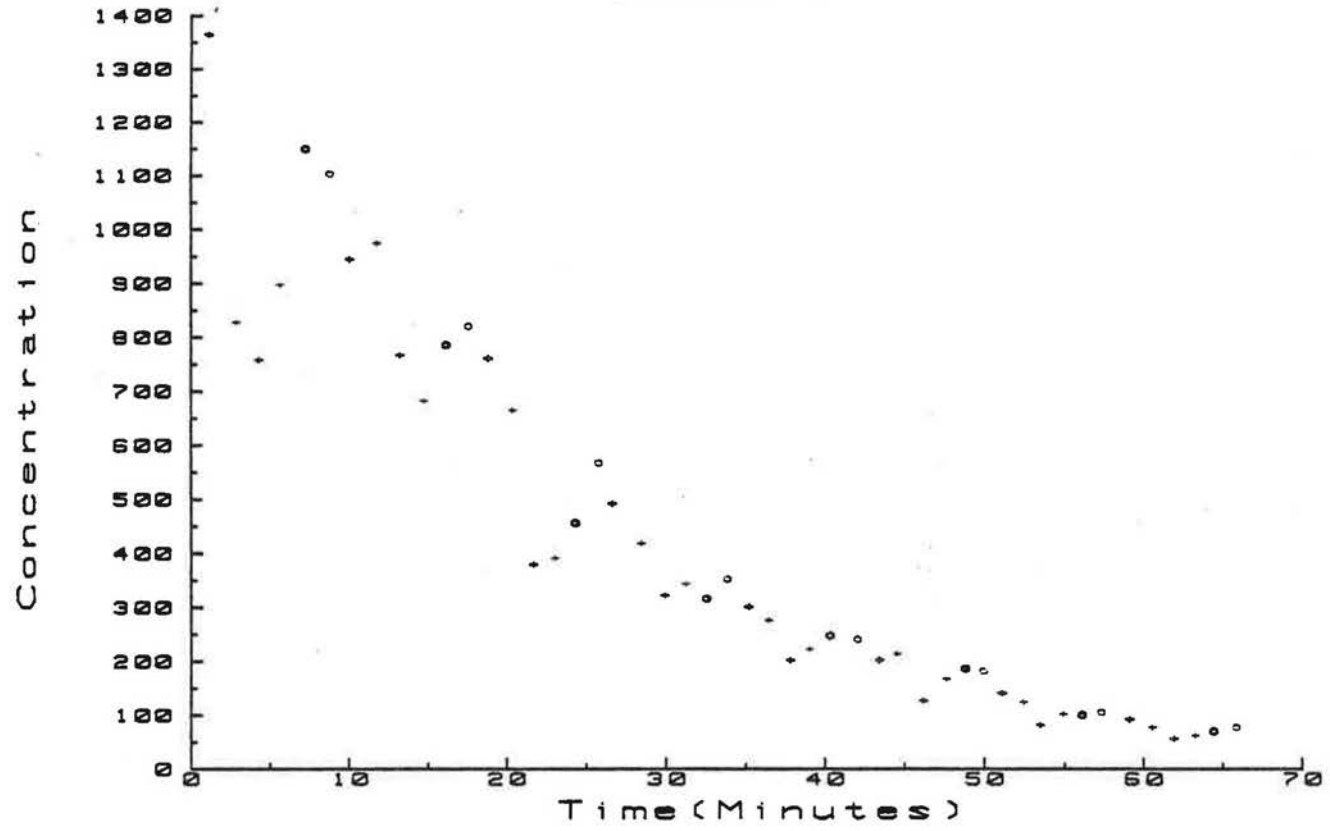
Gas-SF6

Date-26/10/82

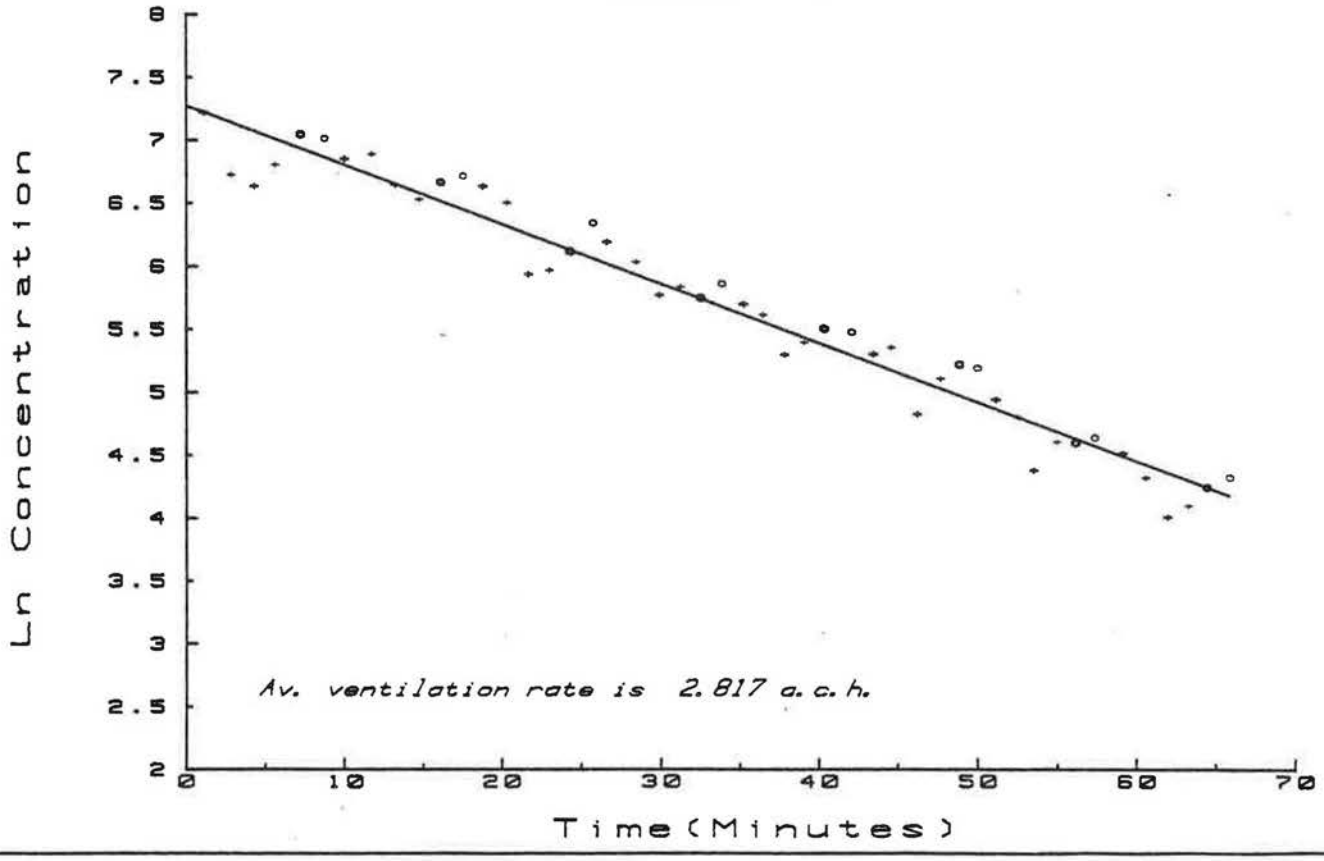
Channel No. 6



Run-B03R04
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82



Run-B03R04
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82



B03 R05

Date: 26th October, 1982

Time: 1600 hours to 1700 hours

Tracer Gas: Sulphur Hexaflouride

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1600 hrs	4.1	13.8
1700 hrs	7.7	12.9

Wind Direction: west south west

Internal Conditions:

air velocity: 0.01 to 0.10 m/s
temperature: 14 to 15^{o}C

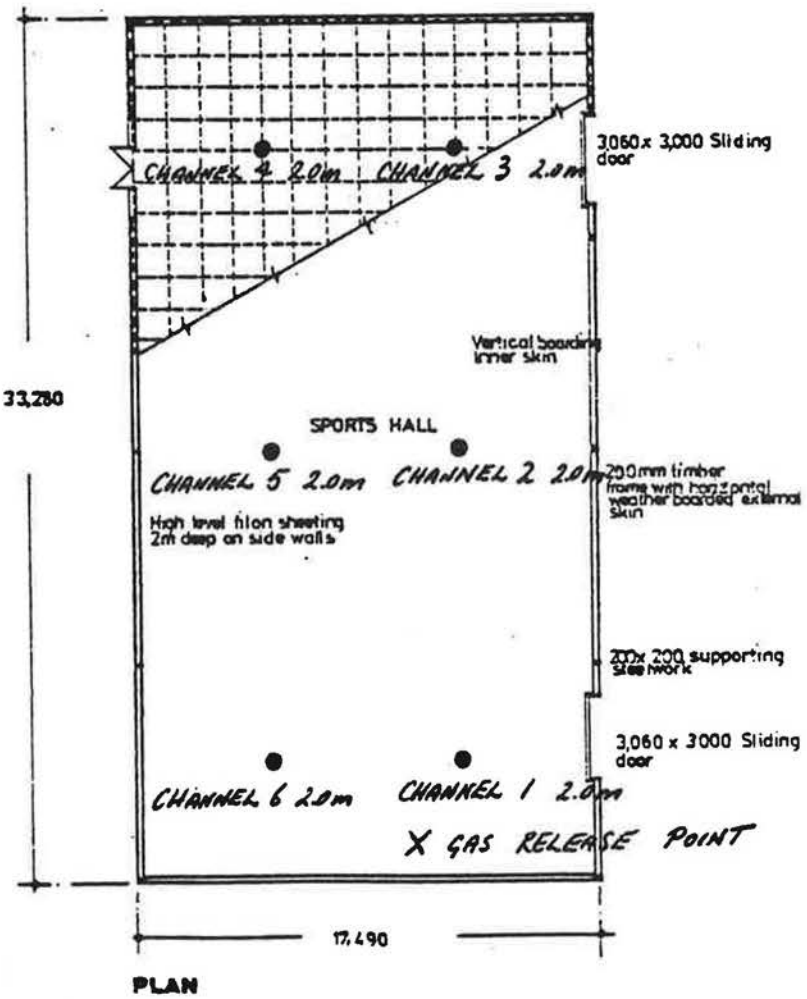
Gas Release:

Gas bled into room without fan or any other mixing at point shown on plan.

Sample Positions:

As shown on plan.

Comment: Gas bled in over a period of about 10 minutes and readings commenced approximately 10 minutes after completion of gas injection.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B03R05
Location: Abbey School Sports Hall, KENILWORTH
Date: 26/10/82
Tracer gas: SF6

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5			Channel 6		
****	**********			**********			**********			**********			**********			**********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	1.3	915	6.819	2.7	1586	7.369	4.4	1283	7.157	6.3	1361	7.216	7.9	1110	7.012	9.5	1011	6.919
2	10.7	1228	7.113	12.2	1016	6.924	13.6	963	6.870	15.1	1065	6.971	16.5	980	6.888	17.8	992	6.900
3	19.3	975	6.882	20.8	1013	6.921	22.5	671	6.509	24.1	754	6.625	25.6	742	6.609	26.9	757	6.629
4	28.3	795	6.678	29.8	728	6.590	31.4	695	6.544	32.7	560	6.328	34.2	650	6.477	35.6	632	6.449
5	36.8	628	6.443	38.2	622	6.433	39.5	576	6.356	40.7	454	6.118	42.1	496	6.207	43.3	571	6.347
6	44.6	540	6.292	46.0	544	6.299	47.2	430	6.064	48.4	383	5.948	49.9	394	5.976	51.1	441	6.089
7	52.4	465	6.142	53.7	396	5.981	55.2	353	5.866	56.5	369	5.911	57.7	346	5.846	59.1	335	5.814
8	60.2	341	5.832	61.4	328	5.793	62.6	288	5.663	63.8	241	5.485	65.0	286	5.656	66.3	270	5.598
9	67.5	267	5.587	68.9	254	5.537	70.1	214	5.366	71.2	205	5.323	72.4	228	5.429	73.5	217	5.380
10	74.7	205	5.323	75.8	191	5.252	77.0	175	5.165	78.2	162	5.088	79.5	176	5.170	80.7	165	5.106
11	81.9	169	5.130	83.1	156	5.050	84.2	148	4.997	85.6	130	4.868	86.8	132	4.883	88.0	130	4.868

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	DF	SS	MS	F
Regression	1	4.127	4.127	132.746
Residual	9	.280	.031	
Total	10	4.407		

INTERCEPT= 7.2506576958
GRADIENT= -2.410760383698-02

Ventilation rate is 1.446 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	DF	SS	MS	F
Regression	1	5.424	5.424	649.911
Residual	9	.075	.008	
Total	10	5.499		

INTERCEPT= 7.43480961565
GRADIENT= -2.774617071588-02

Ventilation rate is 1.666 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	DF	SS	MS	F
Regression	1	4.916	4.916	600.137
Residual	9	.074	.008	
Total	10	4.989		

INTERCEPT= 7.27808812439
GRADIENT= -2.659441193468-02

Ventilation rate is 1.596 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	DF	SS	MS	F
Regression	1	5.729	5.729	976.976
Residual	9	.053	.006	
Total	10	5.782		

INTERCEPT= 7.36167257718
GRADIENT= -2.889111666928-02

Ventilation rate is 1.733 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	DF	SS	MS	F
Regression	1	4.814	4.814	1038.270
Residual	9	.042	.005	
Total	10	4.856		

INTERCEPT= 7.31450356939
GRADIENT= -2.661004617368-02

Ventilation rate is 1.597 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 6

Source	DF	SS	MS	F
Regression	1	4.945	4.945	464.680
Residual	9	.096	.011	
Total	10	5.041		

INTERCEPT= 7.3666696871
GRADIENT= -2.706475485818-02

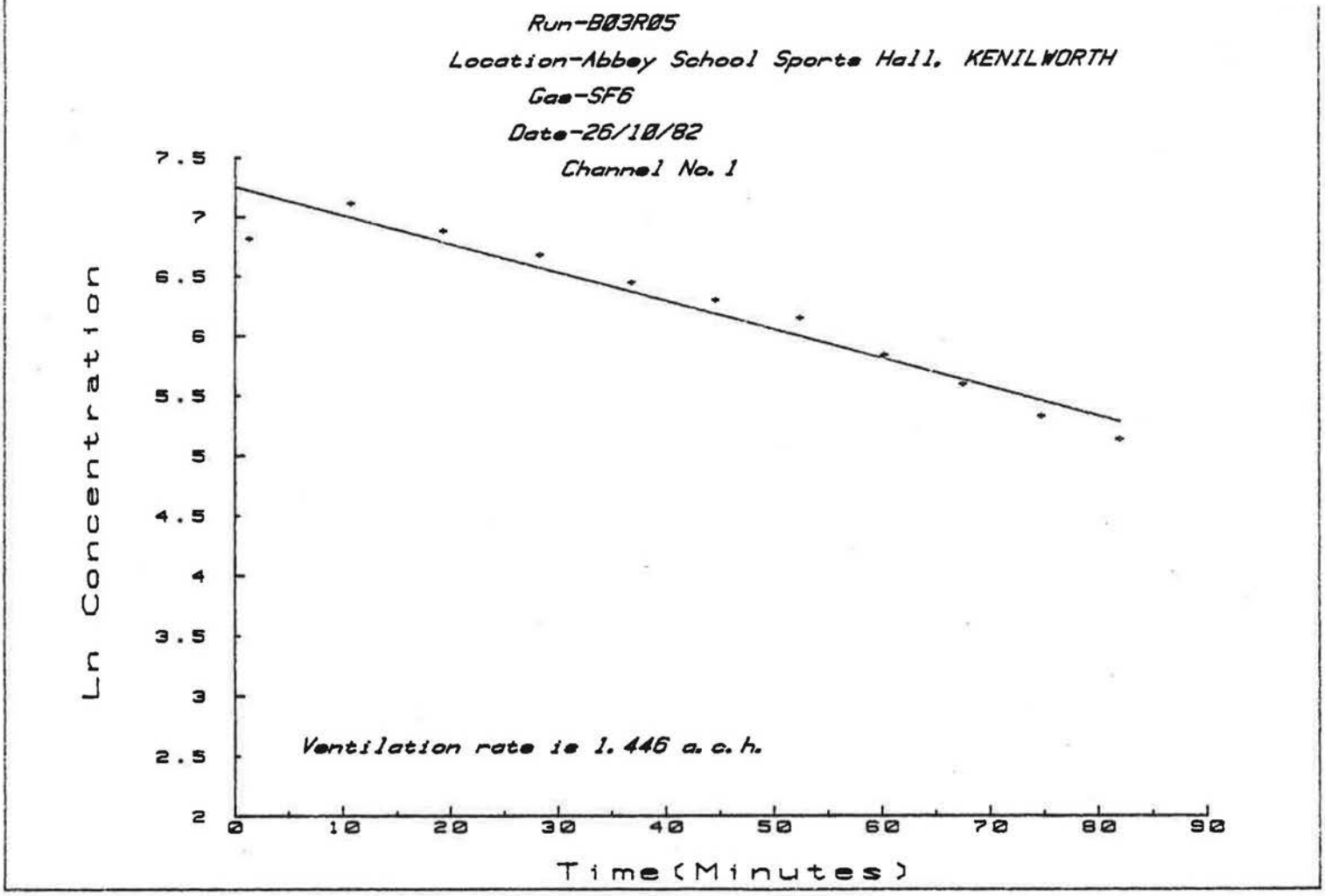
Ventilation rate is 1.624 air changes per hour

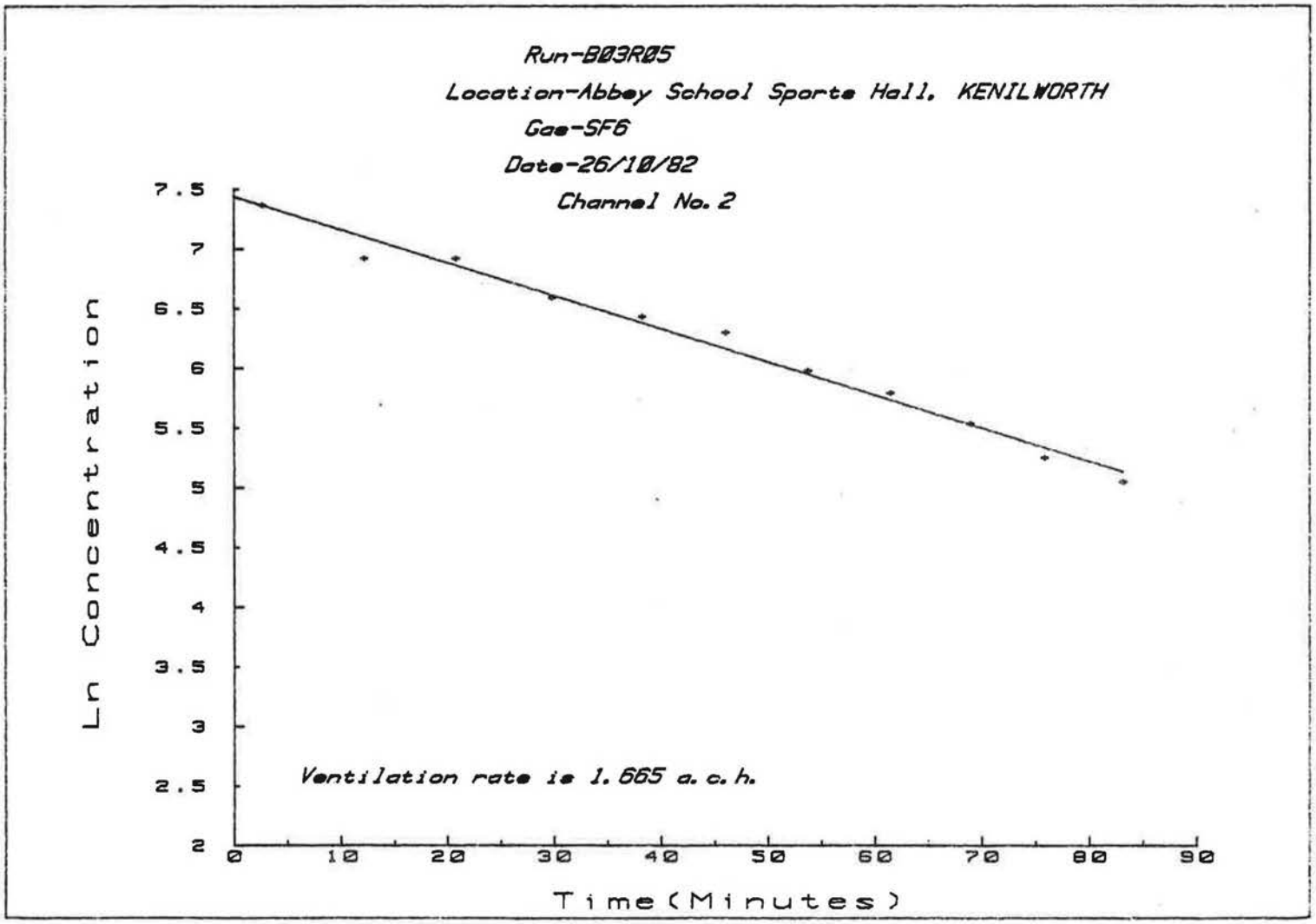
STATISTICAL ANALYSIS - ALL CHANNELS

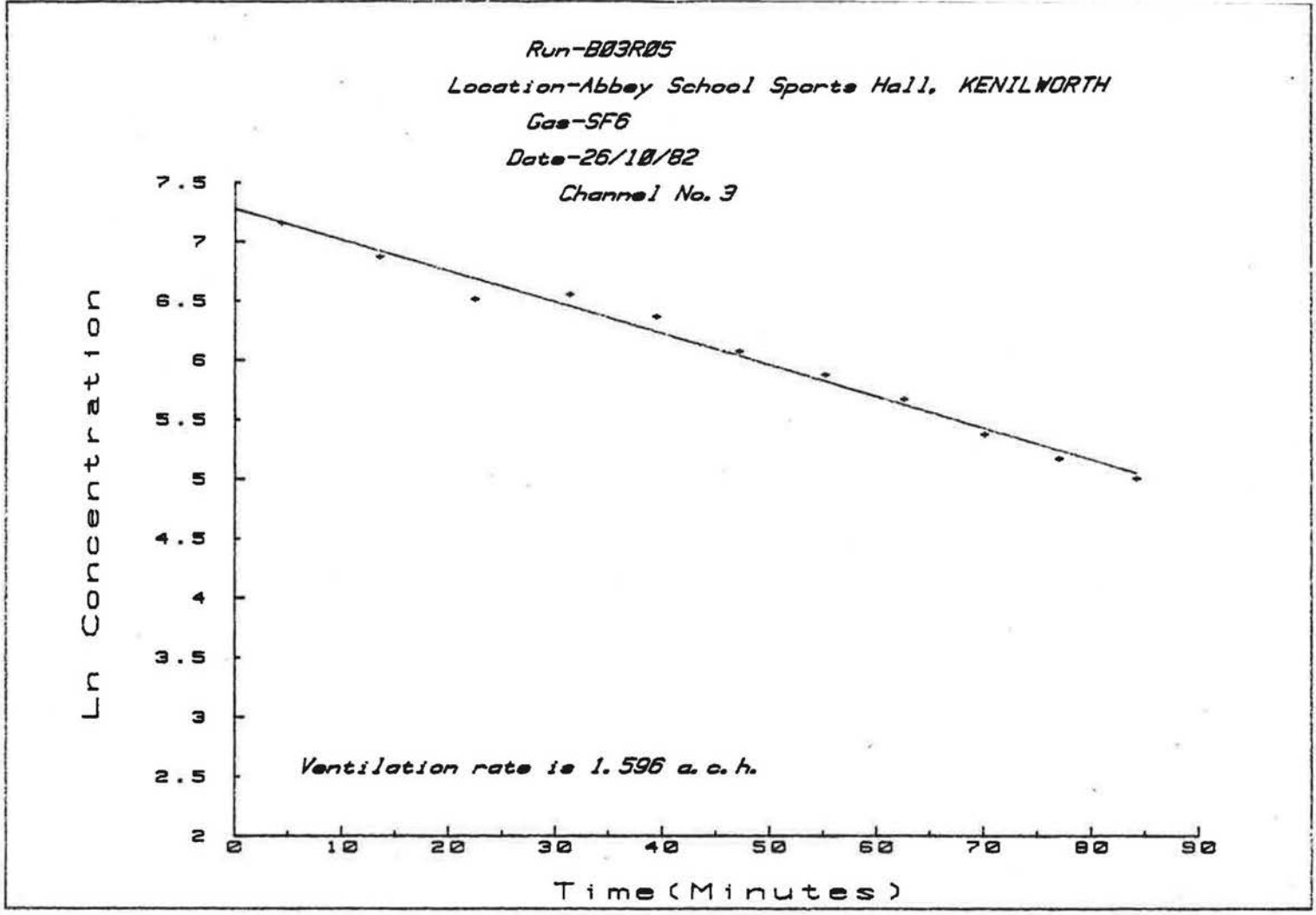
Source	DF	SS	MS	F
Regression	1	30.245	30.245	2286.090
Residual	64	.847	.013	
Total	65	31.092		

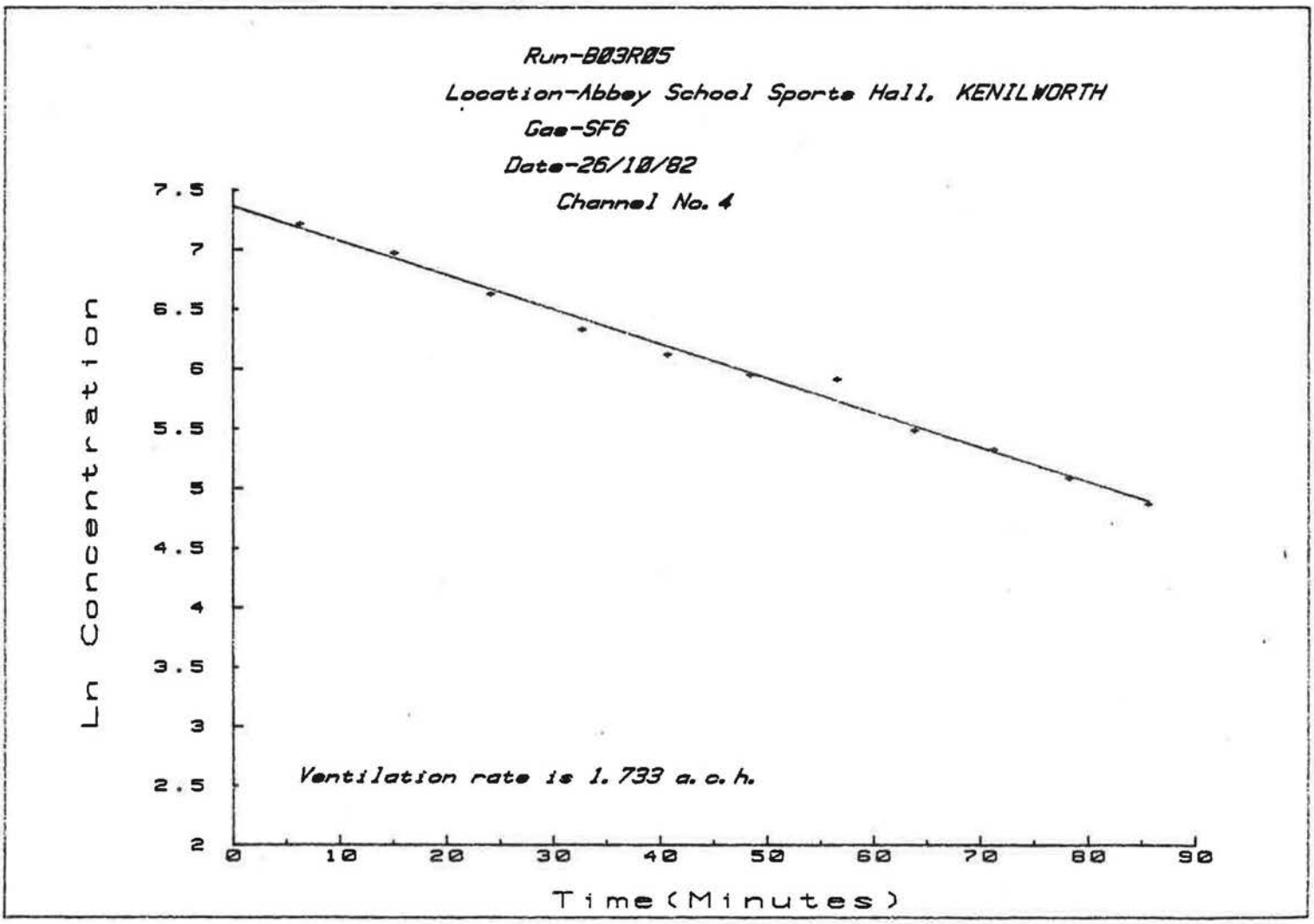
INTERCEPT= 7.23542e94619
GRADIENT= -2.667961982056-02

Ventilation rate is 1.613 air changes per hour


Run-B03R05
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 1
Ln Concentration
Ventilation rate is 1.446 a.c.h.
Time(Minutes)


Run-B03R05
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 2
Ln Concentration
Ventilation rate is 1.665 a.c.h.
Time(Minutes)


Run-B03R05
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 3
Ln Concentration
Ventilation rate is 1.596 a.c.h.
Time(Minutes)

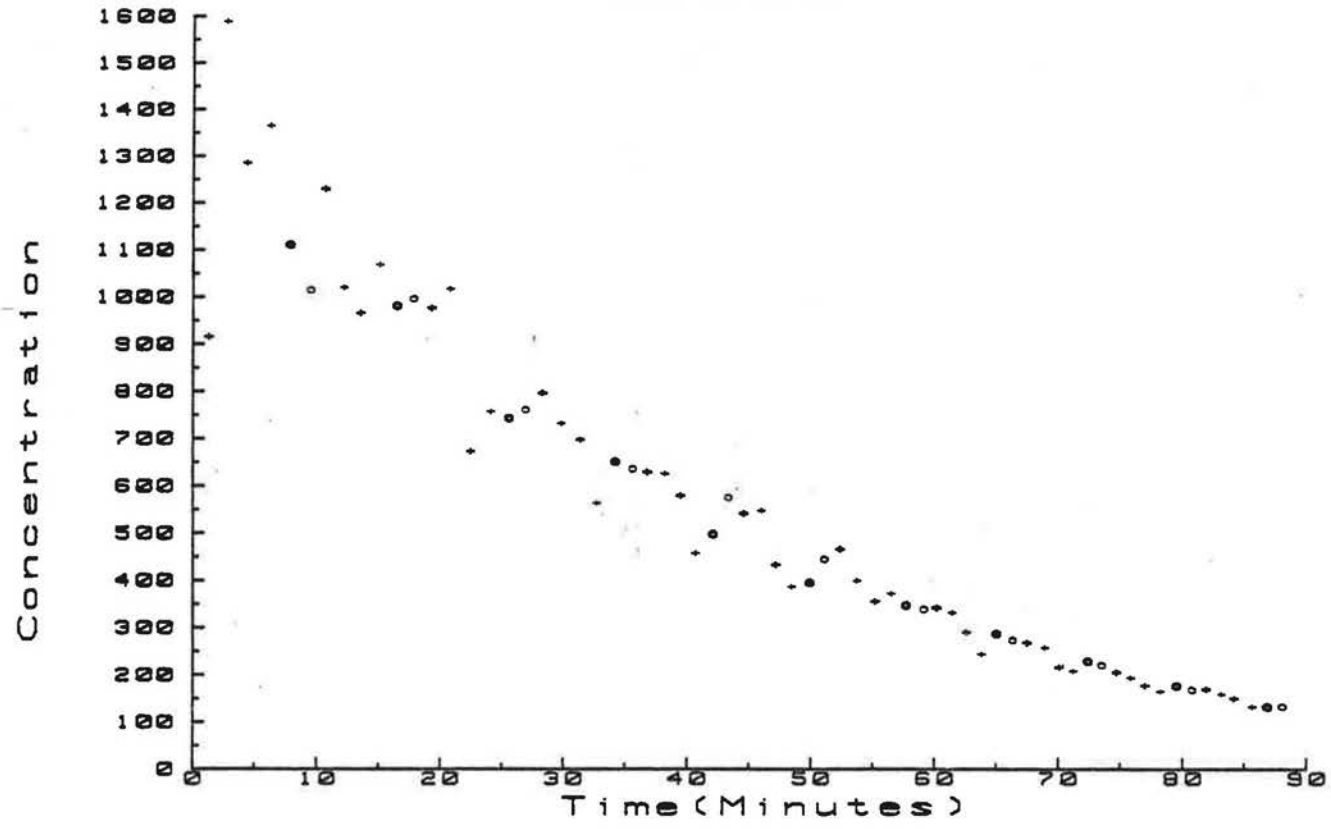

Run-B03R05
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-26/10/82
Channel No. 4
Ln Concentration
Ventilation rate is 1.733 a.c.h.
Time(Minutes)

Run-B03R05

Location-Abbey School Sports Hall. KENILWORTH

Gas-SF6

Date-26/10/82

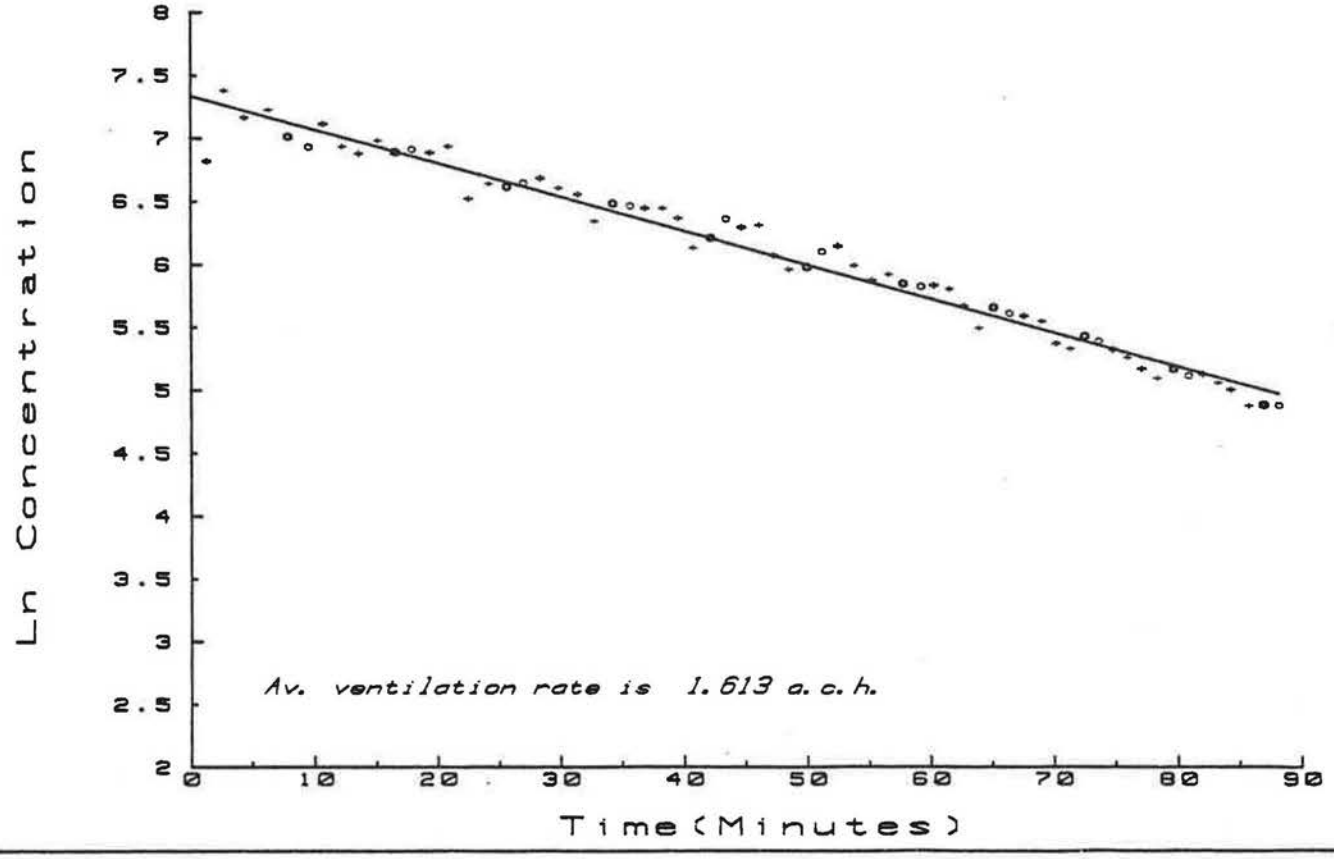


Run-B03R05

Location-Abbey School Sports Hall. KENILWORTH

Gas-SF6

Date-26/10/82



BO3 RO6

Date: 27th October, 1982.

Time: 1533 hours to 1708 hours

TracerGas: Sulphur Hexaflouride

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1500 hrs	2.6	11.9
1600 hrs	2.1	11.2
1700 hrs	2.6	8.8

Wind Direction: south west

Internal Conditions:

air velocity: 0.02 to 0.08 m/s
temperature: 14^{o}C

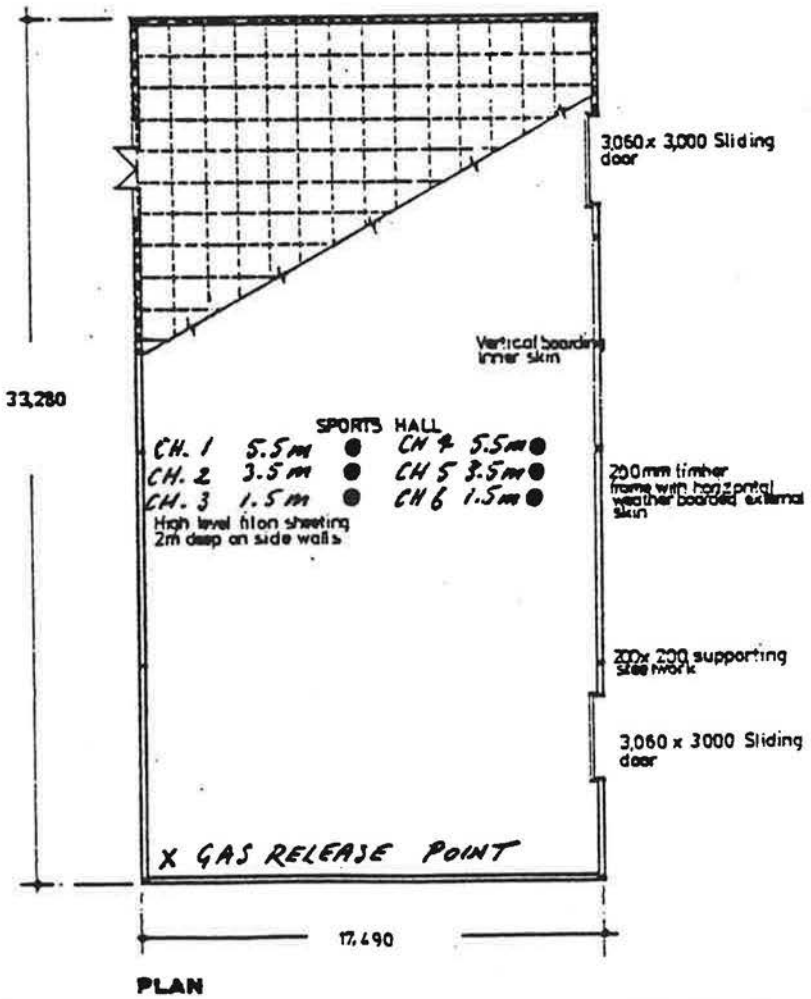
Gas Release:

At position shown on plan without any artificial stirring.

Sample Positions:

As shown on plan.

Comment: These results are decay portion of run BO3 RO9. Data point 1 of this run corresponds to data point 5 of run BO3 RO9.



****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B03R06
Location: Abbey School Sports Hall, KENILWORTH
Date: 27/10/82
Tracer gas: SF6

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5			Channel 6		
****	**********			**********			**********			**********			**********			**********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	33.3	1518	7.325	35.1	1322	7.187	36.8	1126	7.026	38.3	980	6.888	39.6	1021	6.929	41.2	962	6.869
2	42.6	958	6.865	44.2	1010	6.918	45.7	1000	6.908	47.1	831	6.723	48.3	820	6.709	49.7	791	6.673
3	51.0	775	6.653	52.2	877	6.777	53.6	908	6.811	55.0	778	6.657	56.6	750	6.620	57.9	720	6.579
4	59.5	715	6.572	60.9	703	6.555	62.6	761	6.635	64.1	649	6.475	65.4	565	6.337	67.0	580	6.363
5	68.8	654	6.483	70.1	690	6.537	71.8	680	6.522	73.4	648	6.474	74.8	468	6.148	76.2	512	6.238
6	77.5	471	6.155	78.8	494	6.203	80.1	518	6.250	81.6	478	6.170	82.9	455	6.120	84.1	370	5.914
7	85.5	363	5.894	86.8	371	5.916	88.3	407	6.009	89.9	391	5.969	91.2	339	5.826	92.5	290	5.670
8	93.8	309	5.733	95.2	290	5.670	96.4	317	5.759	97.8	334	5.811	99.1	290	5.670	100.4	266	5.583
9	101.8	260	5.561	103.5	251	5.525	104.9	270	5.598	106.2	285	5.652	107.7	226	5.421	109.1	217	5.380
10	110.7	215	5.371	111.9	220	5.394	113.2	260	5.561	114.6	250	5.521	115.7	216	5.375	117.3	194	5.268
11	118.5	203	5.313	119.8	205	5.323	121.5	229	5.434	122.9	219	5.389	124.1	207	5.333	125.9	190	5.247

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	DF	SS	MS	F
Regression	1	4.240	4.240	471.103
Residual	9	.081	.009	
Total	10	4.321		

INTERCEPT= 7.84281131141
GRADIENT= -2.30470782001E-02

Ventilation rate is 1.284 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	DF	SS	MS	F
Regression	1	4.227	4.227	566.708
Residual	9	.067	.007	
Total	10	4.294		

INTERCEPT= 7.8466625894
GRADIENT= -2.30954918604E-02

Ventilation rate is 1.386 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	DF	SS	MS	F
Regression	1	3.367	3.367	463.367
Residual	9	.065	.007	
Total	10	3.433		

INTERCEPT= 7.87157889653
GRADIENT= -2.06591729844E-02

Ventilation rate is 1.240 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	DF	SS	MS	F
Regression	1	2.666	2.666	561.062
Residual	9	.043	.005	
Total	10	2.709		

INTERCEPT= 7.64745360591
GRADIENT= -1.8400ue039597E-02

Ventilation rate is 1.104 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	DF	SS	MS	F
Regression	1	3.140	3.140	578.485
Residual	9	.049	.005	
Total	10	3.189		

INTERCEPT= 7.69034741417
GRADIENT= -1.99976822558E-02

Ventilation rate is 1.200 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 6

Source	DF	SS	MS	F
Regression	1	3.442	3.442	483.979
Residual	9	.064	.007	
Total	10	3.506		

INTERCEPT= 7.73145662423
GRADIENT= -2.09068128574E-02

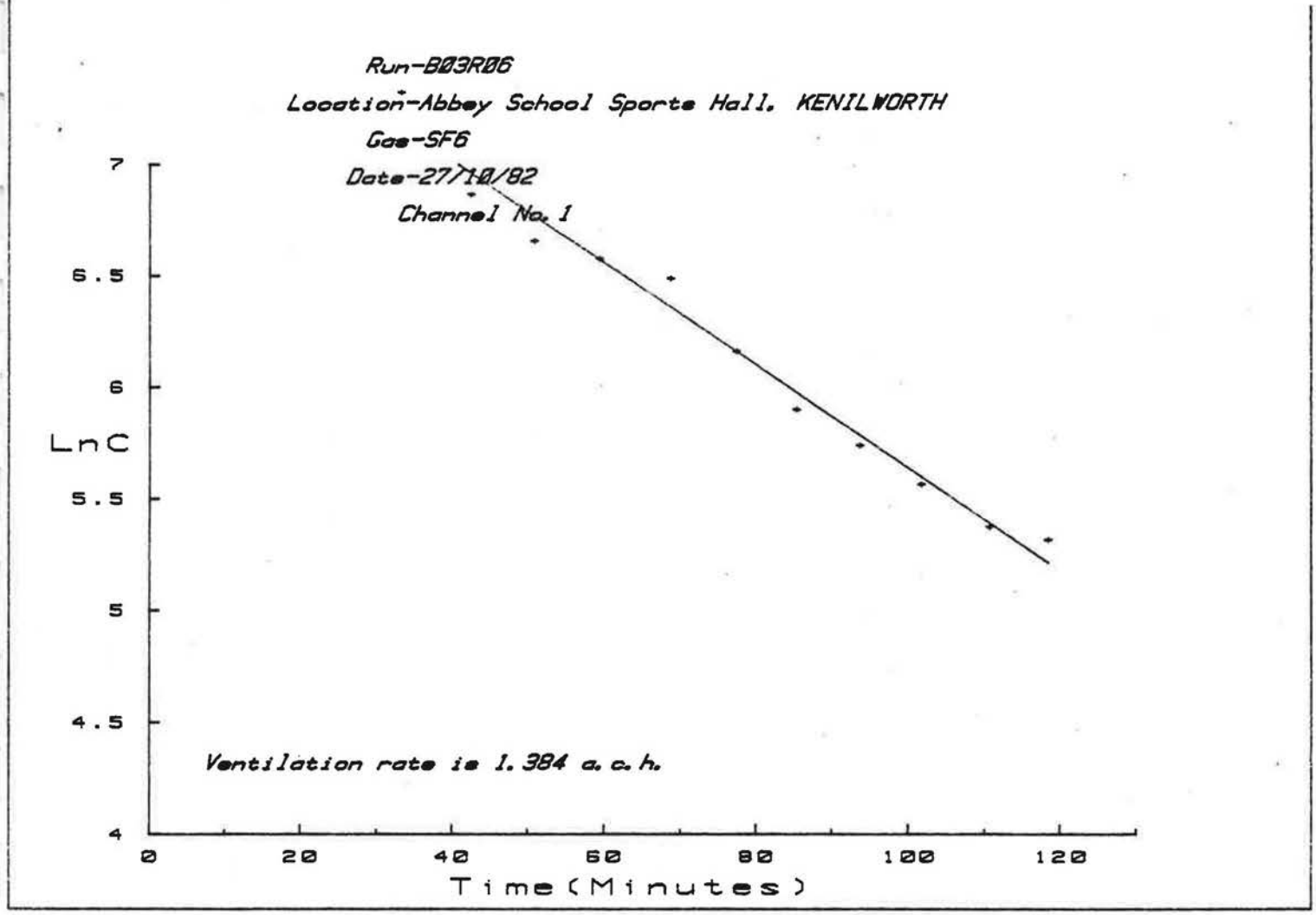
Ventilation rate is 1.254 air changes per hour

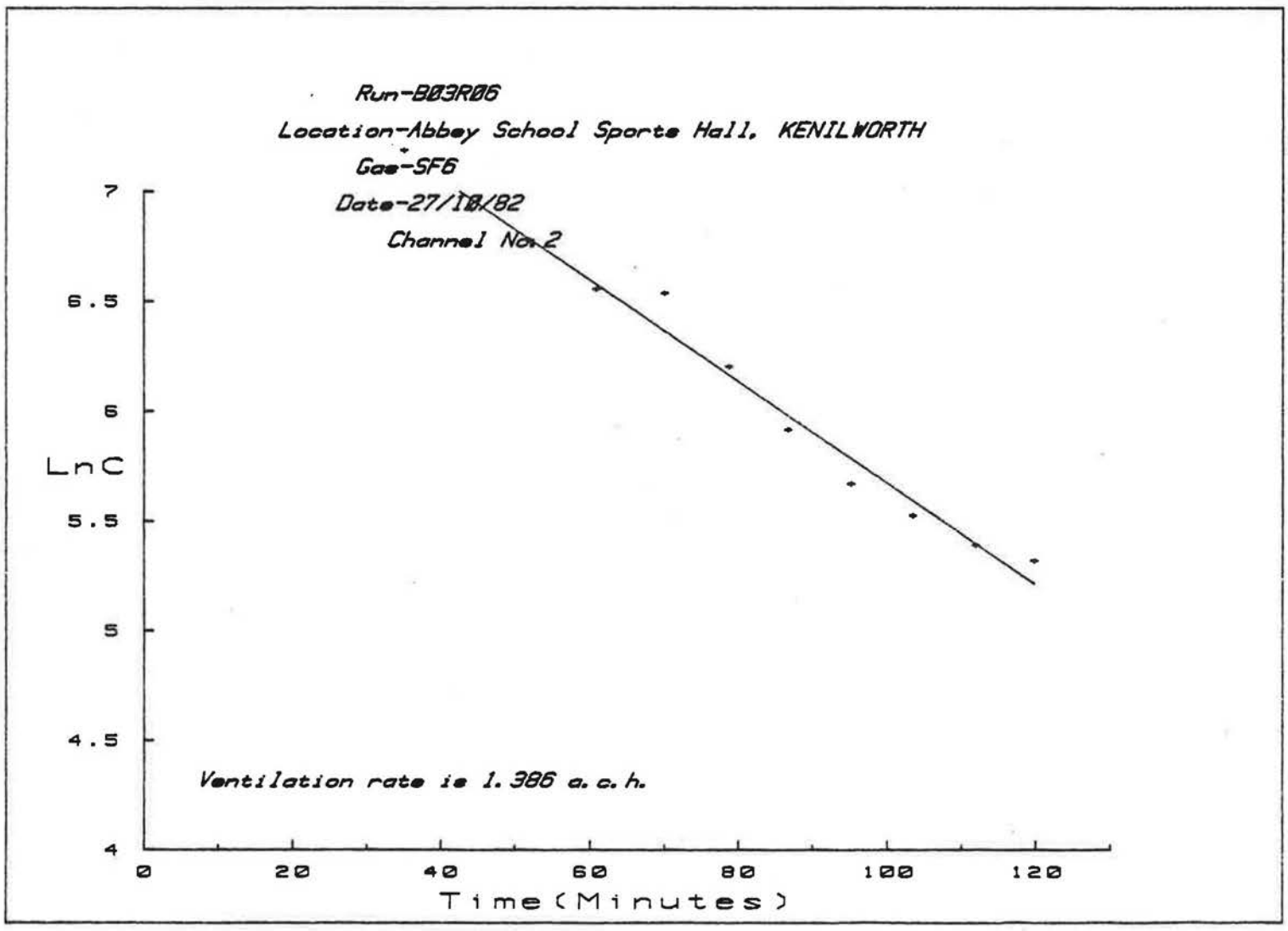
STATISTICAL ANALYSIS - ALL CHANNELS

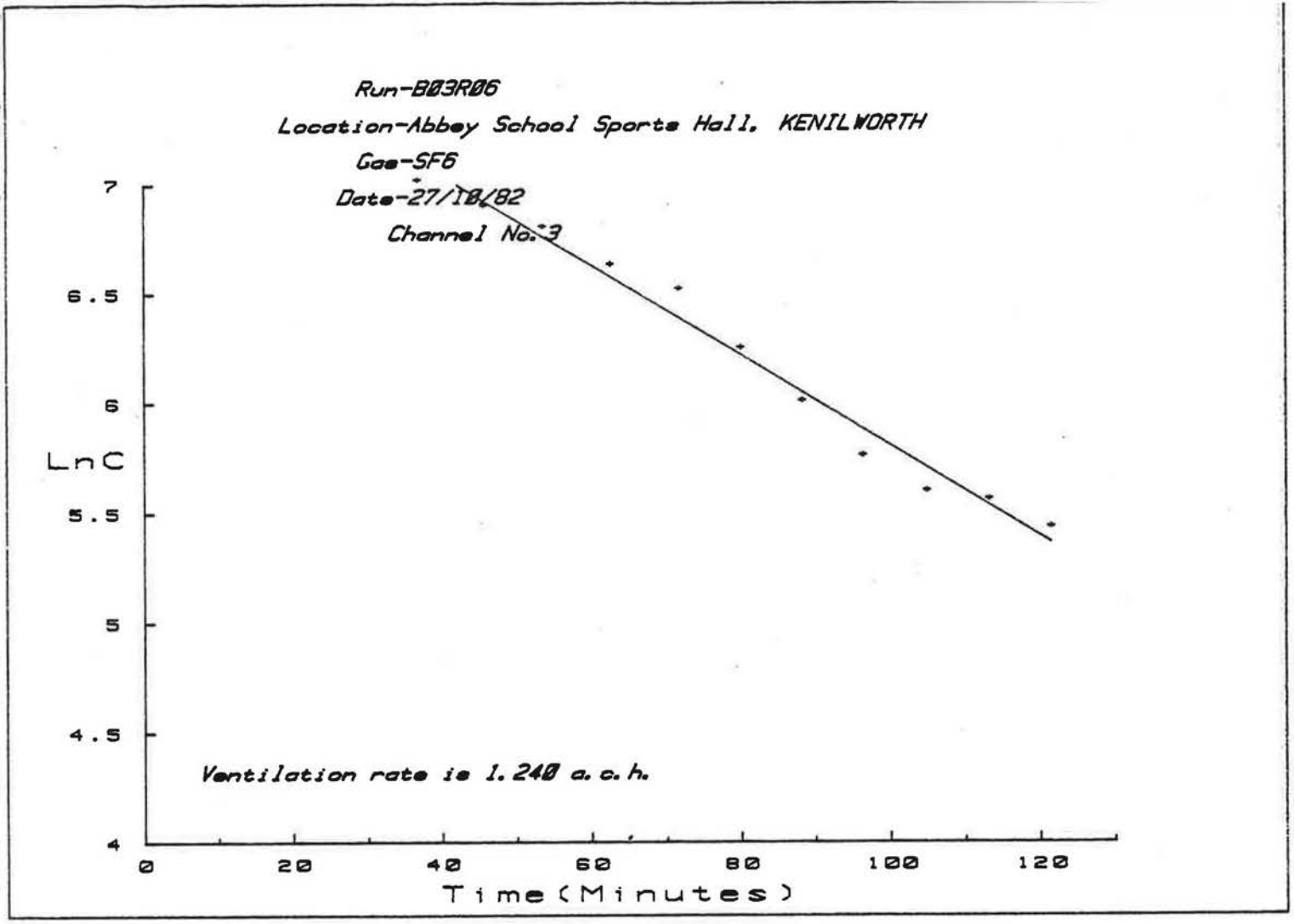
Source	DF	SS	MS	F
Regression	1	21.254	21.254	1972.471
Residual	64	.690	.011	
Total	65	21.944		

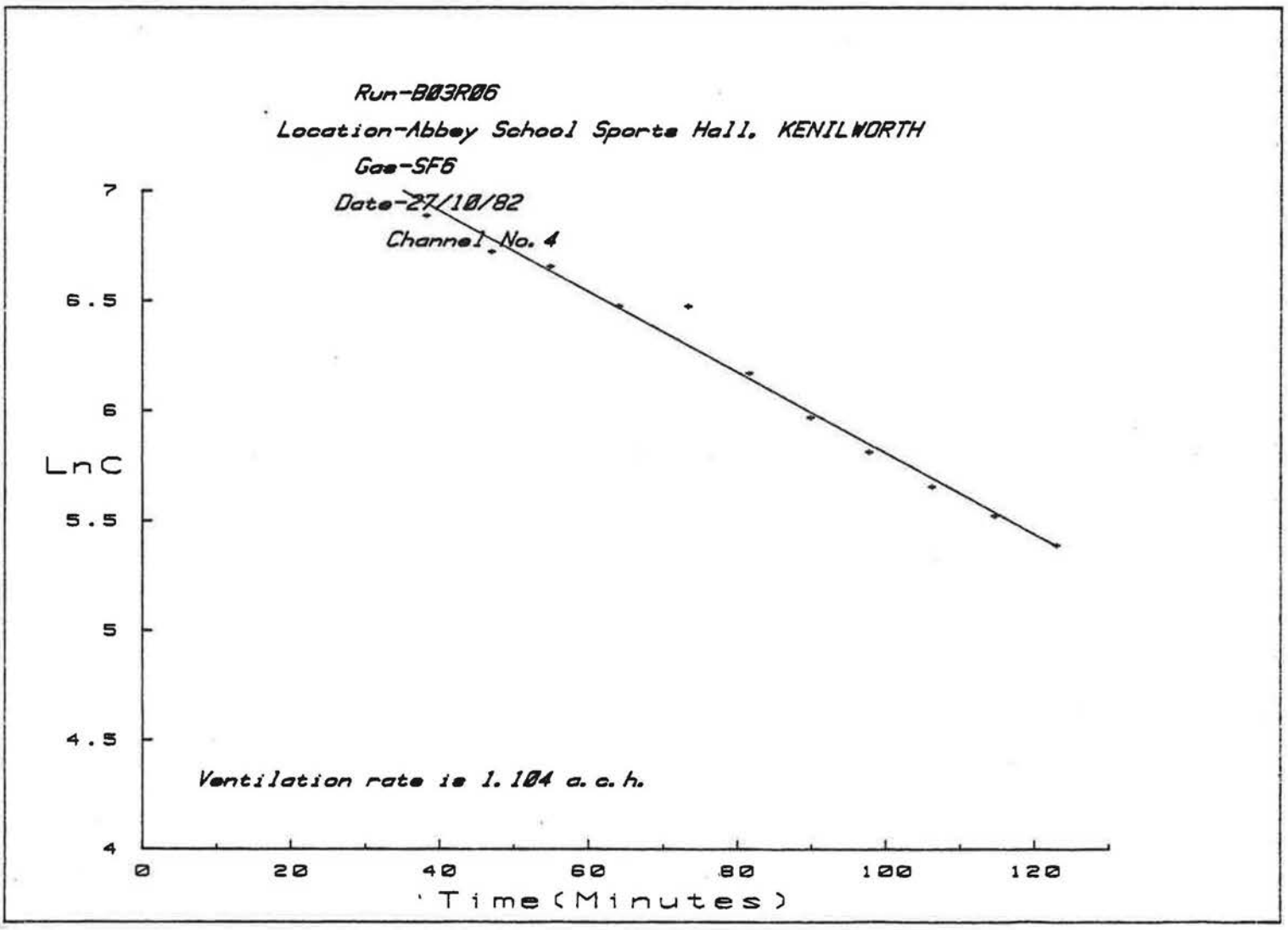
INTERCEPT= 7.81983556438
GRADIENT= -2.10929393162E-02

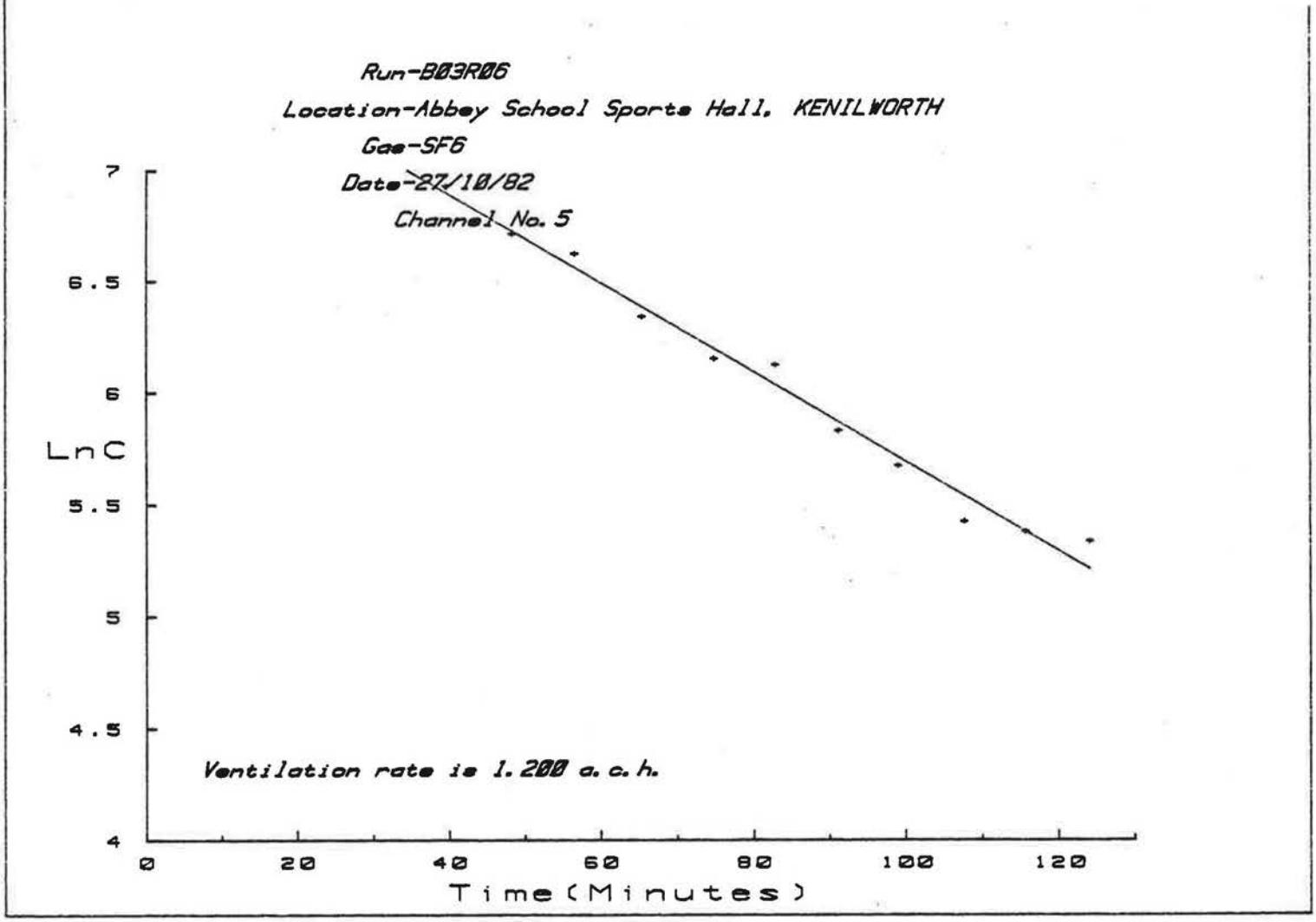
Ventilation rate is 1.266 air changes per hour

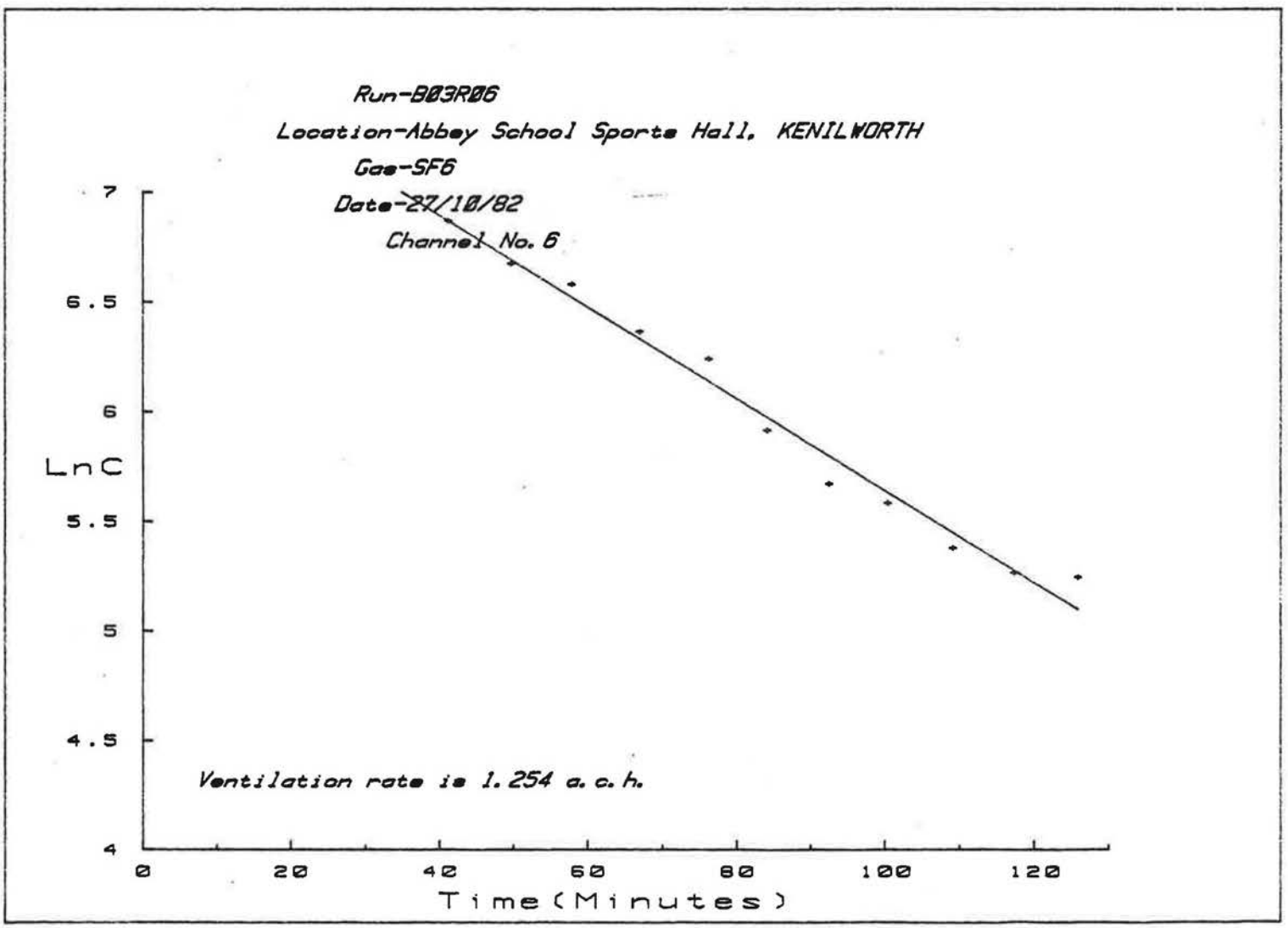

Run-B03R06
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 1
7
6.5
6
5.5
5
4.5
4
LnC
Ventilation rate is 1.384 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)


Run-B03R06
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 2
7
6.5
6
5.5
5
4.5
4
LnC
Ventilation rate is 1.386 a.c.h.
0
20
40
60
80
100
120
Time(Minutes)


Run-B03R06
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 3
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is 1.240 a.c.h.


Run-B03R06
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 4
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is 1.104 a.c.h.


Run-B03R06
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 5
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is 1.200 a.c.h.

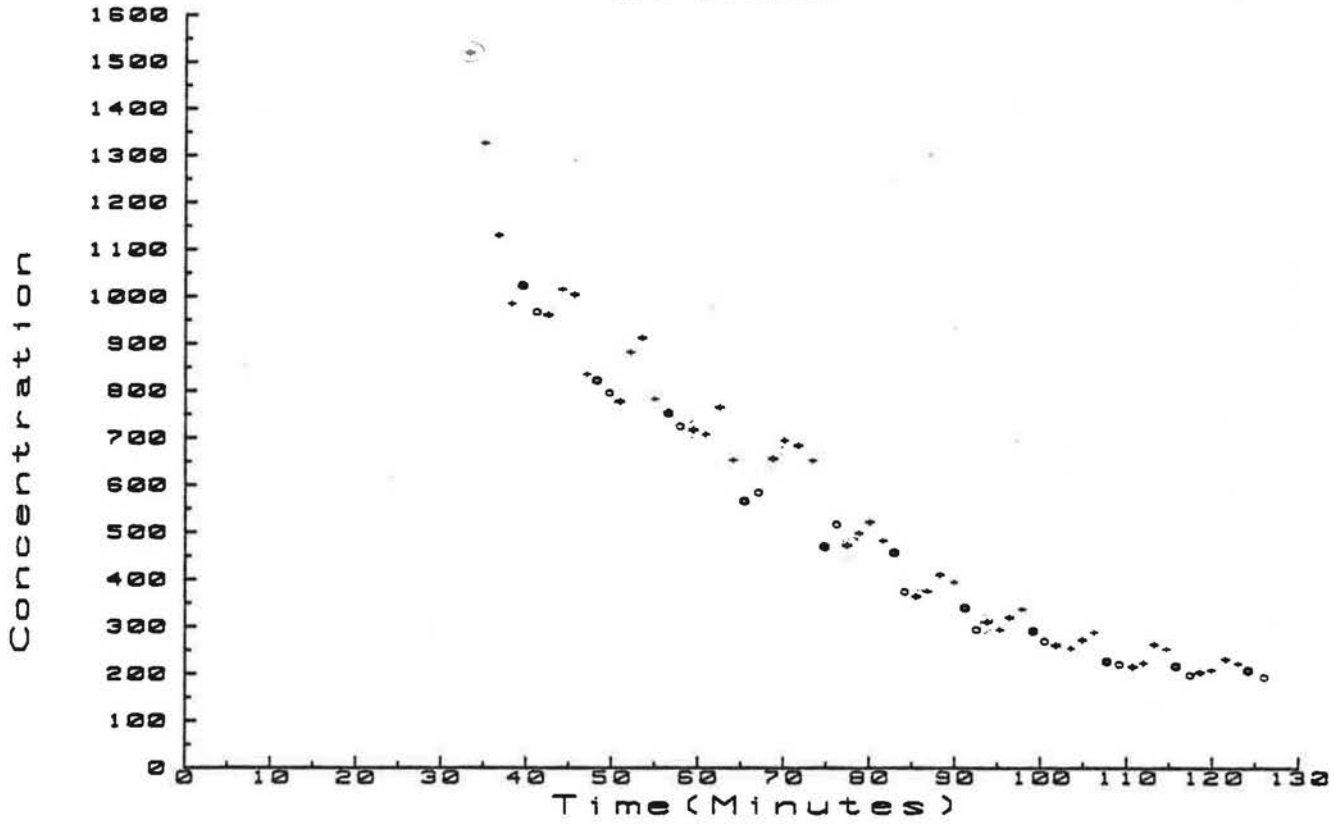

Run-B03R06
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 6
LnC
7
6.5
6
5.5
5
4.5
4
0
20
40
60
80
100
120
Time(Minutes)
Ventilation rate is 1.254 a.c.h.

Run-B03R06

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-27/10/82

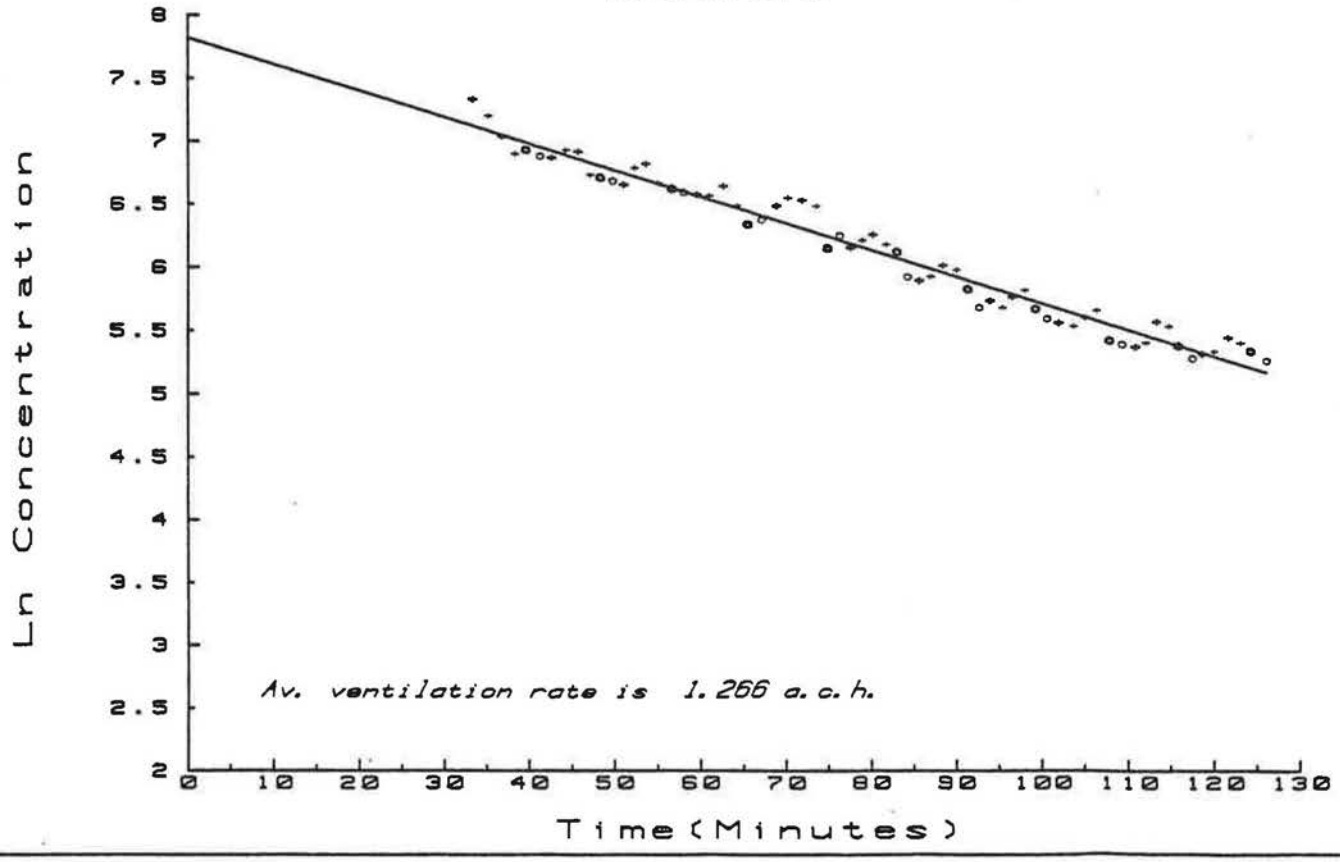


Run-B03R06

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-27/10/82



BO3 RO7

Date: 28th October 1982

Time: 1030 hours to 1215 hours

Tracer Gas: Sulphur Hexaflouride

External Conditions:

Time	Windspeed (m/s)	Temperature
1000 hrs	3.6	8.0
1100 hrs	3.6	9.6
1200 hrs	4.6	11.8

Wind Direction: south

Internal Conditions:

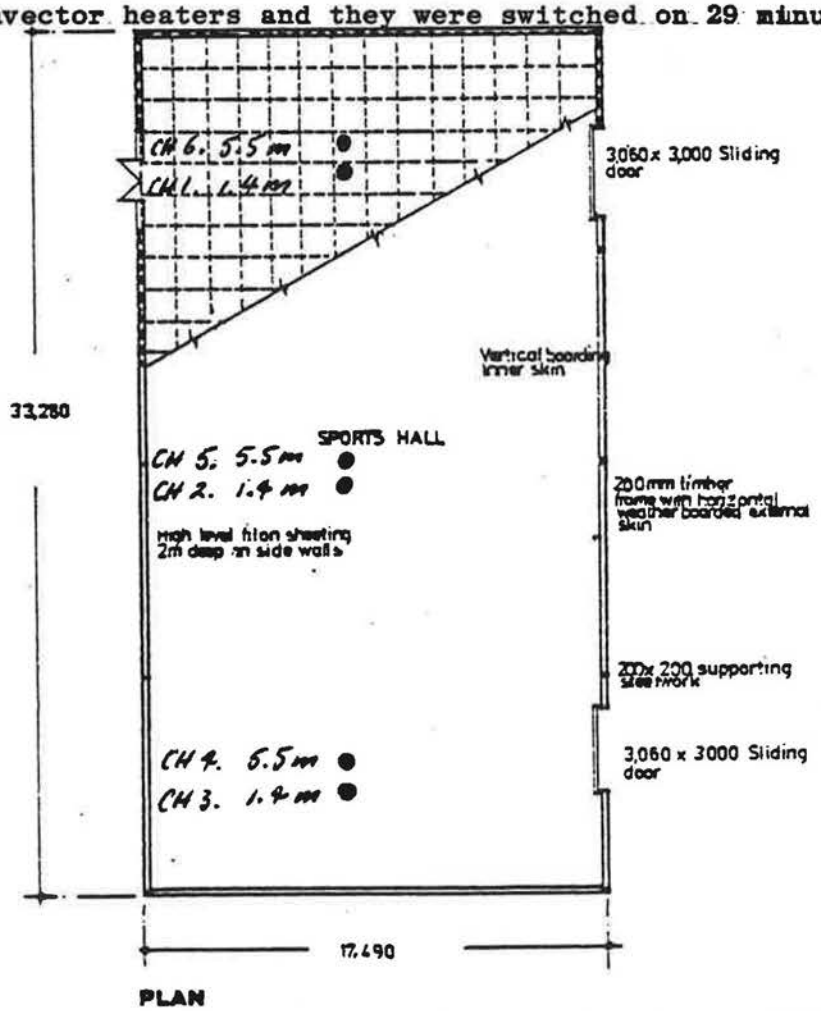
air velocity: 0.02 to 0.06 m/s
temperature: 8.5°C at 1104 hrs
11.5°C at 1142 hrs

Gas Release:

Tracer gas was mixed to an approximately uniform concentration before heating commenced.

Sample Positions:

As shown on plan.
Comment: Position of heater is shown on the plan. These were both 3 KW fan assisted convector heaters and they were switched on 29 minutes into the run.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B03R07
Location: Abbey School Sports Hall,KENILWORTH
Date: 28/10/82
Tracer gas: SF6

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5			Channel 6		
****	**********			**********			**********			**********			**********			**********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	.8	829	6.720	2.2	1352	7.209	3.6	1307	7.175	5.7	1263	7.141	7.5	694	6.542	9.1	999	6.907
2	10.7	1097	7.000	13.9	1087	6.991	15.3	853	6.749	16.8	787	6.668	18.1	820	6.709	19.6	687	6.532
3	12.6	1094	6.998	23.2	1034	6.941	24.4	973	6.880	25.7	662	6.495	27.0	641	6.463	28.7	583	6.368
4	21.9	1027	6.934	32.4	823	6.713	33.7	844	6.738	35.2	488	6.190	36.6	474	6.161	37.9	332	5.805
5	30.9	788	6.669	41.1	633	6.450	42.7	677	6.518	44.1	279	5.631	45.8	353	5.866	47.0	269	5.595
6	39.6	696	6.545	50.1	425	6.052	51.5	467	6.146	53.0	297	5.694	54.3	283	5.645	55.7	167	5.118
7	48.6	474	6.161	58.8	337	5.820	60.0	399	5.989	61.4	203	5.313	62.7	204	5.318	63.9	126	4.836
8	57.3	341	5.832	66.6	255	5.541	67.8	242	5.489	69.3	149	5.004	70.7	138	4.927	71.9	110	4.700
9	65.3	206	5.328	75.2	210	5.347	76.5	182	5.204	78.0	89	4.489	79.3	98	4.585	80.8	47	3.850
10	73.4	131	4.875	87.7	111	4.710	89.0	112	4.718	90.5	101	4.615	91.7	41	3.714	93.0	30	3.401

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	DF	SS	MS	F
Regression	1	10.439	10.439	106.725
Residual	10	.978	.098	
Total	11	11.416		

INTERCEPT= 7.4072e004726
GRADIENT= -.031635806928

Ventilation rate is 1.896 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	DF	SS	MS	F
Regression	1	9.521	9.521	201.037
Residual	9	.426	.047	
Total	10	9.947		

INTERCEPT= 7.58223077074
GRADIENT= -.032262916208

Ventilation rate is 1.926 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	DF	SS	MS	F
Regression	1	9.394	9.394	105.948
Residual	9	.798	.089	
Total	10	10.192		

INTERCEPT= 7.58903171897
GRADIENT= -3.211816320468-02

Ventilation rate is 1.927 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	DF	SS	MS	F
Regression	1	10.990	10.990	219.429
Residual	9	.451	.050	
Total	10	11.441		

INTERCEPT= 7.35653845775
GRADIENT= -3.486171409918-02

Ventilation rate is 2.092 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	DF	SS	MS	F
Regression	1	11.594	11.594	157.679
Residual	9	.662	.074	
Total	10	12.256		

INTERCEPT= 7.3420928J706
GRADIENT= -3.586357094018-02

Ventilation rate is 2.158 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 6

Source	DF	SS	MS	F
Regression	1	16.161	16.161	667.234
Residual	9	.218	.024	
Total	10	16.379		

INTERCEPT= 7.45505163403
GRADIENT= -4.24014d20e188-02

Ventilation rate is 2.544 air changes per hour

STATISTICAL ANALYSIS - ALL CHANNELS

Source	DF	SS	MS	F
Regression	1	70.895	70.895	548.558
Residual	65	8.401	.129	
Total	66	79.295		

INTERCEPT= 7.47973400603
GRADIENT= -3.544419174268-02

Ventilation rate is 2.127 air changes per hour

$r = \sqrt{\frac{9.521}{9.947}}$

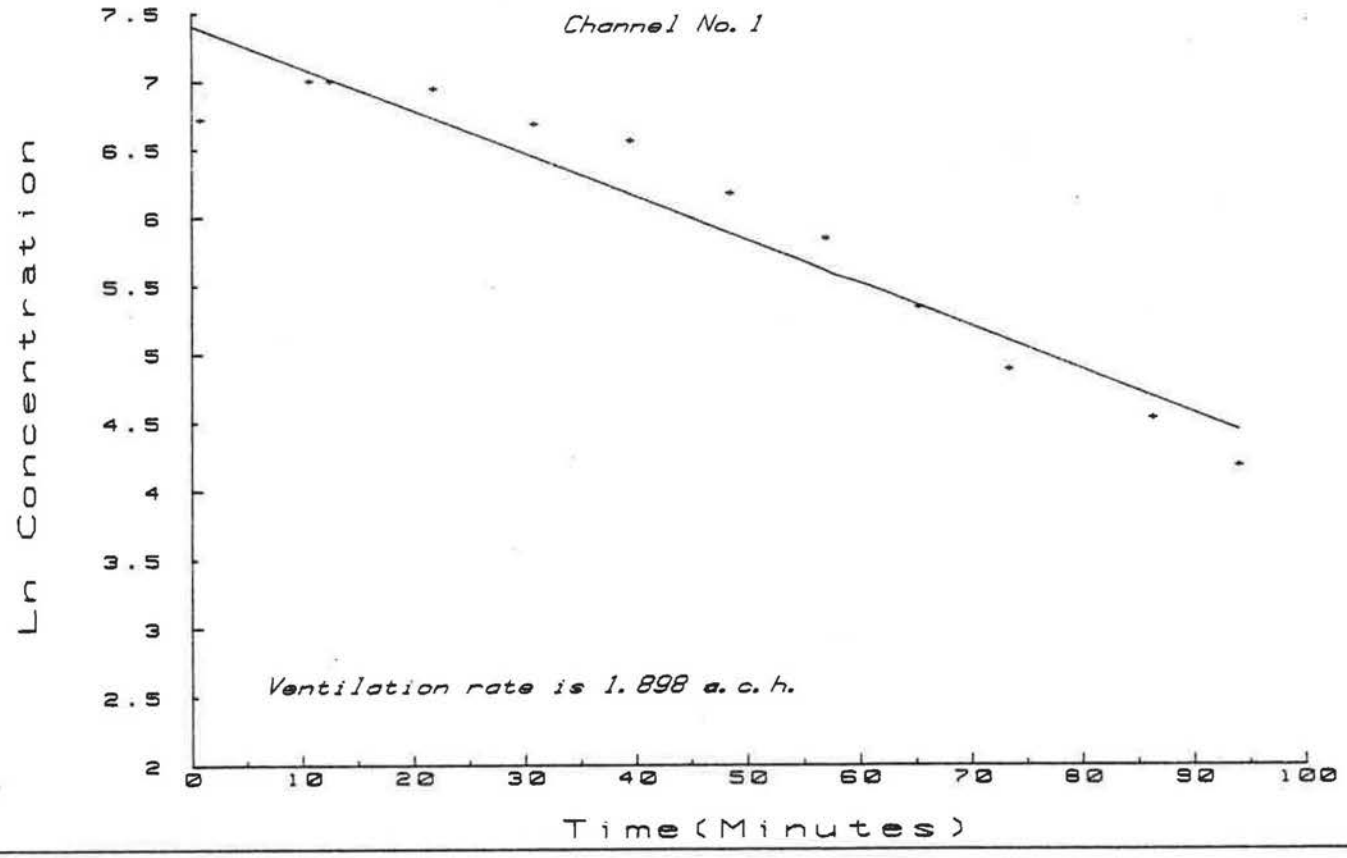
Run-B03R07

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-28/10/82

Channel No. 1



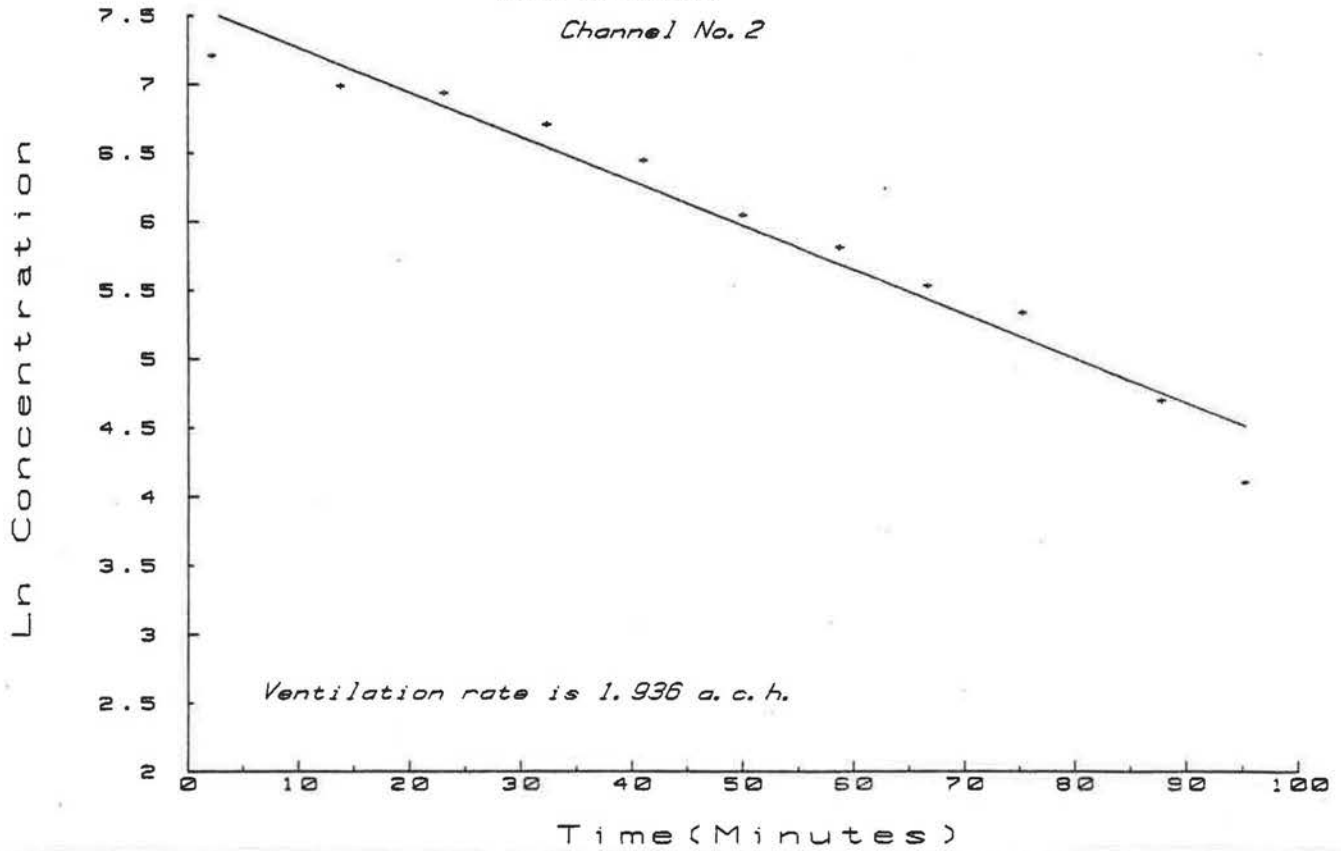
Run-B03R07

Location-Abbey School Sports Hall, KENILWORTH

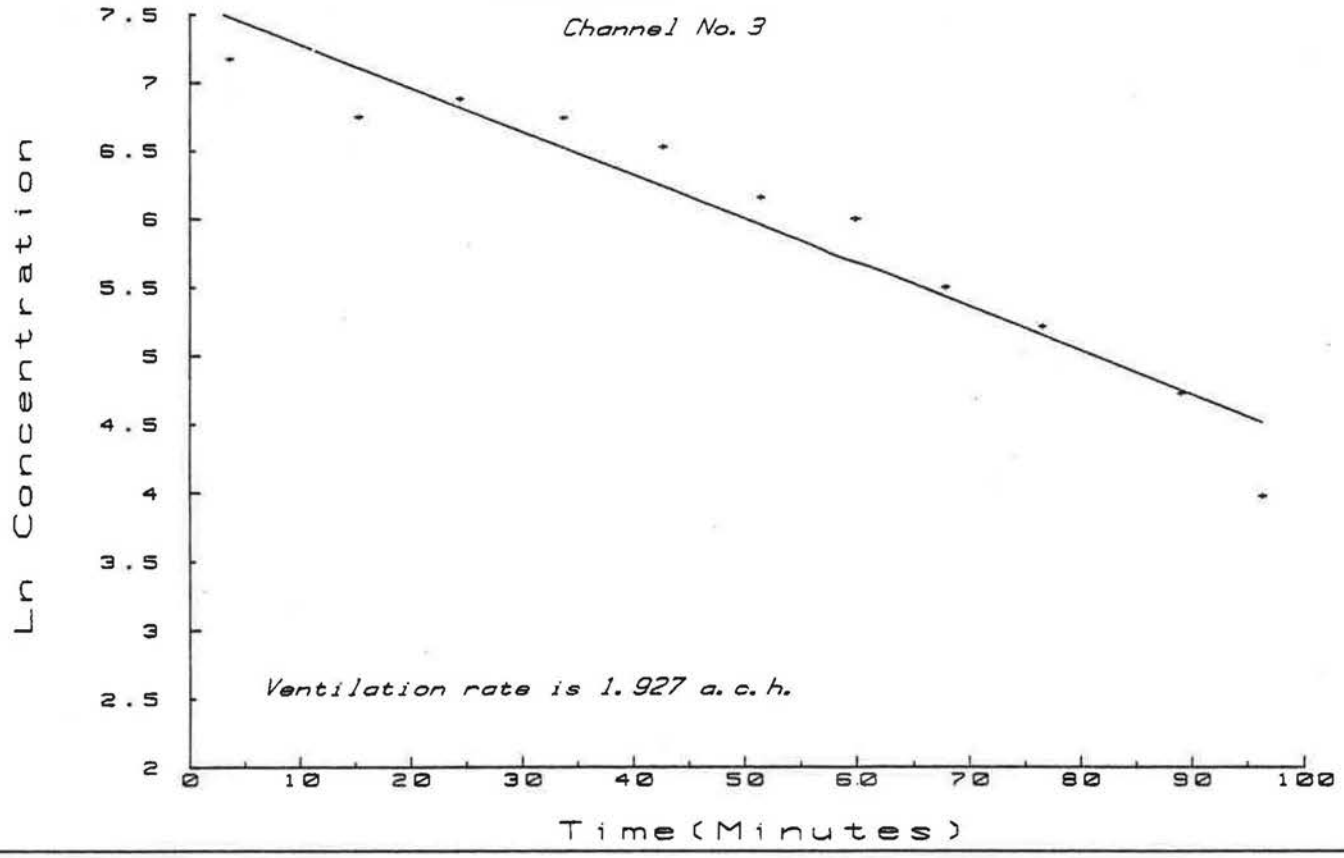
Gas-SF6

Date-28/10/82

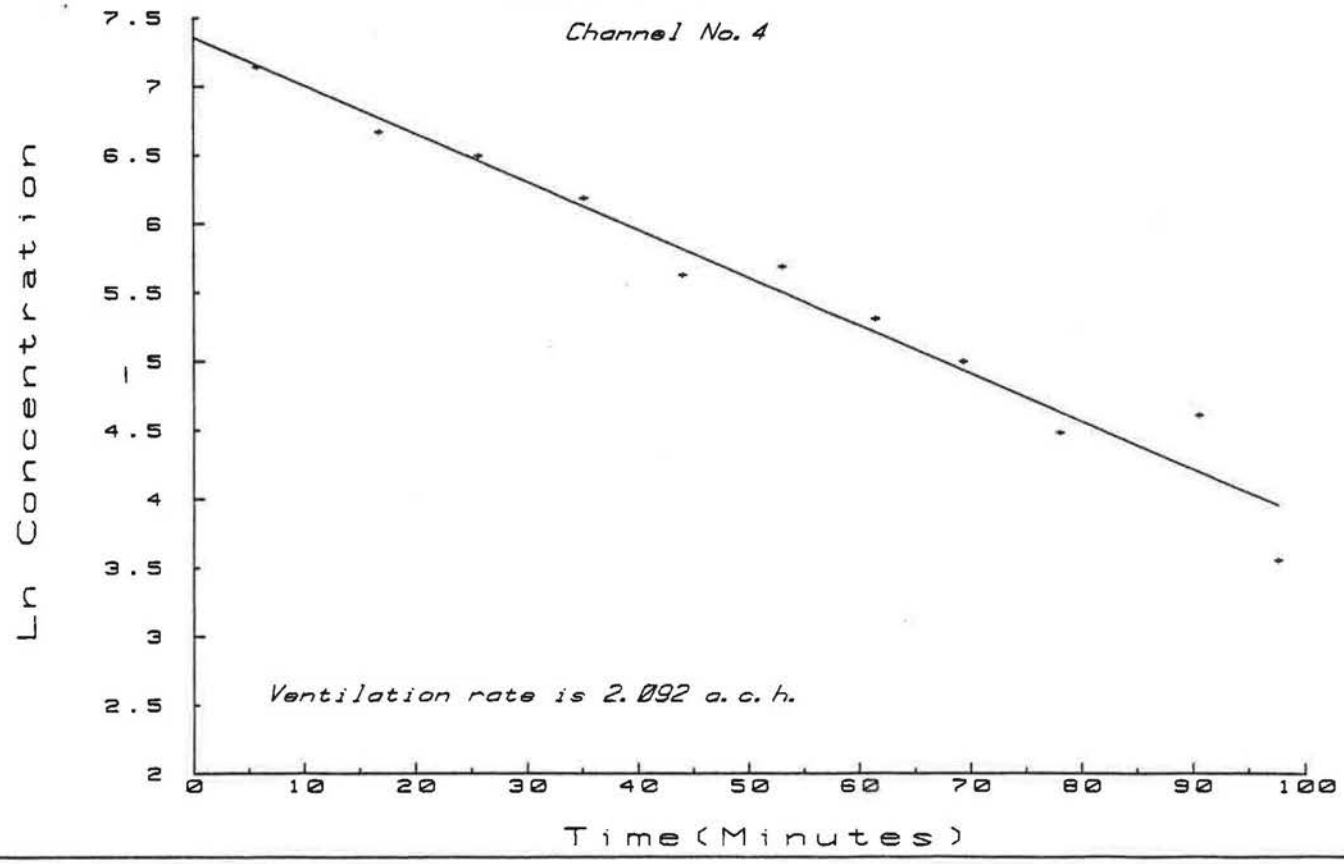
Channel No. 2



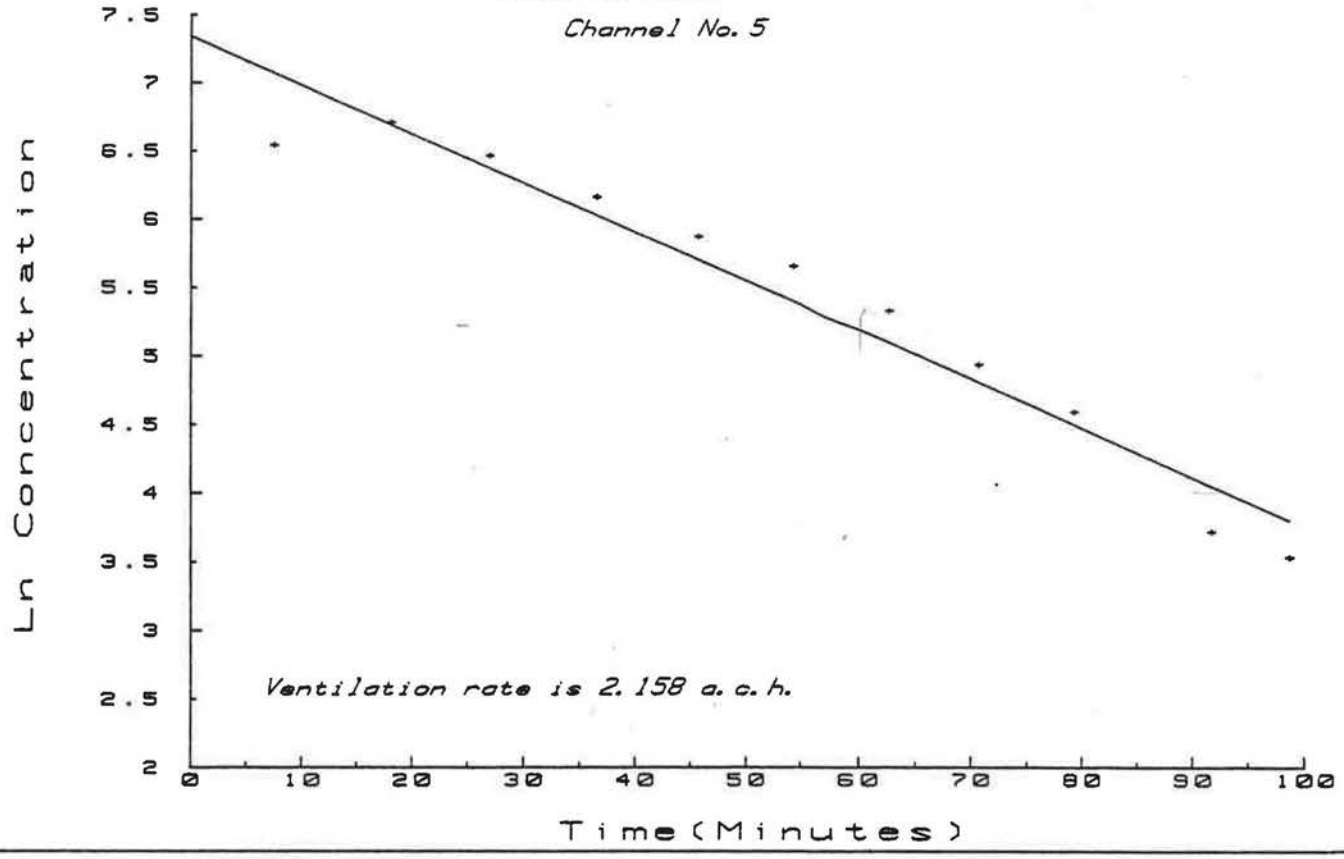
Run-B03R07
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-28/10/82
Channel No. 3



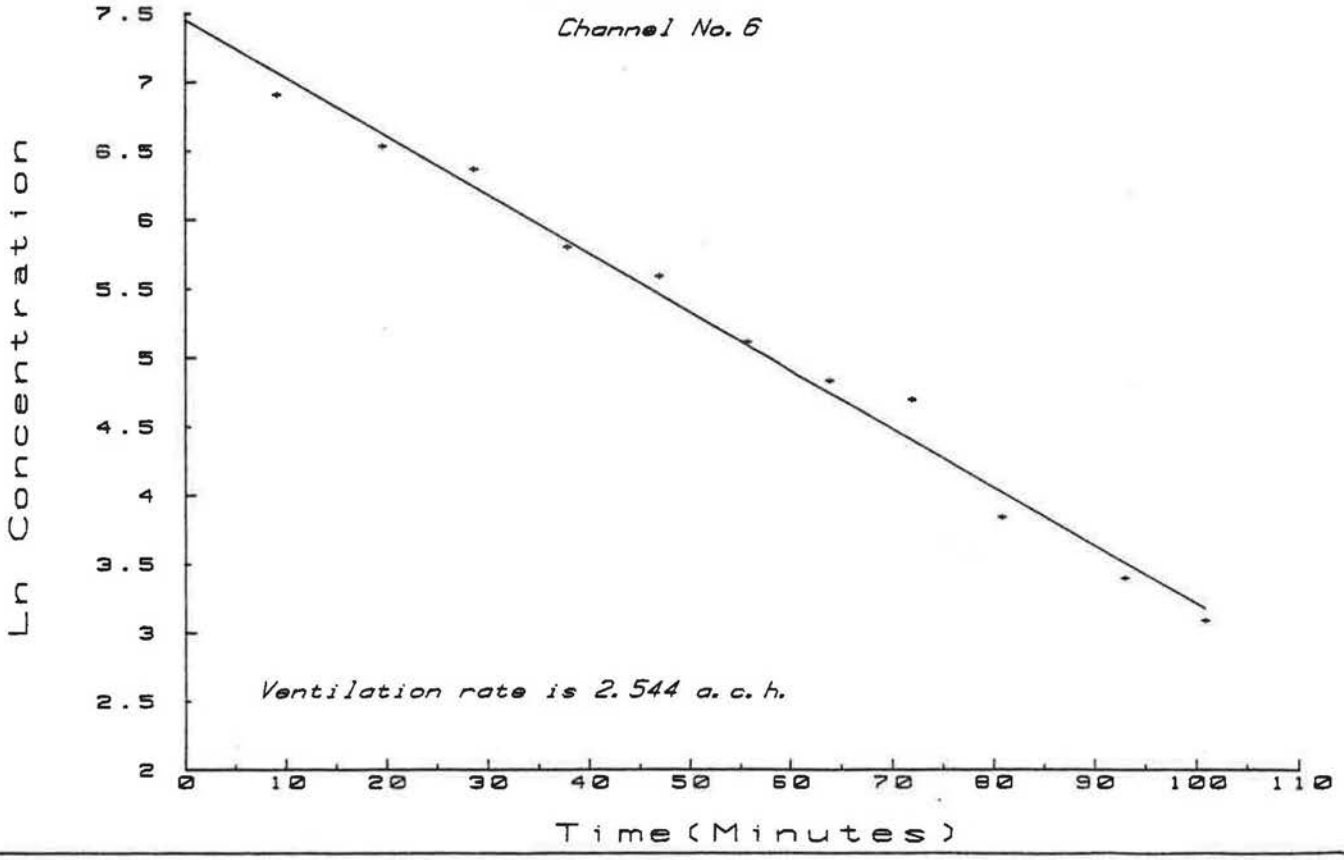
Run-B03R07
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-28/10/82
Channel No. 4



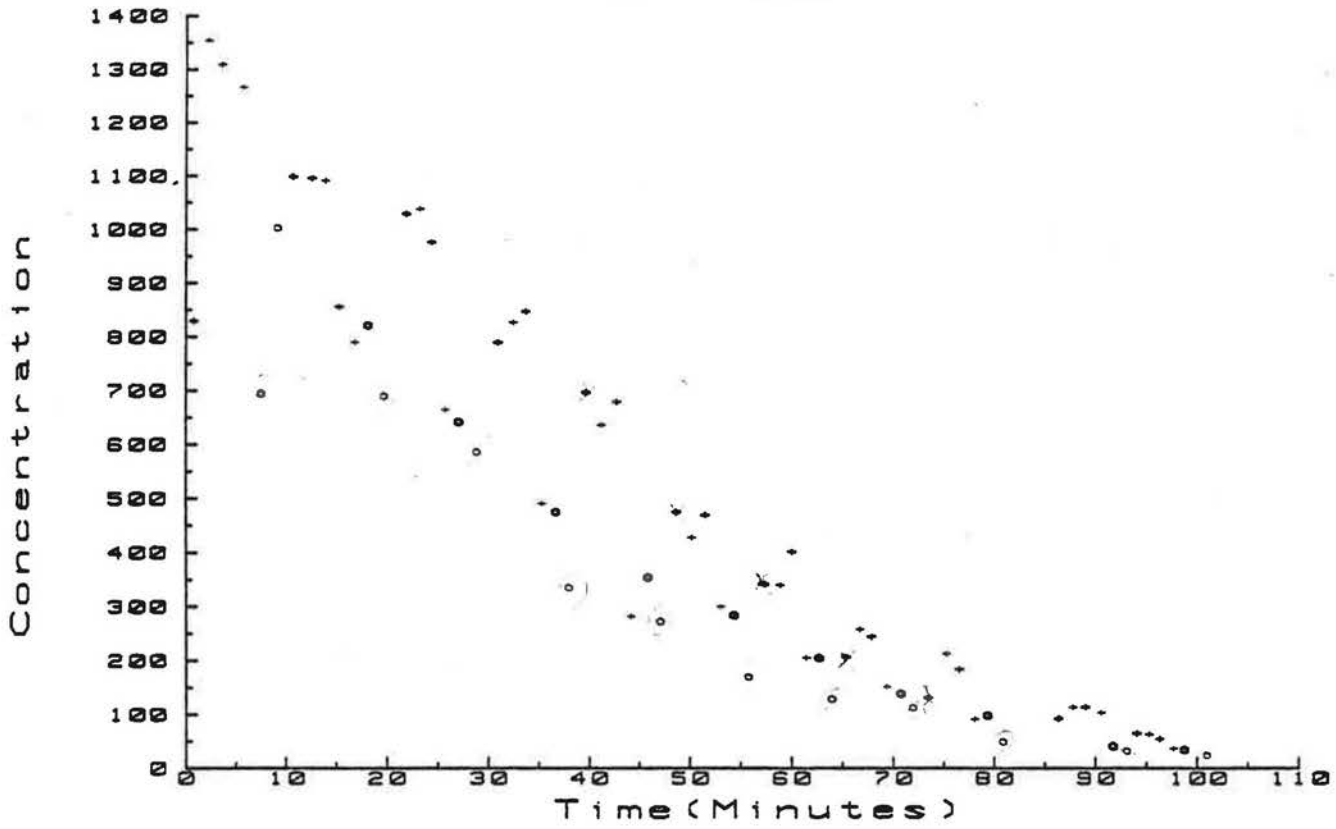
Run-B03R07
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-28/10/82
Channel No. 5



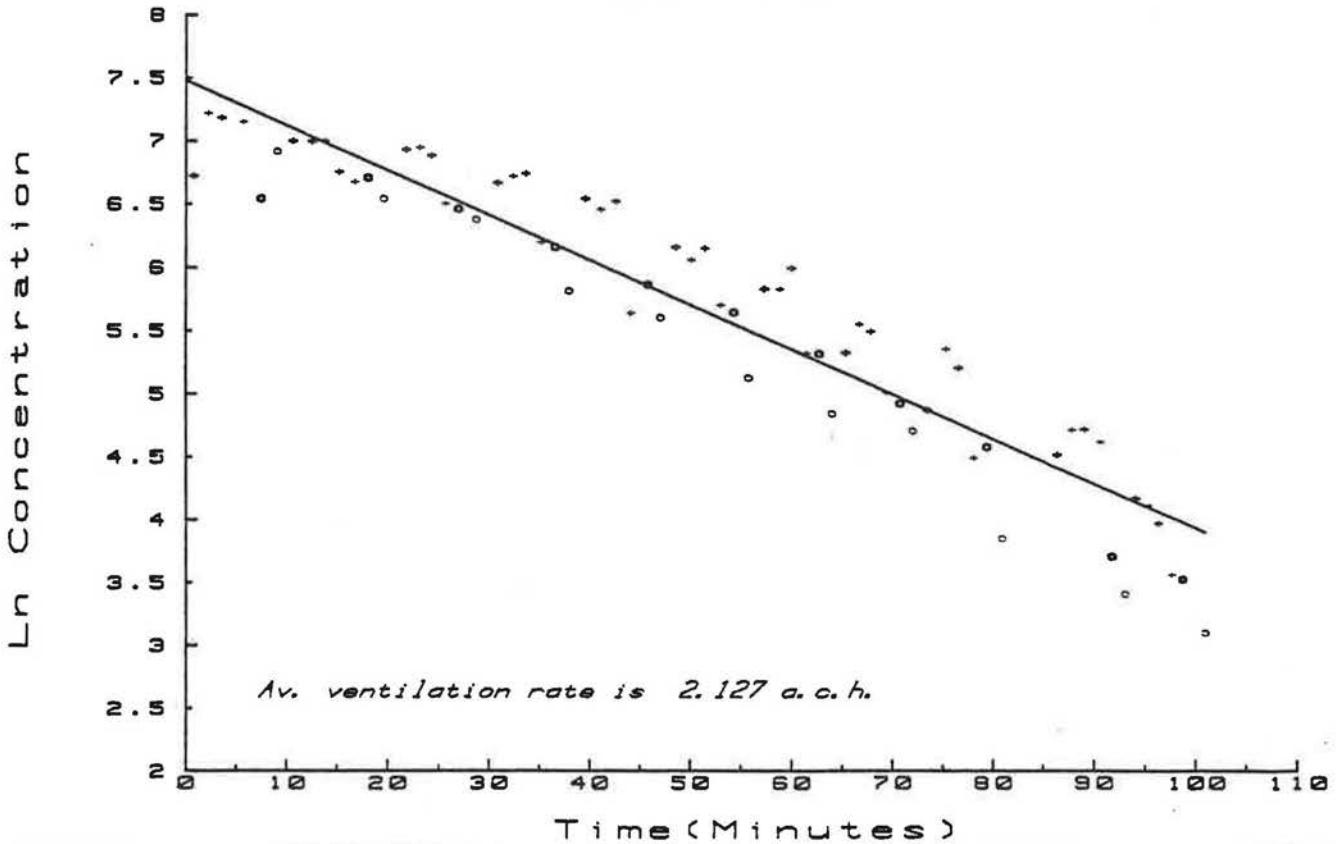
Run-B03R07
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-28/10/82
Channel No. 6



Run-B03R07
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-28/10/82



Run-B03R07
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-28/10/82



B03 R08

Date: 20th October, 1982

Time: 1220 hours to 1350 hours

Tracer Gas: Sulphur Hexaflouride

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1200 hrs	4.6	11.8
1300 hrs	4.6	12.9
1400 hrs	4.1	13.4

Wind Direction: south

Internal Conditions:

air velocity: 0.02 to 0.06 m/s
temperature: 13^{o}C at 1218 hrs
14^{o}C at 1245 hrs
15^{o}C at 1350 hrs

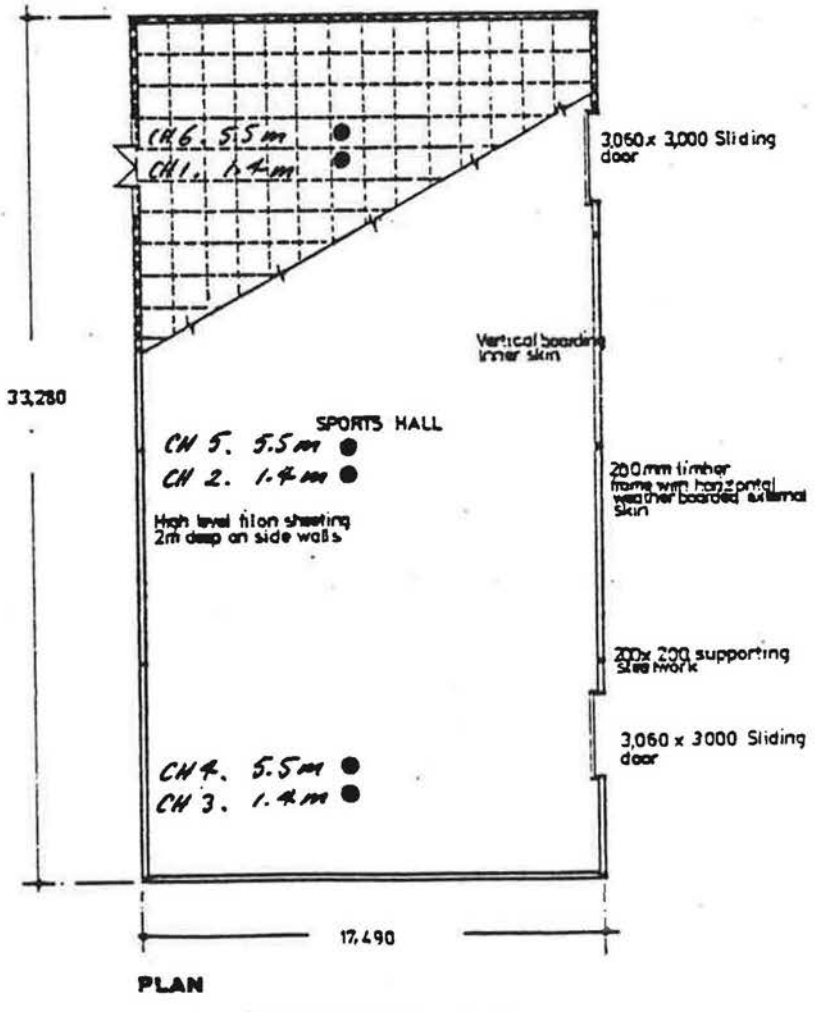
Gas Release:

Tracer gas was mixed to an approximately uniform concentration before heating commenced.

Sample Positions:

As shown on plan.

Comment: Repeat of run B03 R07 except that heaters were switched on at commencement of run.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B03R08
Location: Abbey School Sports Hall,KENILWORTH
Date: 28/10/82
Tracer gas: SF6

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5			Channel 6		
****	**********			**********			**********			**********			**********			**********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	.4	1644	7.405	1.9	1707	7.442	3.9	1716	7.448	5.5	1643	7.404	6.7	1646	7.406	8.1	1438	7.271
2	9.5	1627	7.394	10.7	1664	7.417	11.9	1691	7.433	13.3	1573	7.361	14.7	1508	7.319	15.8	1224	7.110
3	17.2	1582	7.366	18.5	1610	7.384	19.9	1540	7.340	21.4	1452	7.281	22.7	1332	7.194	24.0	1008	6.916
4	25.3	1479	7.299	26.7	1400	7.244	28.1	1395	7.241	29.4	1199	7.089	30.7	1045	6.952	32.2	722	6.582
5	33.7	1106	7.009	35.1	1303	7.172	36.9	1228	7.113	38.4	919	6.823	39.9	784	6.664	41.5	679	6.521
6	42.8	1176	7.070	44.4	955	6.862	46.0	946	6.852	47.2	698	6.548	48.3	687	6.532	50.2	605	6.405
7	51.3	780	6.659	52.4	719	6.578	53.7	654	6.483	54.8	581	6.365	56.0	418	6.035	57.2	404	6.001
8	58.3	636	6.455	59.5	703	6.555	60.8	465	6.142	62.1	353	5.866	63.2	364	5.897	64.5	314	5.749
9	65.7	476	6.165	66.9	451	6.111	68.1	441	6.089	69.2	279	5.631	70.4	279	5.631	71.5	257	5.549
10	72.7	370	5.914	74.0	370	5.914	75.1	190	5.247	76.2	155	5.043	77.3	191	5.252	78.5	170	5.136
11	79.7	168	5.124	80.8	244	5.497	82.1	149	5.004	83.5	149	5.004	84.9	140	4.942	86.1	140	4.942

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	Df	SS	MS	F
Regression	1	4.674	4.674	53.427
Residual	9	.787	.087	
Total	10	5.462		

INTERCEPT= 7.765316e4046
GRADIENT= -2.57945e531788-02

Ventilation rate is 1.548 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	Df	SS	MS	F
Regression	1	4.146	4.146	103.806
Residual	9	.359	.040	
Total	10	4.506		

INTERCEPT= 7.78642645991
GRADIENT= -2.436506477758-02

Ventilation rate is 1.462 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	Df	SS	MS	F
Regression	1	6.752	6.752	75.388
Residual	9	.804	.089	
Total	10	7.555		

INTERCEPT= 7.8643287695e
GRADIENT= -3.13765e32652E-02

Ventilation rate is 1.877 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	Df	SS	MS	F
Regression	1	7.619	7.619	159.075
Residual	9	.431	.048	
Total	10	8.050		

INTERCEPT= 7.92147220789
GRADIENT= -3.337310912558-02

Ventilation rate is 2.002 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	Df	SS	MS	F
Regression	1	7.083	7.083	341.269
Residual	9	.187	.021	
Total	10	7.270		

INTERCEPT= 7.85589173843
GRADIENT= -3.222504066168-02

Ventilation rate is 1.934 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 6

Source	Df	SS	MS	F
Regression	1	5.998	5.998	331.822
Residual	9	.163	.018	
Total	10	6.160		

INTERCEPT= 7.62899070037
GRADIENT= -2.971504290298-02

Ventilation rate is 1.783 air changes per hour

STATISTICAL ANALYSIS - ALL CHANNELS

Source	Df	SS	MS	F
Regression	1	37.229	37.229	545.640
Residual	64	4.367	.068	
Total	65	41.595		

INTERCEPT= 7.63747326778
GRADIENT= -2.967779793078-02

Ventilation rate is 1.791 air changes per hour

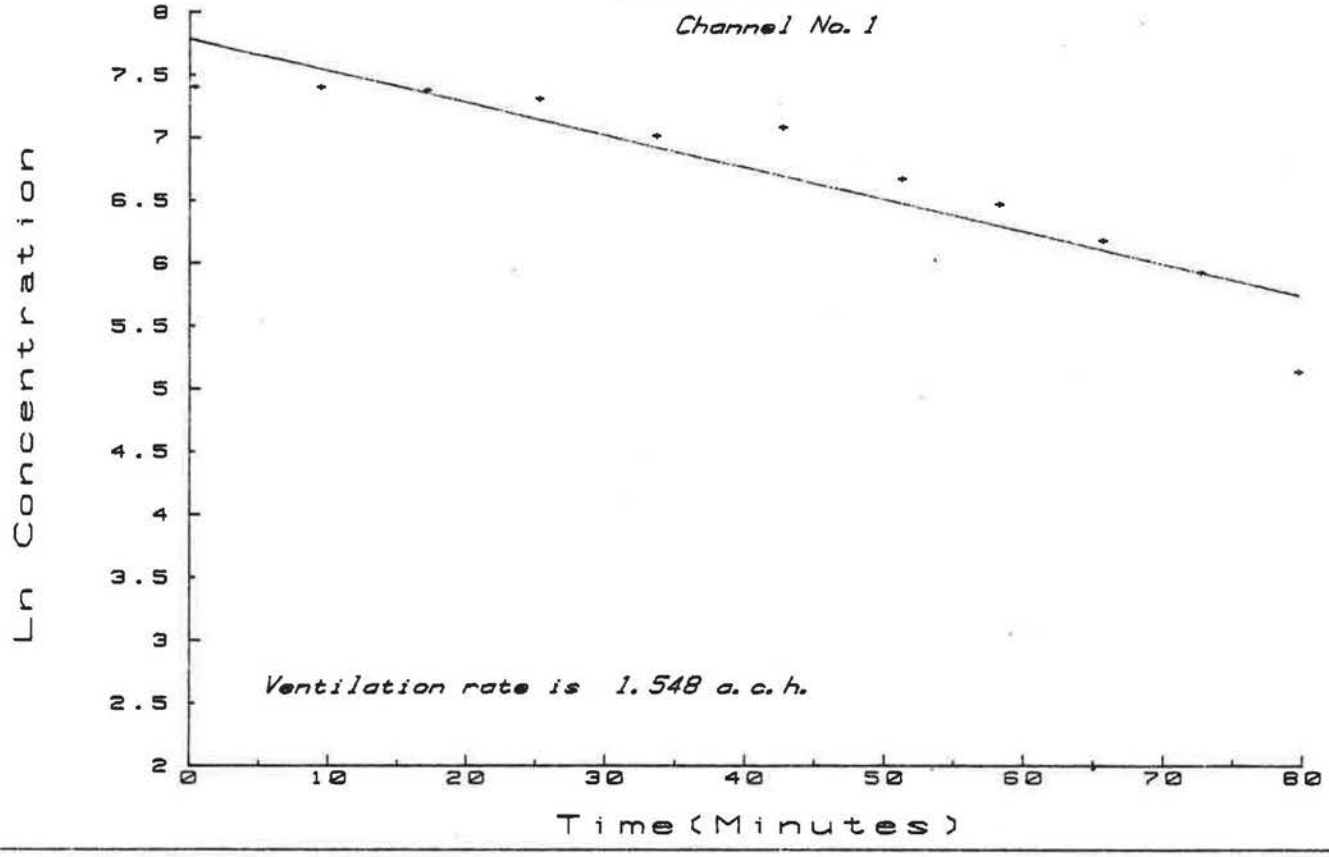
Run-B03R08

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-28/10/82

Channel No. 1



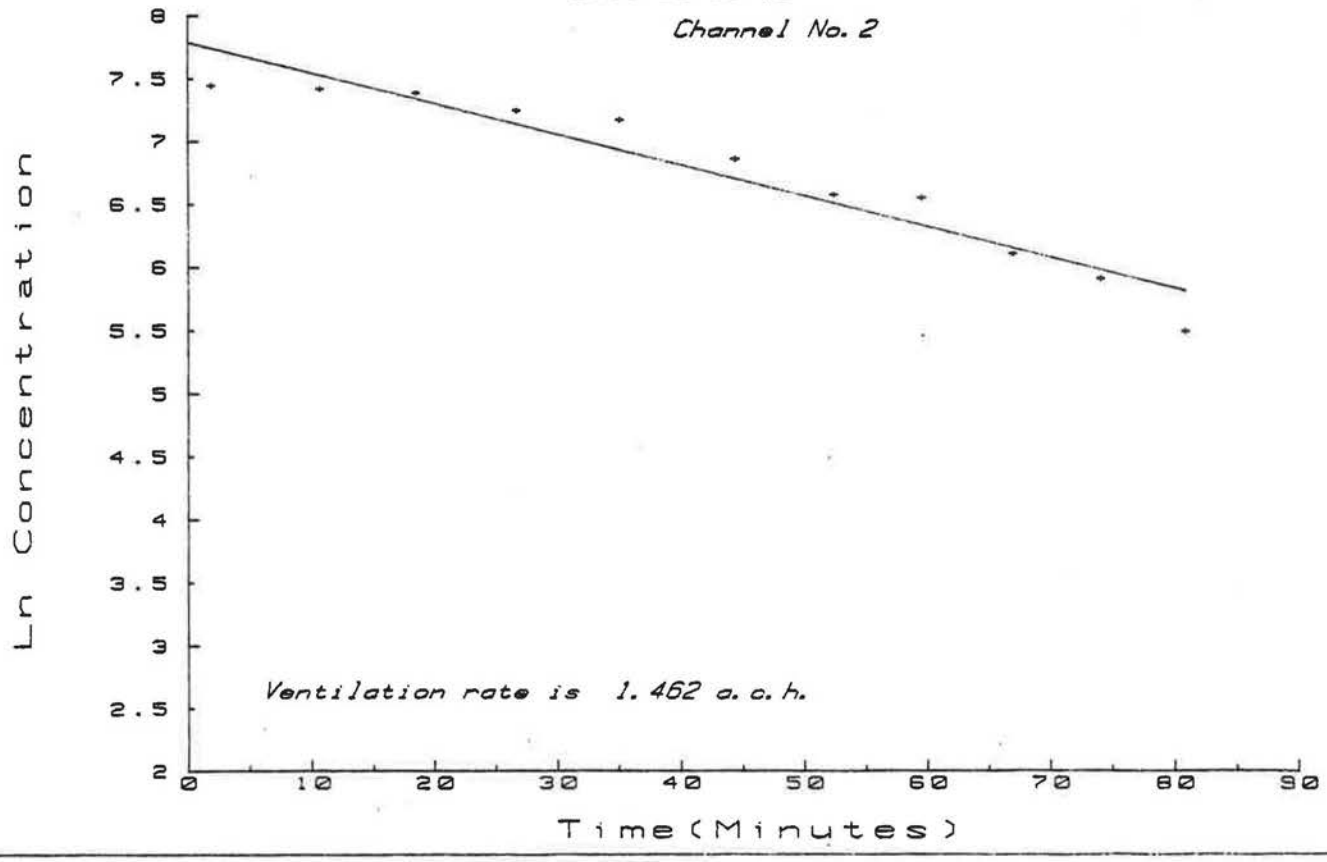
Run-B03R08

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-28/10/82

Channel No. 2



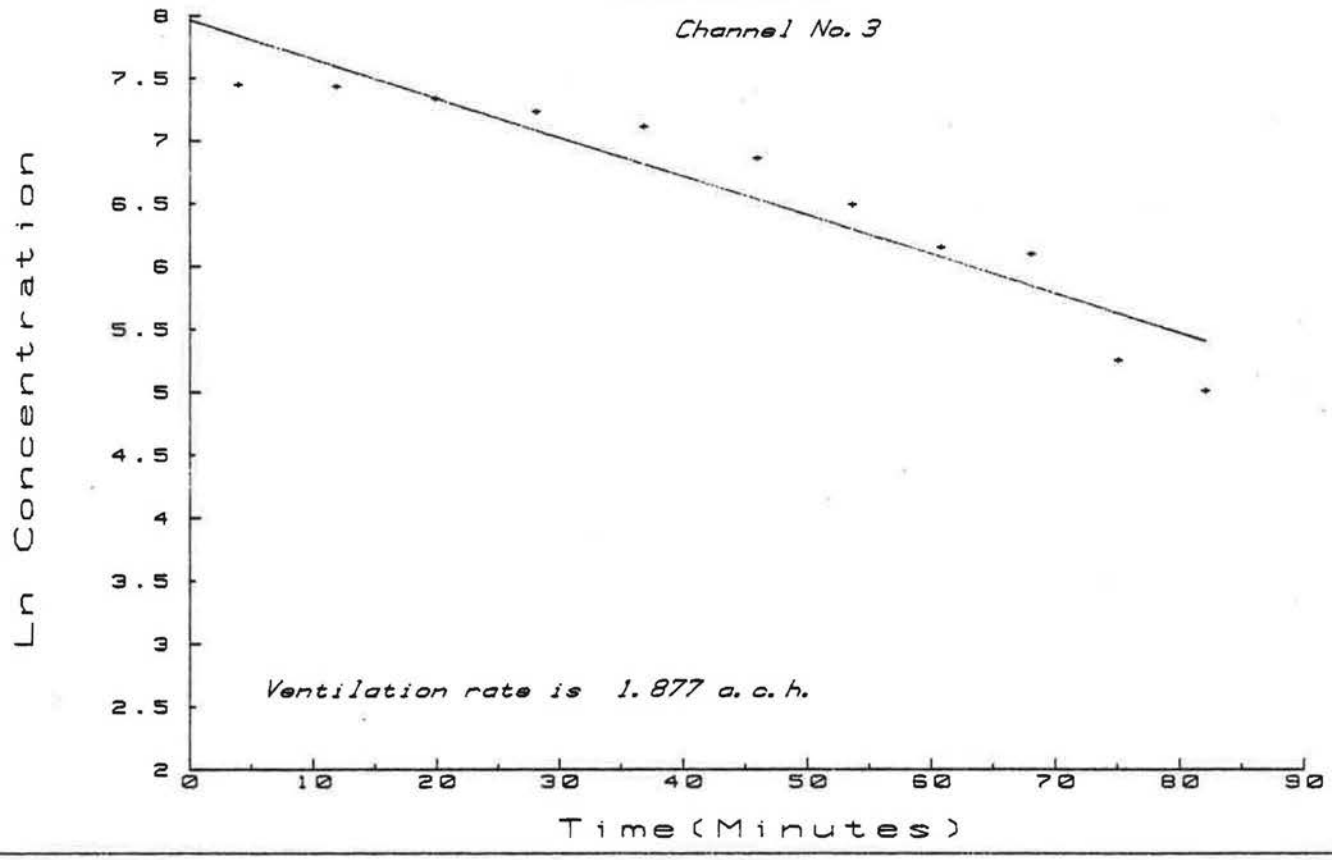
Run-B03R08

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-28/10/82

Channel No. 3



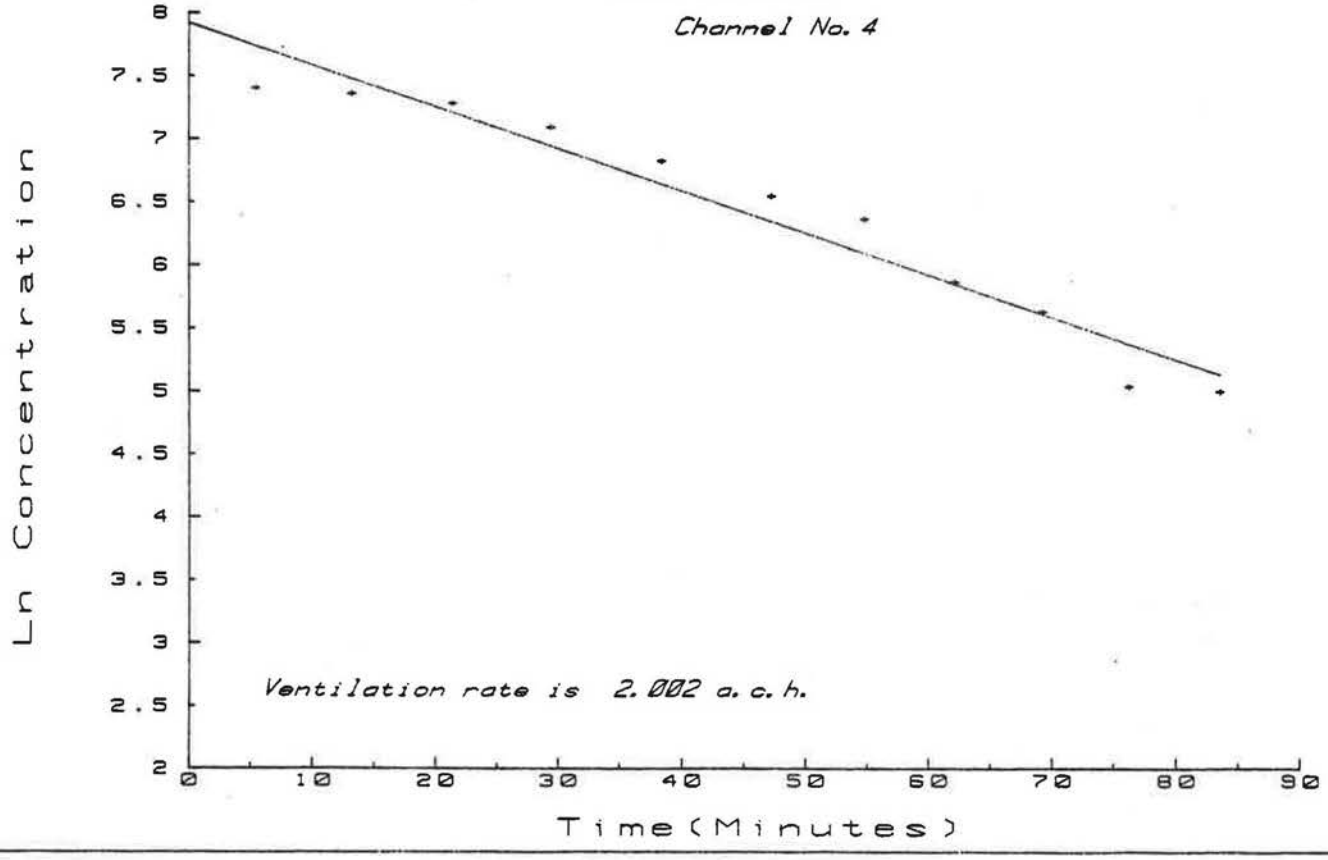
Run-B03R08

Location-Abbey School Sports Hall, KENILWORTH

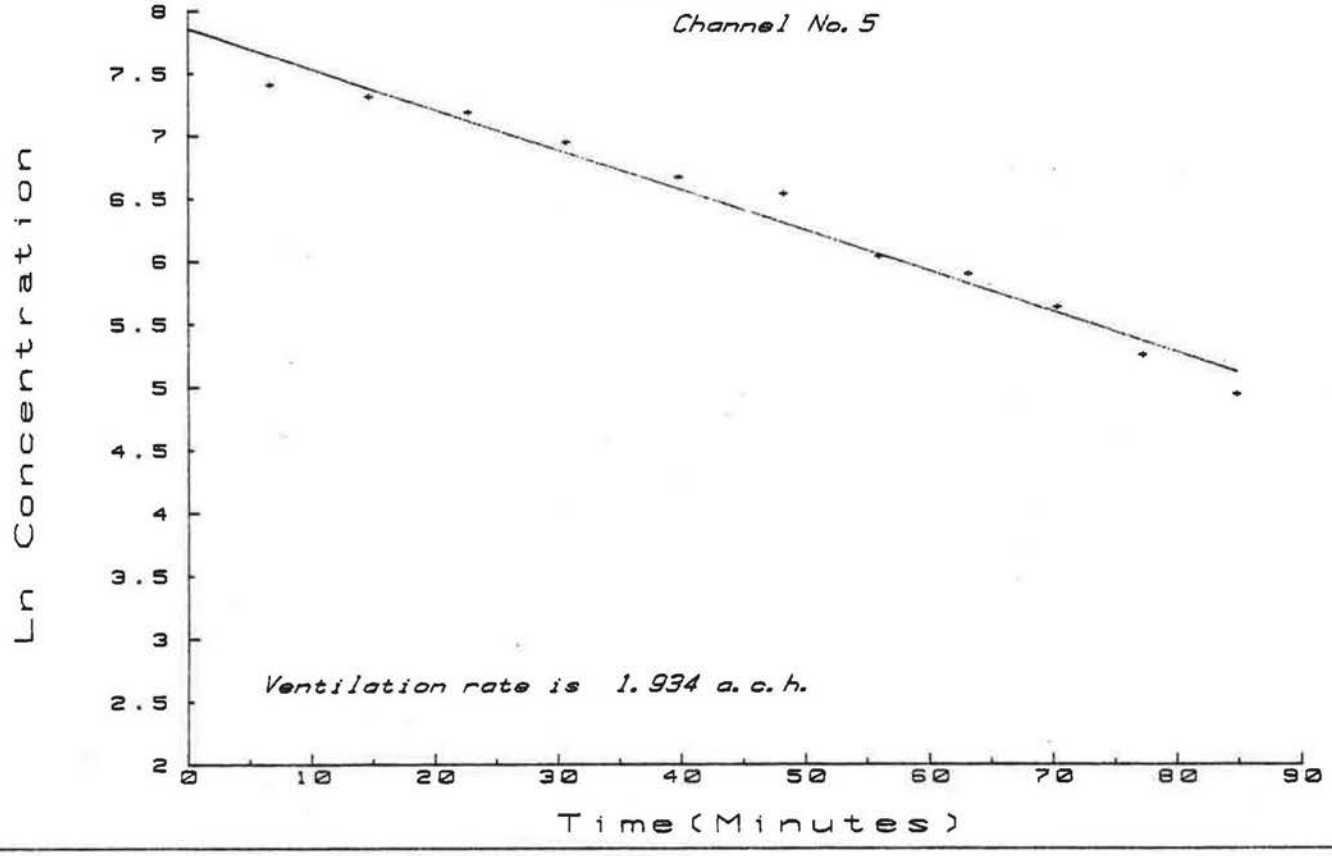
Gas-SF6

Date-28/10/82

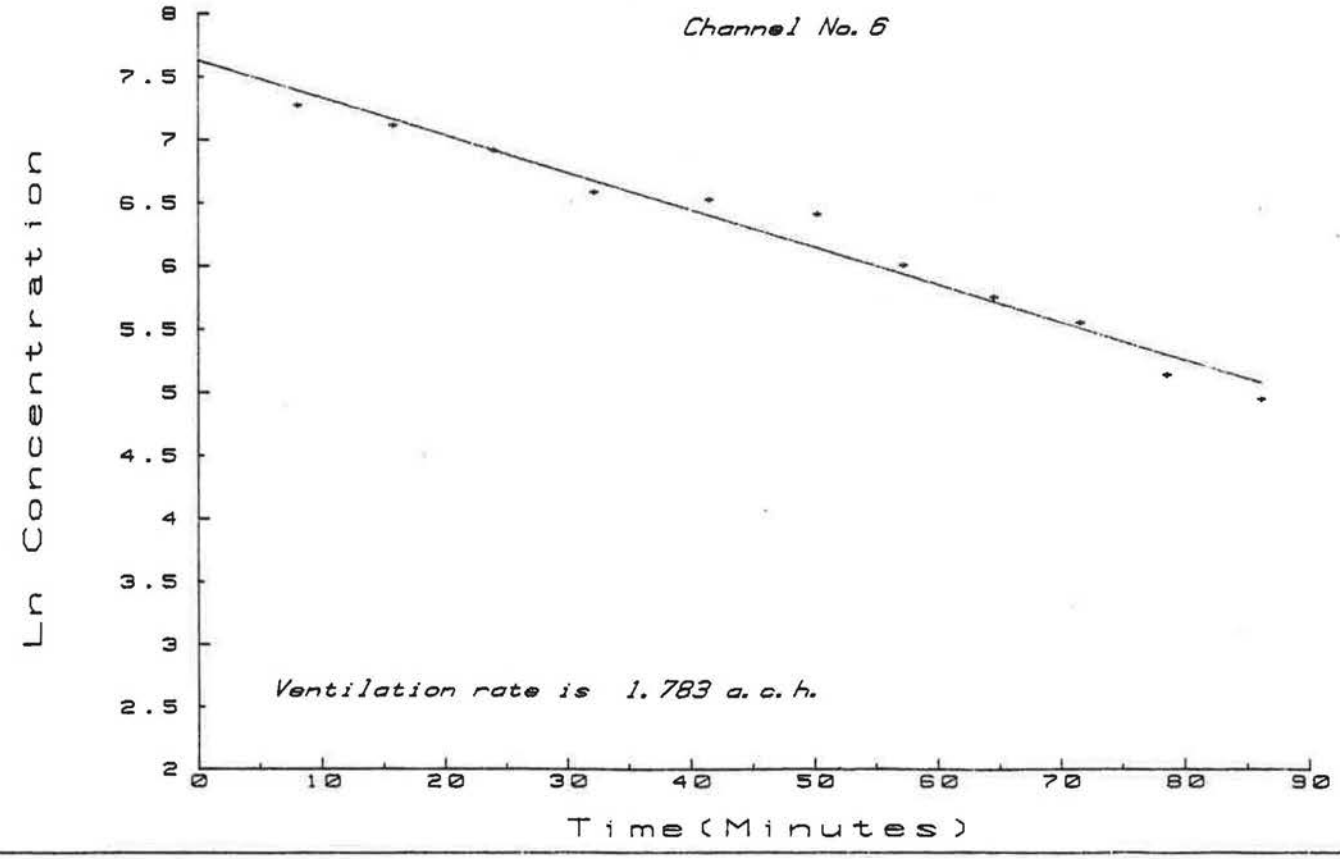
Channel No. 4



Run-B03R08
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-28/10/82
Channel No. 5



Run-B03R08
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-28/10/82
Channel No. 6

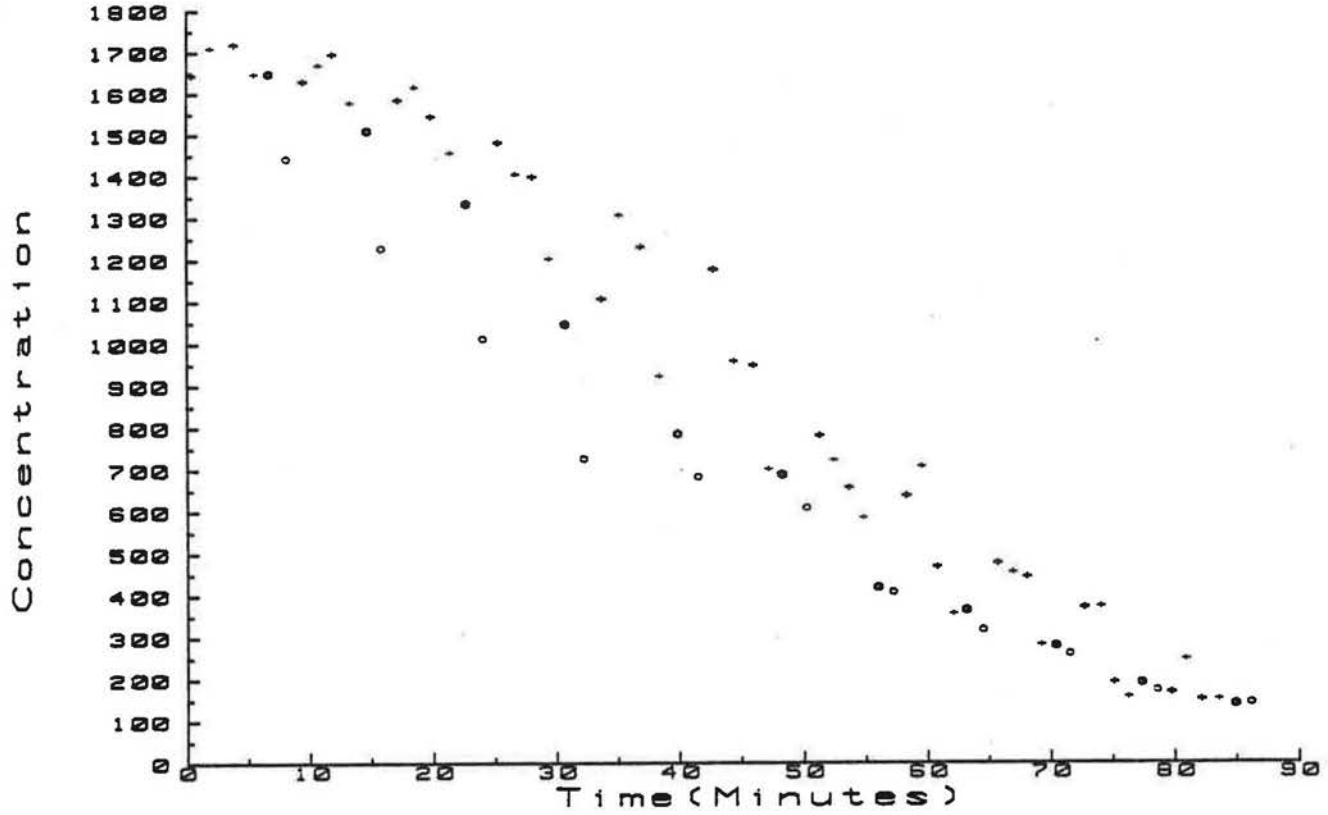


Run-B03R08

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-28/10/82

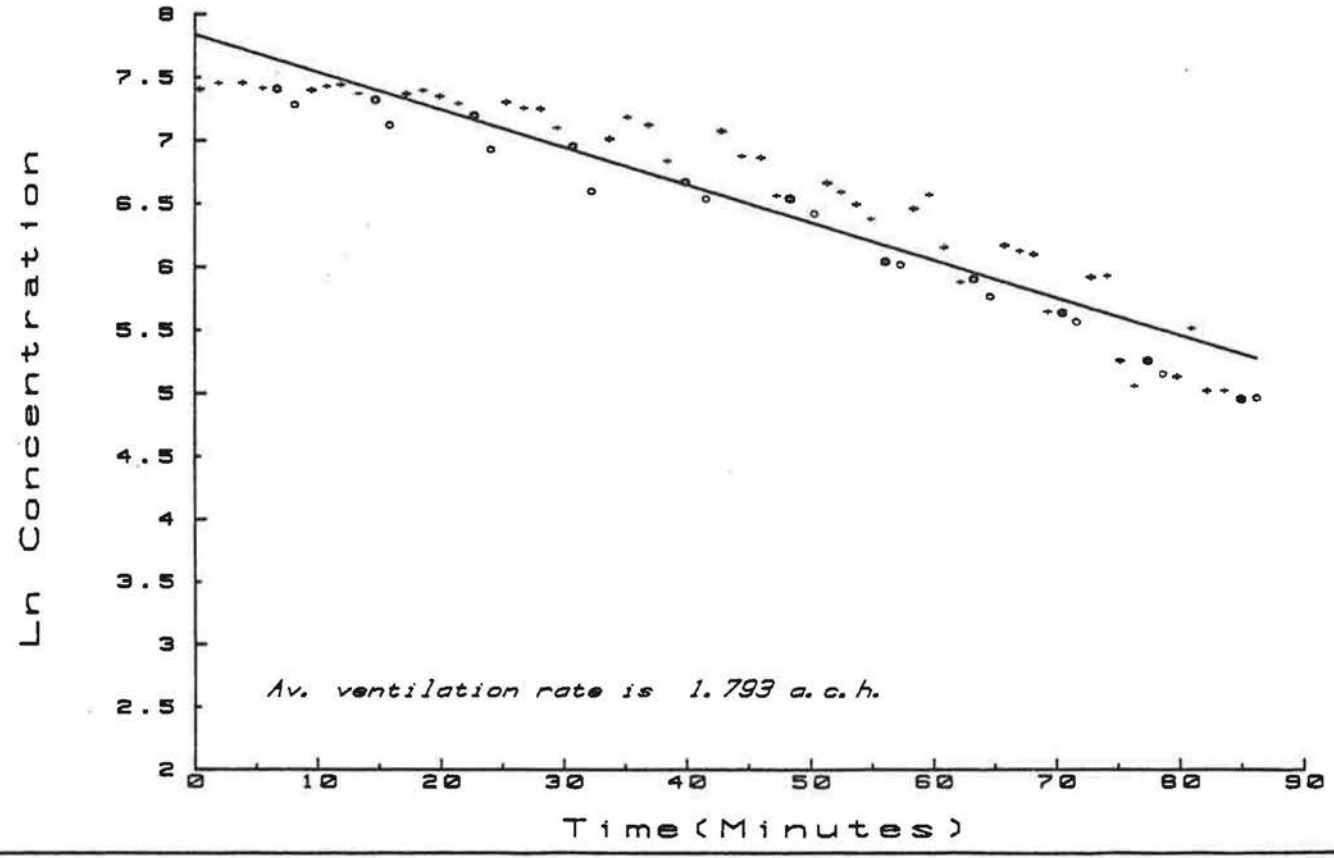


Run-B03R08

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-28/10/82



B03 R09

Date: 27th October, 1982

Time: 1500 hours to 1708 hours

Tracer Gas: Sulphur hexaflouride

External Conditions:

Time	Windspeed (m/s)	Temperature (^{o}C)
1500 hrs	2.6	11.9
1600 hrs	2.1	11.2
1700 hrs	2.C	8.8

Wind Directions: south west

Internal Conditions:

air velocity: 0.02 to 0.08 m/s
temperature: 14^{o}C

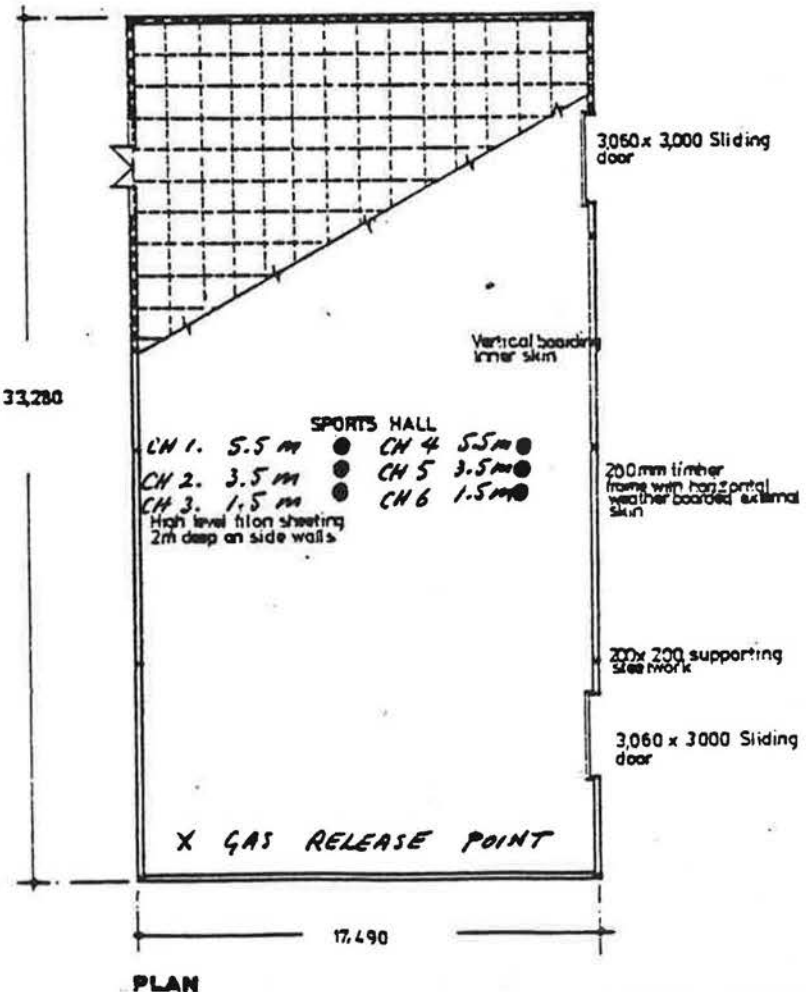
Gas Release:

At position shown on plan without any artificial stirring.

Sample Positions:

As shown on plan.

Comment: This is a complete set of results showing build up of gas during gas release phase as well as the subsequent decay. The single cell analysis of the results is therefore meaningless. Analysis of the decay portion only from data point 5 onwards forms run B03 R06.



PLAN

****
ANALYSIS OF FACTORY VENTILATION RATES
****

Experimental run number: B03R09
Location: Abbey School Sports Hall,KENILWORTH
Date: 27/10/82
Tracer gas: SF6

T=Time in minutes.
C=Concentration (arbitrary units)
Lnc=Natural log of concentration.

TABLE OF RESULTS
***** ** *******

Data Pt.	Channel 1			Channel 2			Channel 3			Channel 4			Channel 5			Channel 6		
****	**********			**********			**********			**********			**********			**********		
	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC	T	C	LnC
1	.8	17	2.833	2.0	0	-6.908	3.2	0	-6.908	4.3	20	2.996	5.6	60	4.094	7.2	61	4.111
2	8.4	29	3.367	9.6	19	2.944	10.8	71	4.263	12.0	121	4.796	13.4	130	4.868	14.7	1526	7.330
3	16.4	640	6.461	17.8	125	4.828	19.2	306	5.724	20.6	719	6.578	22.0	832	6.724	23.2	1497	7.311
4	24.8	1466	7.290	26.1	1018	6.926	27.6	900	6.802	29.2	1309	7.177	30.6	1251	7.132	32.0	1414	7.254
5	33.3	1518	7.325	35.1	1322	7.187	36.8	1126	7.026	38.3	980	6.888	39.6	1021	6.929	41.2	962	6.869
6	42.6	958	6.865	44.2	1010	6.918	45.7	1000	6.908	47.1	831	6.723	48.3	820	6.709	49.7	791	6.673
7	51.0	775	6.653	52.2	877	6.777	53.6	908	6.811	55.0	778	6.657	56.6	750	6.620	57.9	720	6.579
8	59.5	715	6.572	60.9	703	6.555	62.6	761	6.635	64.1	649	6.475	65.4	565	6.337	67.0	580	6.363
9	68.8	654	6.483	70.1	690	6.537	71.8	680	6.522	73.4	648	6.474	74.8	468	6.148	76.2	512	6.238
10	77.5	471	6.155	78.8	494	6.203	80.1	516	6.250	81.6	478	6.170	82.9	455	6.120	84.1	370	5.914
11	85.5	363	5.894	86.8	371	5.916	88.3	407	6.009	89.9	391	5.969	91.2	339	5.826	92.5	290	5.670
12	93.8	309	5.733	95.2	290	5.670	96.4	317	5.759	97.8	334	5.811	99.1	290	5.670	100.4	266	5.583
13	101.8	260	5.561	103.5	251	5.525	104.9	270	5.598	106.2	285	5.652	107.7	226	5.421	109.1	217	5.380
14	110.7	215	5.371	111.9	220	5.394	113.2	260	5.561	114.6	250	5.521	115.7	216	5.375	117.3	194	5.268
15	118.5	203	5.313	119.8	205	5.323	121.5	229	5.434	122.9	219	5.389	124.1	207	5.333	125.9	190	5.247

STATISTICAL ANALYSIS FOR CHANNEL 1

Source	DF	SS	MS	F
Regression	1	.543	.543	.312
Residual	13	22.653	1.742	
Total	14	23.196		

INTERCEPT= 5.550521111369
GRADIENT= 5.171063387228E-03

Ventilation rate is -.110 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 2

Source	DF	SS	MS	F
Regression	1	30.498	30.498	2.861
Residual	13	138.901	10.685	
Total	14	169.382		

INTERCEPT= 2.693427691811
GRADIENT= 1.672324708632E-02

Ventilation rate is -2.323 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 3

Source	DF	SS	MS	F
Regression	1	25.289	25.289	2.347
Residual	13	140.086	10.776	
Total	14	165.375		

INTERCEPT= 1.027988668438
GRADIENT= 1.523970162988E-02

Ventilation rate is -2.114 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 4

Source	DF	SS	MS	F
Regression	1	.178	.178	.158
Residual	13	14.962	1.151	
Total	14	15.140		

INTERCEPT= 5.761221798868
GRADIENT= 2.983646793548E-03

Ventilation rate is -.177 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 5

Source	DF	SS	MS	F
Regression	1	.108	.108	.143
Residual	13	9.789	.753	
Total	14	9.897		

INTERCEPT= 6.103630611039
GRADIENT= -2.302199742068E-03

Ventilation rate is .128 air changes per hour

STATISTICAL ANALYSIS FOR CHANNEL 6

Source	DF	SS	MS	F
Regression	1	2.488	2.488	3.427
Residual	13	9.439	.726	
Total	14	11.927		

INTERCEPT= 6.854292343623
GRADIENT= -1.104879882868E-02

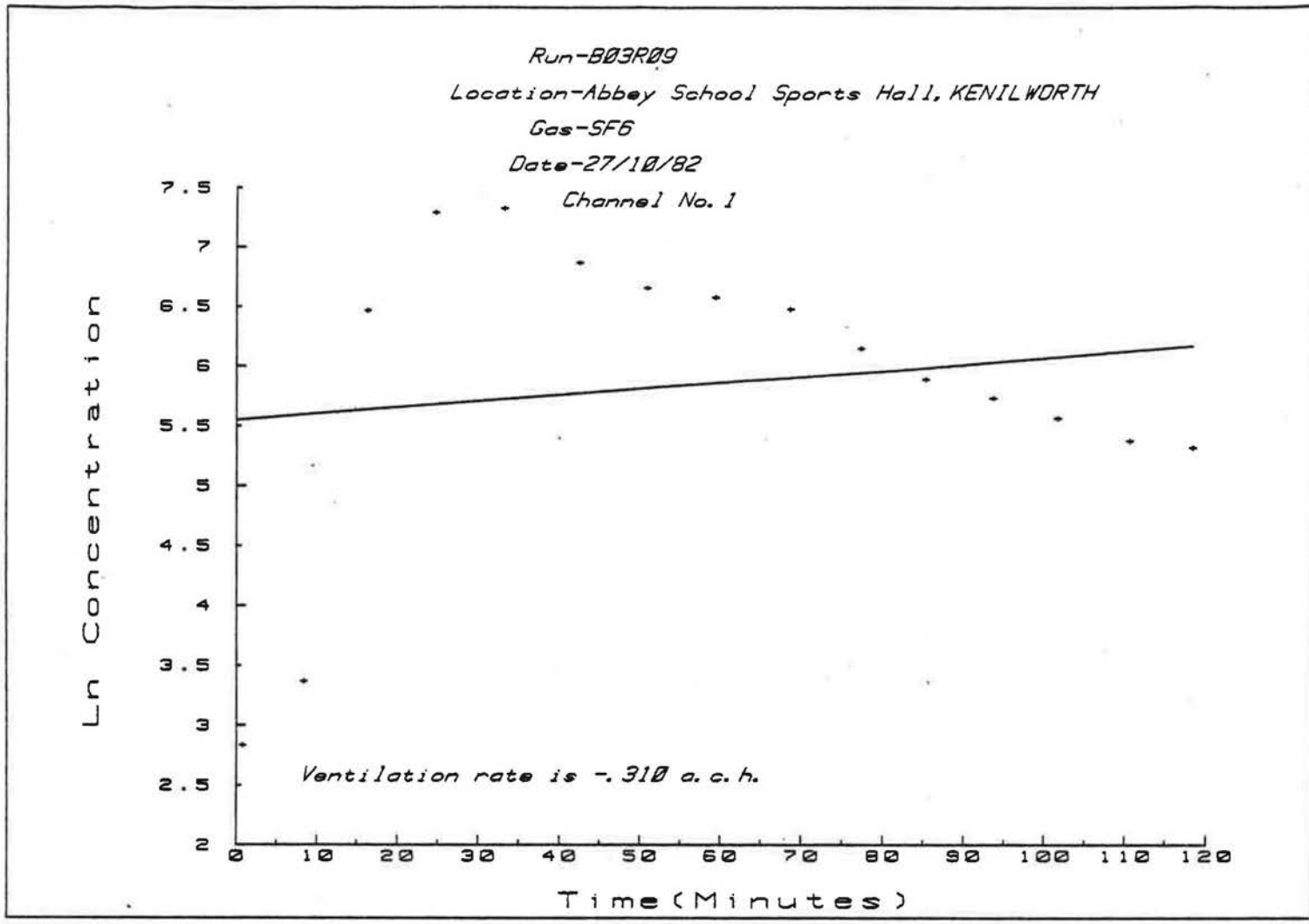
Ventilation rate is .662 air changes per hour

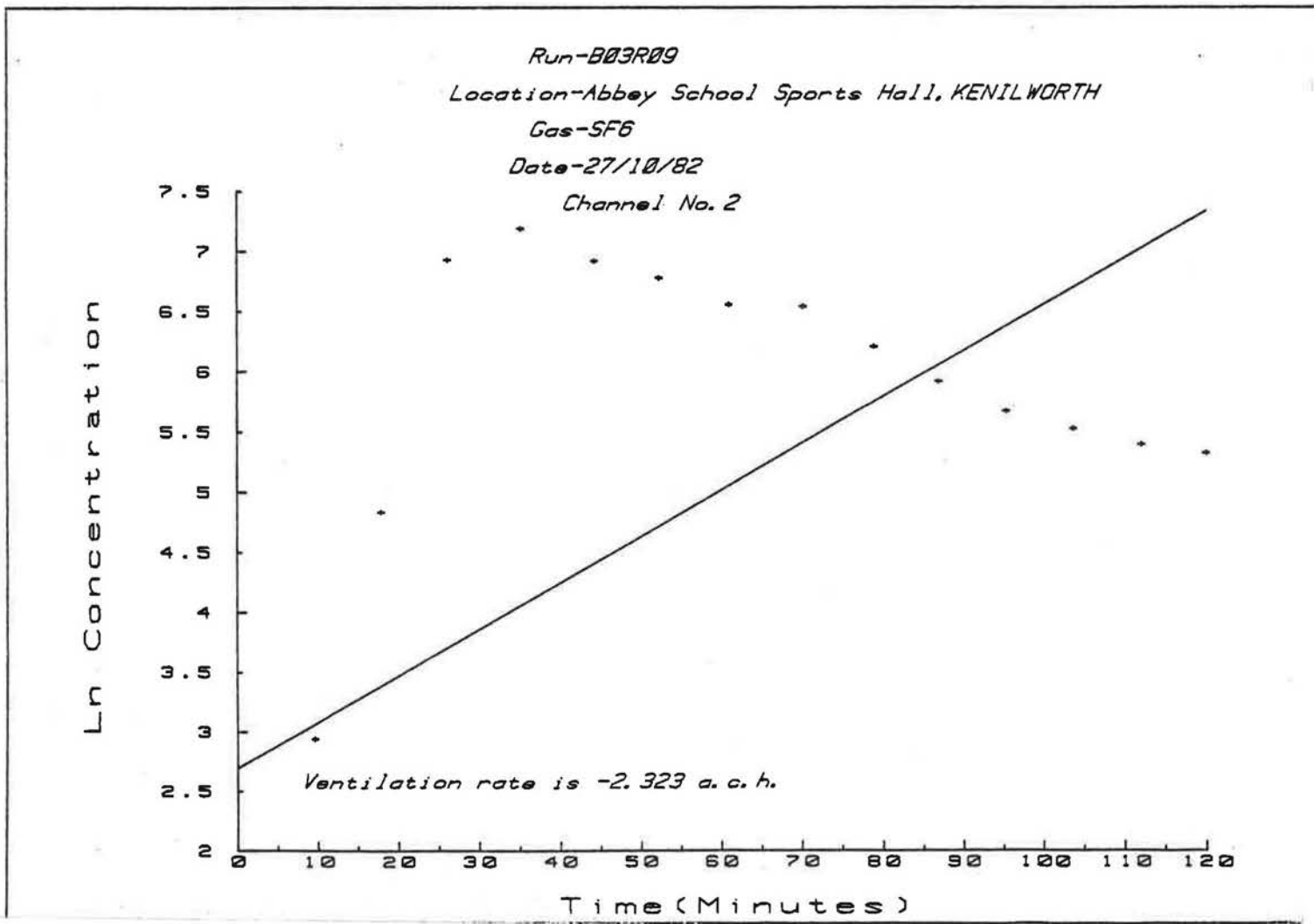
STATISTICAL ANALYSIS - ALL CHANNELS

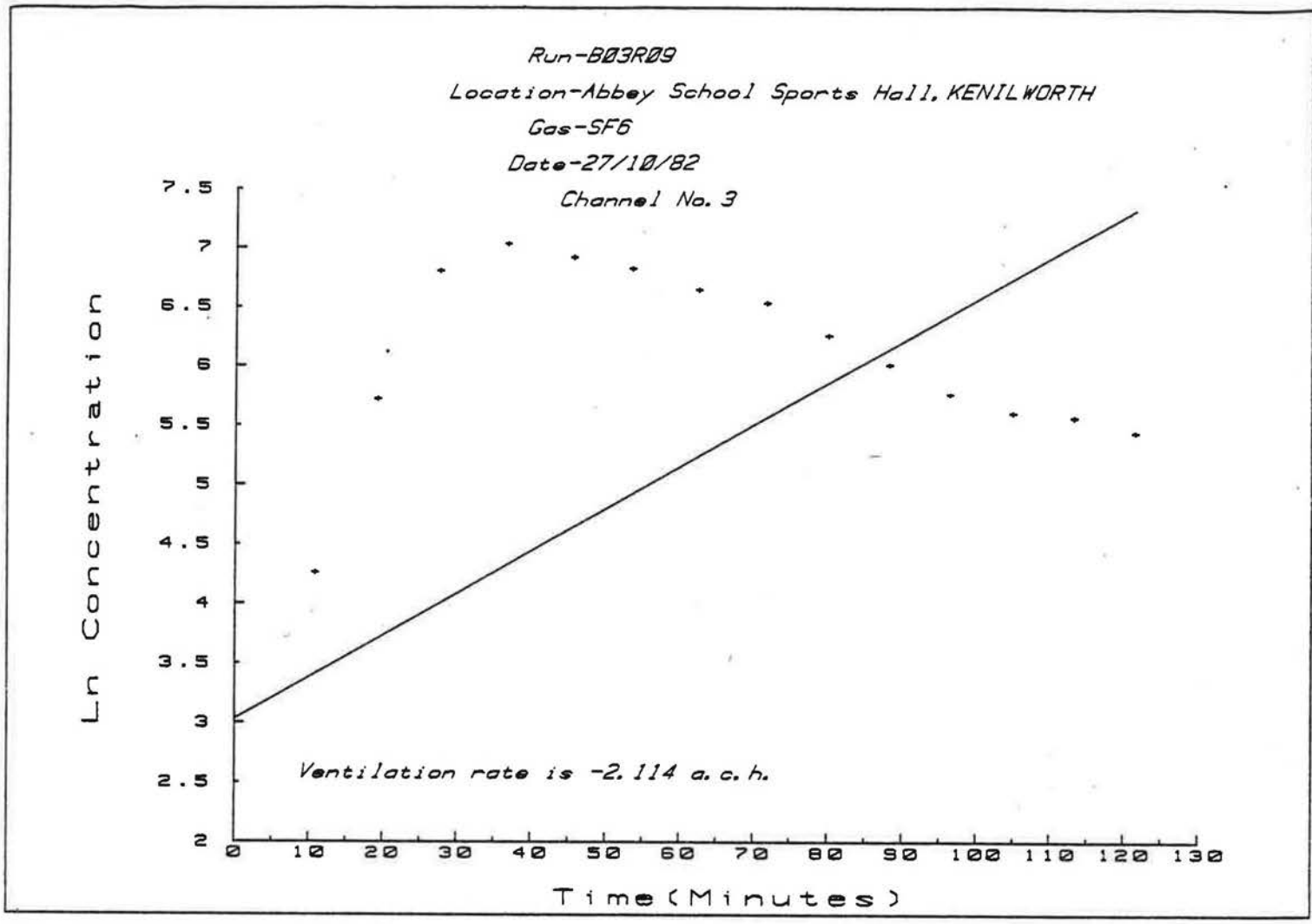
Source	DF	SS	MS	F
Regression	1	17.078	17.078	3.830
Residual	88	392.412	4.459	
Total	89	409.490		

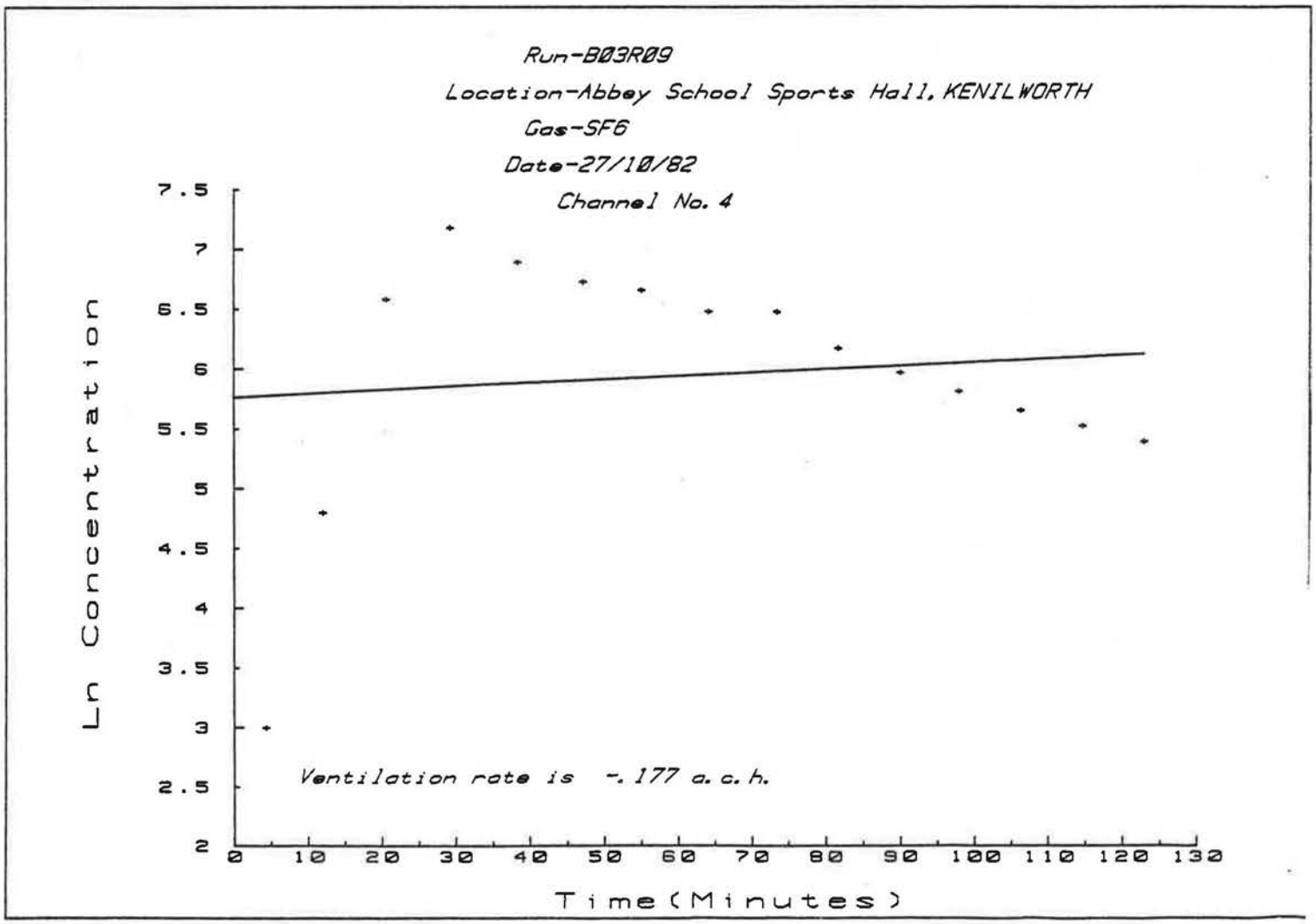
INTERCEPT= 4.949834312055
GRADIENT= 1.179672188232E-02

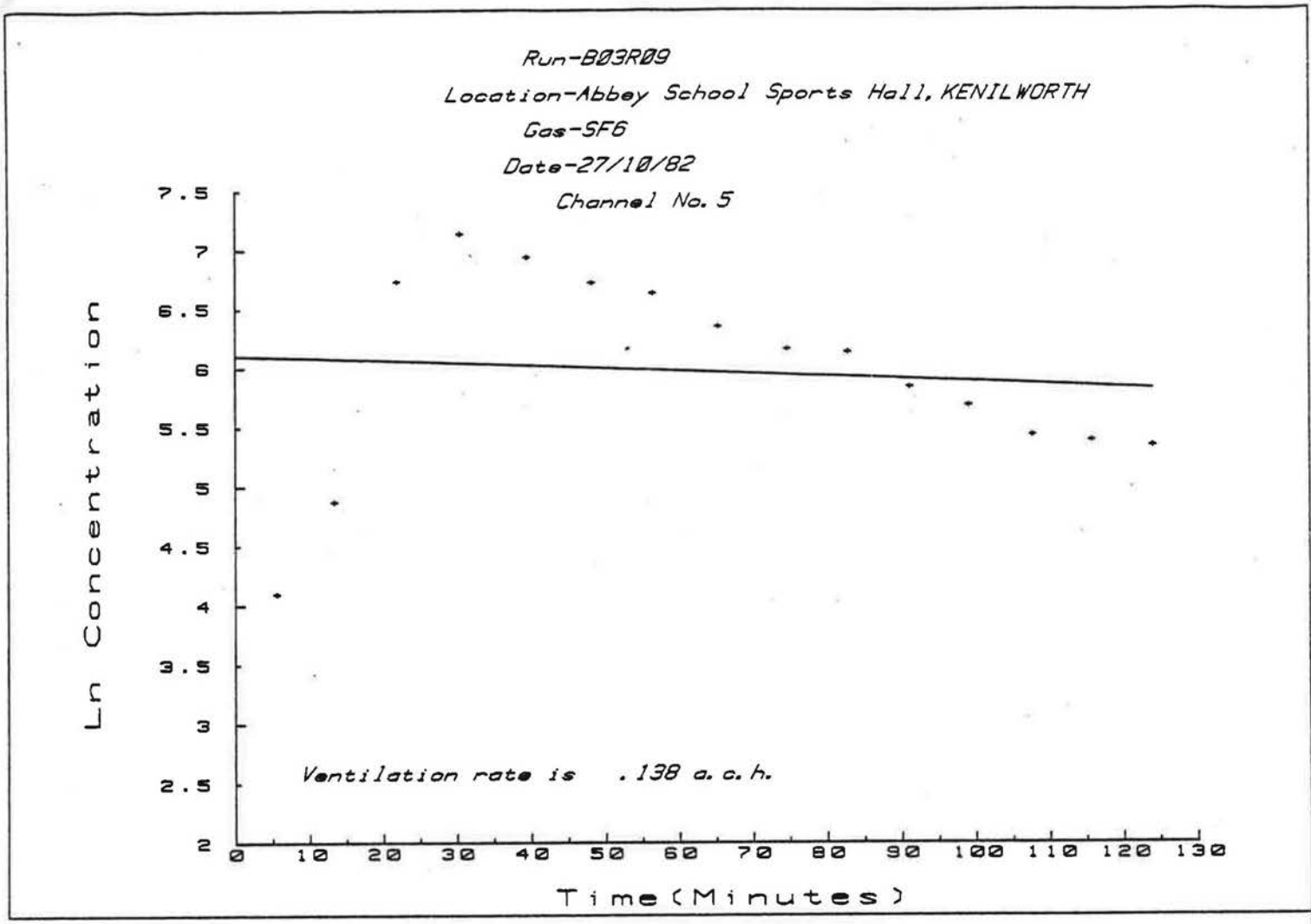
Ventilation rate is -.788 air changes per hour

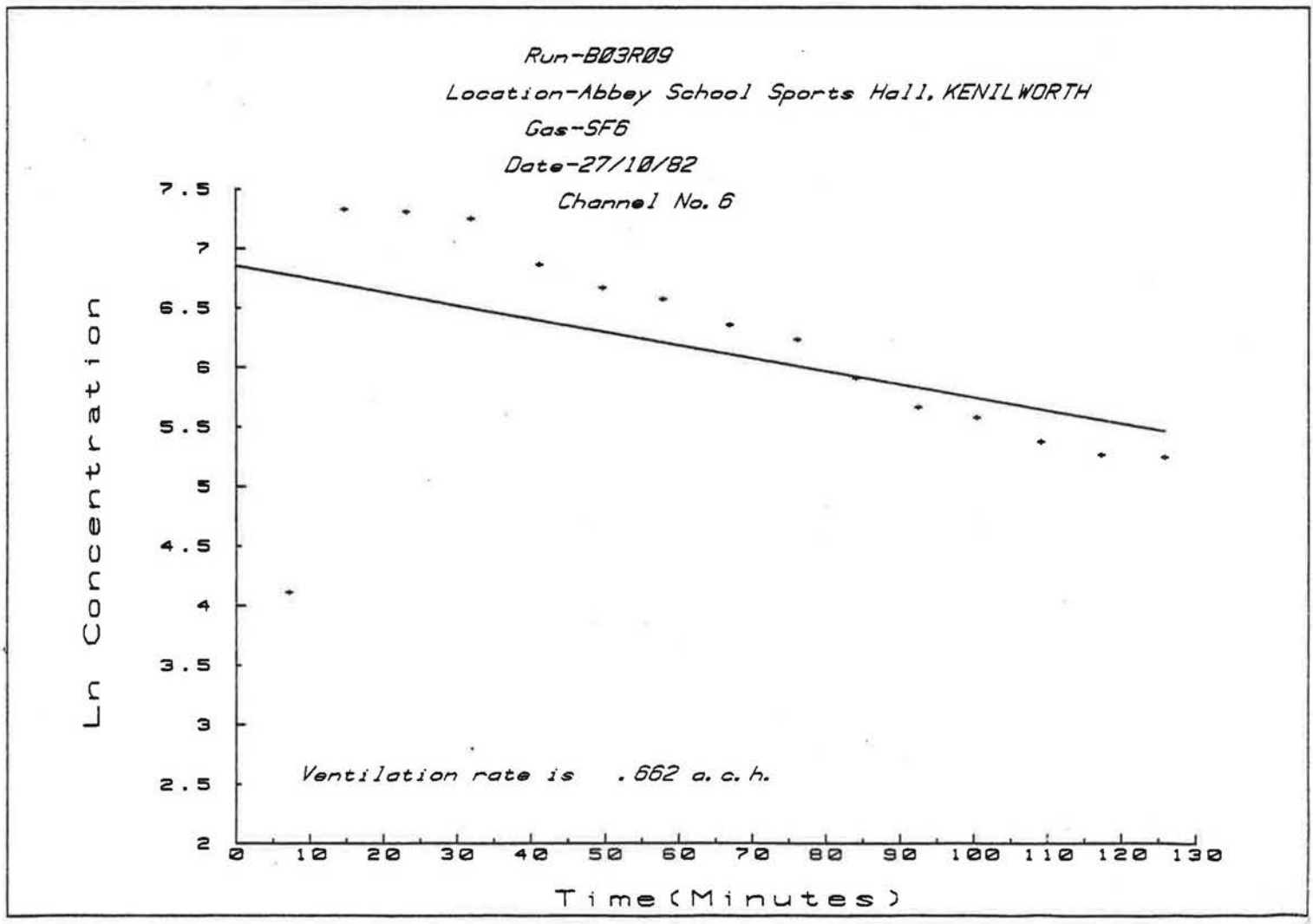

Run-B03R09
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 1
Ln Concentration
Ventilation rate is -.310 a.c.h.
Time (Minutes)


Run-B03R09
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 2
Ln Concentration
Ventilation rate is -2.323 a.c.h.
Time (Minutes)


Run-B03R09
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 3
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
Ventilation rate is -2.114 a.c.h.
0 10 20 30 40 50 60 70 80 90 100 110 120 130
Time (Minutes)


Run-B03R09
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 4
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
Ventilation rate is -.177 a.c.h.
0 10 20 30 40 50 60 70 80 90 100 110 120 130
Time (Minutes)


Run-B03R09
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 5
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0 10 20 30 40 50 60 70 80 90 100 110 120 130
Time (Minutes)
Ventilation rate is .138 a.c.h.


Run-B03R09
Location-Abbey School Sports Hall, KENILWORTH
Gas-SF6
Date-27/10/82
Channel No. 6
Ln Concentration
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
0 10 20 30 40 50 60 70 80 90 100 110 120 130
Time (Minutes)
Ventilation rate is .662 a.c.h.

Run-B03R09

Location-Abbey School Sports Hall, KENILWORTH

Gas-SF6

Date-27/10/82