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# EXPERIENCE IN THE MEASUREMENT OF NOISE FROM MILITARY AIRCRAFT

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## INTRODUCTION

In December 1987 Wimpey Laboratories Limited was appointed by the Ministry of Defence (MOD) to carry out noise surveys over a period of four years at 28 Airfields in England, Wales, and Northern Ireland. The results of the noise surveys were to be used by the MOD to validate contours produced by computer prediction. The validated contours were then used to form the basis for the MOD noise insulation grant scheme. This paper describes our experience to date, with surveys at the first nine airfields completed in 1988.

The background to the Ministry of Defence policy which includes grant assistance for residential properties exposed to noise levels of at least 70dB$L_{Aeq,12\ hour}$ has been described by Mr Boardman of the Ministry of Defence (1).

This paper deals solely with the procedure for carrying out the noise surveys and the production of validated noise contours for the noise insulation schemes.

## CONTRACTUAL REQUIREMENTS

In March 1987, the Ministry of Defence circulated noise consultancy firms with an invitation to tender for the "Noise surveys at Various Military Airfields". A briefing meeting was held in April 1987, at which all tenderers were encouraged to ask questions concerning the contract. The "Task" was defined in the contract documents as follows:

> In order to validate the computer predictions, the Contractor will take noise measurements at carefully selected locations around the airfields. Normally, a minimum of 20 measurement sites at each airfield will be chosen so that they straddle the theoretical model. In addition, any particularly sensitive areas may be specially measured. The local District Council will be consulted prior to each survey so that any special matters of local concern can be taken into account.
>
> Every noise survey must take full account of flying patterns at the airfield. The Single Event Exposure Level ($L_{AX}$) and the maximum 'A' weighted sound level ($L_{AMAX}$) should be recorded for a number of take-offs, rollers, overshoots and landings at each measurement site for each resident aircraft. The period of the surveys will vary depending on the circumstances at each airfield and the meterological conditions but the Contractor must ensure that sufficient data is collected for the establishment of a statistical mean value for each measurement site. Noise from ground engine running should also be measured where this is practical and included in the results.

The Contractor will analyse the data collected and calculate the 70 and 83dB$L_{Aeq,\ 12\ hour}$ values for each measurement site using the $L_{AX}$ values and the average number of aircraft movements per day over a 12 month period.

The term $L_{AX}$ is used throughout this paper. The sound exposure level SEL or $L_{AE}$ is effectively the same as $L_{AX}$; although SEL includes the whole duration of an event $L_{AX}$ is limited to the 10dB down points. In practical measurements of aircraft noise the difference is negligible.

Approximately 15 consultancy firms were invited to tender, with tenders to be returned in May 1987.

The main information obtained at the pre-tender meeting was that a survey had previously taken the RAF team approximately 10 days with each of 3 or 4 people operating a single noise measurement system. It was established that the use of unattended noise measurement systems would be acceptable as long as the results could be used with confidence.

The great unknowns in putting a tender together were the flying operations at each of 28 airfields and the weather. No special flights could be made; the survey was to be carried out in normal flying conditions.

A guide to past movements at most airfields and numbers of aircraft types at each airfield was provided, but in the end, the tenderers had to estimate how long it would take them to complete measurements at twenty sites around each airfield and calculate their costs accordingly. The concern over having a team on site for days when flying is interrupted by unpredictable weather or technical reasons was a critical factor for the tenderers.

## CHOICE OF NOISE MEASUREMENT EQUIPMENT

The equipment required to carry out the survey had to be capable of accurately providing $L_{AX}$ and $L_{AMAX}$ values for individual flight movements. Therefore a straightforward modern precision sound level meter with an operator was all that was required at each site. However, to complete the 20 measurement sites, as quickly as possible, the maximum number of sites should be in operation at any one time. Unattended sites could be equipped with either a programmable sound level meter which stores data for each event, to give a time history, a simple meter with a chart recorder or computer system which digitised and stored the information with the analysis to be completed either after the survey or at the end of the day on a portable computer.

Unattended sites had to be secure and it was essential that the data obtained could be interpreted correctly and unambiguously linked to each aircraft event.

The choice ranged from having a large number of unattended sites gathering data, with one or two people checking the sites regularly, or having as many people as possible in the field with more simple instrumentation.

It was acknowledged that as the survey was carried out to determine noise insulation scheme contours, local residents should be able to see field operatives measuring noise.

The factors which influenced the chosen procedure of the tenderers were cost and reliability of equipment, ease of data production and efficiency of utilisation of staff in the field. The choice had to be made between systems which gave instant results in the field, or those requiring subsequent further analysis. Chart level recorder events would require graphical analysis to yield $L_{AX}$, and the efficiency of computer storage systems would depend on the expertise and familiarity of the operative.

## WIMPEY LABORATORIES' PROPOSED SURVEY PROCEDURE

After taking account of all the above factors, it was decided to obtain as much data as possible in the field with as many staff as could reasonably be made available. A team of five people was proposed; four in the field and one in the Control Tower, linked to each of the four field members via a personal radio. Each of the four field team members would have two sites to look after. At his attended site, he would have a sound level meter which could provide $L_{AX}$ and $L_{AMAX}$ directly. At his unattended site nearby, there would be a simple precision sound level meter connected to a chart level recorder to provide a continuous time history. Each field operative would have a list of times of events at his manned site and all the data at his remote site would be referenced to the events on his list. In turn, each list would be checked with the master log compiled in the Control Tower. In addition an allowance was made to provide a tape recorder at each attended site to record during busy periods of multiple events.

With this system, eight simultaneous sites could be operated by the five man team. We estimated that if a 3/4 man team had taken 10 days to gather sufficient information, then the survey period would be on average 5 days, by operating eight simultaneous sites. We stressed that having four team members at eight sites would enable local inhabitants to be fully aware of the noise survey.

We stressed that all measurement systems would be in accordance with BS 5727:1979 (2). Calibration before and after each day's survey would be carried out with both pistonphones at 250Hz and piezoelectric calibrators at 1000Hz, as required in the contract.

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## PHASE - IN PERIOD

After the award of the contract a phase-in-period allowed equipment to be purchased and checked. Meetings were held with the Ministry of Defence to agree procedures.

Wimpey Laboratories Limited carry out noise measurements under the NAMAS accreditation system for power generators, welders, lawn mowers, excavators etc. This system requires a procedure manual listing exactly how measurements are carried out. In order to ensure a uniform approach, an aircraft noise monitoring procedure manual was proposed by Wimpey Laboratories Limited and the MOD welcomed this. Therefore a procedure manual was compiled and all members of the team were provided with a copy before the survey.

Equipment was assembled and checked in the office. Wooden boxes with locks were made for the unattended sites. Radios were purchased and their operating frequencies were checked with the MOD. Meetings were held with the MOD to check that all equipment met the specifications in our tender proposal.

The Procedure Manual was accepted by the MOD and we then directed our attention to the first surveys.

## PREPARATION FOR THE FIRST SURVEYS

The MOD provided a list of 28 airfields in order of priority. The first two airfields on the list were bases in Suffolk which were less than 4 miles apart. A visit to the first base was arranged and information on aircraft movements and flight paths was obtained. A computer-predicted set of contours for each base was provided by the RAF Institute of Community and Occupational Medicine and provisional measurement sites around the contour were identified.

The base gave information on the likely times of flying, the types of manoeuvre, and the average numbers of events. A provisional date for the survey was selected.

At the same time, a meeting attended by the MOD was held with the Local Authority Environmental Health Department, to explain the survey procedure and the noise insulation grant scheme. Areas of noise complaints were identified and measurements planned for these areas. The Local Authority was invited to attend the survey and carry out their own measurements if they wished.

## THE FIRST SURVEYS

The week when we had intended to start the first survey had to be delayed at short notice, due to operational factors at the base.

The following week everything went smoothly and we had eight simultaneous sites operating for most of three days. At the end of this time we judged that we had sufficient data; we had completed 34 sites compared with the minimum of 20. The bomber aircraft of which there was only one type took off regularly at predictable times and it was relatively easy to obtain sufficient data. The weather was dry and sunny; perfect for noise measurements. The wind maintained its S.W. direction and all take-offs were measured over the same areas.

After three days, we then moved to the second base, which was a transport operation with unpredictable take-offs every one or two hours by aircraft of 6 different types. After four days on site, the weather deteriorated with winds and heavy rain, and we curtailed the survey and concentrated on the analysis of data.

An average $L_{AX}$ value for each aircraft, at each site was calculated, and the $L_{Aeq,\ 12\ hour}$ value was then computed, using the predicted numbers of aircraft movements.

At the first base, we had sufficient data to produce a reliable contour, which was similar in width to the computer-predicted version, but was greater in length.

At the second base, it was decided that we required more data on one of the aircraft types and a repeat visit of three days was subsequently carried out. This gave sufficient data for the production of a reliable contour. In this case the width was again similar to the computer predicted contour but the length was significantly shorter.

A report was produced for each airfield along the lines agreed in the contract. The reports were finally accepted by the MOD after several drafts.

## POTENTIAL PITFALLS

In surveys of this type there are obviously a large number of things which can go wrong and we hope that by now we have already encountered the worst. Some of the potential problems are listed below:

a) Sudden surprise exercise at base with non-typical flying, prevents noise measurement survey taking place.

b) Sudden worsening in weather disrupts survey.

c) Sudden change in wind direction, alters runway operation so that take-offs occur in opposite direction. Fast change in sites required.

d) Low cloud base allows take-offs and landings, but no manoeuvres such as rollers and overshoots.

e) Training airfields do not send students up unless a diversion airfield is available.

f) Equipment at unattended sites can be interfered with by children and cows.

g) Unattended equipment can malfunction. Regular inspection is advised.

h) Sites which have quiet backgrounds at the start of the survey, can be affected by tractors, lawnmowers, noisy cows etc.

i) No-notice take-offs may not allow sufficient warning to be given from Control Tower.

j) Team members at sites near end of runway should have ear defenders for noise levels which can reach 120dB$L_{AMAX}$.

k) Some aircraft are grounded at the end of the month when they have used their quota of fuel.

l) Lack of flights by one or more of relevant aircraft types.

m) Weather and/or ground topography can adversely affect radio communication.

n) Selection of measurement sites can be difficult e.g aircraft taking-off over private farm land or the sea.

## SUMMARY

Having encountered the problems listed above, the experience gained in our first year's surveys has enabled us to look forward to the remaining surveys with confidence.

We are happy with the equipment at the attended sites, some of which are programmable sound level meters which could themselves be left unattended, if required. For the unattended sites we have purchased level recorders which give a print out of each aircraft event as a time-history when a pre-set threshold noise level is exceeded. The $L_{AX}$ and $L_{AMAX}$ value of the event is then printed onto the paper chart. This system saves considerable analysis time.

Nine airfields have been completed in 1988 and the remaining 19 are to be carried out within the next two or three years. The surveys are popular with the staff involved and the work makes a welcome diversion from some of our more regular work in the field of noise and vibration assessment.

## REFERENCES

1. A.M. Boardman 1986
The review of the MOD's Compensation arrangements near Military Airfields
Proceedings of the Institute of Acoustics Volume 8 Part 4.

2. British Standard BS 5727:1979 "Method for describing aircraft noise heard on the ground".