FIFTH INTERNATIONAL CONGRESS ON SOUND AND VIBRATION

DECEMBER 15-18, 1997
ADELAIDE, SOUTH AUSTRALIA

Invited Paper

EFFECTIVENESS OF THE NOISE INSULATION PROGRAM FOR HOUSES AROUND SYDNEY AIRPORT

Marion Burgess

Acoustics and Vibration Unit, University College, University of New South Wales,
Australian Defence Force Academy, Canberra ACT 2600

Abstract The Residential Insulation Scheme is an important part of the Sydney Airport Noise Amelioration Project. This scheme is based on the application of treatments from a Menu based on the external aircraft noise. Following implementation in over 400 houses the acoustic data obtained from measurements in a sample of 61 houses before and after treatment have been analysed. The aim of the analysis was to assess the effectiveness of the insulation scheme and in particular to ascertain if improvements or changes were necessary. For the majority of the sample, the aircraft noise attenuation achieved for the bedrooms was as would be expected. The reasons for lower than expected attenuation were identified for the others. Two important finding from the study were that kitchens and living rooms are likely to achieve lower attenuation than bedrooms and that attention to detail in the inspection process is essential. It was also found that the use of the Menu appears to be a balanced and equitable means for choosing the appropriate measures and, given the constraints of applying the remedial measures to existing homes, the overall improvement that has been achieved is very good.

1. INTRODUCTION

To cope with the increasing air traffic for Sydney Kingsford Smith Airport, it was decided to construct a new runway parallel to the existing north-south runway. In November 1994, the Minister for Transport announced measures to reduce the impact of aircraft noise in the residents in the vicinity of the airport. These measures included the acquisition of residences within the 40 Australian Noise Exposure Forecast (ANEF) contours and sound insulation for the residences between the 30 and 40 ANEF contours. Prior to commencing this sound insulation work, a pilot study was undertaken to identify the most effective insulation measures for the residences [1 and 2].

For the pilot study, eight unoccupied houses were treated first. The experience and knowledge gained from the evaluation of various treatments for these houses was used for the treatment of ten occupied homes. The goal was to investigate the practicality of achieving the reductions sufficient to meet the requirements of Australian Standard AS 2021 [3], ie the noise during a flyover should not exceed 50 dB(A) in the bedroom and 60 dB(A) in the other living areas of the house, excluding bathrooms, laundries etc.

2. NOISE INSULATION PROGRAM

Following the consideration of the findings of this pilot study, a procedure for the treatment of the houses was established. In summary, the steps for the work on each residence as part of the Sydney Aircraft Noise Insulation Project are:

- the external aircraft noise level for each house is determined with reference to the tables in AS 2021 [3] and is based on the information on the fight paths, aircraft types etc;
- each home owner is provided with an information package which includes a video;
- the 'scoper' from the Project inspects each house and uses the appropriate parts from the Menu of Approved Treatments for the external aircraft noise level to determine the extent of the work to be done;
- the home owner chooses decorator items such as window style;
- taking into consideration the home owner choice and the standard specifications, the scoper prepares the Scope of Works;
- three quotations for the work are obtained by the home owner;
- the lowest quote from an acceptable builder, up to a limit of $45,000, is accepted by the Project and the work is undertaken;
- inspections are undertaken by staff from the Project mid way through the work, at the end of the work and, in some cases after 3 months; and
- for up to 20% of the houses, noise level measurements are made before and after the work to determine the noise reduction achieved in three rooms.

The essence of the program is the use of the Menu of Approved Treatments rather than a consideration of the noise reduction required for each room. Once the external noise level has been defined, the Menu lists the treatments that are considered applicable. The aim is to provide adequate insulation around the perimeter of the residence even though this may provide higher noise reduction than may be necessary in general areas such as corridors etc. This "perimeter insulation approach" has been adopted because the use of substantial internal doors between the rooms was considered unacceptable by the home owners in the pilot study. This emphasises the need to balance the acoustic performance against the practical aspects of undertaking work on existing houses.

The work undertaken as part of the Menu includes provision of air conditioning or mechanical ventilation plus measures to improve the attenuation of :

- external doors by replacement and/or seals;
- external walls by blocking vents and openings;
- windows by replacement and/or secondary glazing;
- roof/ceiling by soft fibre insulation and loaded vinyl;

For different external noise levels, the differences in the menu items relate to factors such as the nature of the door, the thickness of the glazing and the mass of the insulation layer in the roof space.

3 AIRCRAFT NOISE ATTENUATION DATA

The data from measurements of the noise reductions before and after the insulation work were provided by the Department as part of a review of the effectiveness of the insulation scheme. This data was obtained by simultaneous noise measurements made inside and outside the house for actual aircraft flyovers. The Aircraft Noise Attenuation (ANA) for each flyover was determined from the difference between the maximum noise level in terms of dB(A) for the external and the internal measurement locations. The average and standard deviation for the ANA was then determined for each room. The aircraft type and the movement direction, ie landing or take off, were noted.

The ANA data from measurements in 61 houses was examined. Of the 53 which were primarily brick construction, some had part lightweight construction, usually the kitchen or living room. For seven of the sample, the data for ANA was only available following the insulation treatment. The data for the ANA for the eighteen houses in the pilot study [1] has also been included in the analysis, where appropriate, for comparison.

Factors which could limit the accuracy of the data are:

- The ANA data for any one house does not represent a mix of landings and take offs. During the measurements for any one house, the fight direction was generally the same. That direction and hence the incident sound, may be different for the before and after treatment measurements.
- It is assumed that the noise measured outside, in the most exposed location, is representative of the noise on all the facades of the house. Unless the aircraft is almost directly overhead, this may not be the case. Thus an apparently higher ANA for a room on the side of the house away from the flight path may be the result of the combination of the actual ANA for that room plus the effect of shielding provided by the other parts of the building or by adjacent buildings. This effect may increase with orientation to the flight path.
- For an inner city suburb, the outside areas may be quite small with solid perimeter walls and fences. The additional reflections from these surfaces can lead to higher noise levels in the outside space than are applicable to the other facades of the house. This could lead to an apparently higher ANA for a room facing away from that space.
- For an inner city suburb, the high levels of background noise from traffic and other activities can cause problems during the measurements but it is understood that the data was only considered valid when it was clearly above the background noise.
- Substantial changes to the internal furnishings may have been made between the measurements before and after treatment. This would mean that the acoustic conditions in the rooms may have changed leading to a small effect on the ANA.

Taking into consideration all the factors which can influence the accuracy of the measurements, it would be reasonable to assume that the measured value of ANA would be within approximately ±2 dB(A) of the real ANA.

4 AIRCRAFT NOISE ATTENUATION ACHIEVED

4.1 Bedrooms

From Figure 4.1 it can be seen that, for most of the 53 houses of predominantly brick construction, the ANA achieved for Bedroom 1 is more than 35. Bedroom 1 is generally at the front of the house, under the pitched roof, furnished and able to be closed off from the rest of the house. Only seven houses had an ANA less than 35 for Bedroom 1. However it is of note that three of these occurred where the aircraft noise level was >91 dB(A), that is where the measures have involved the more extensive work and where an ANA closer to 45 would be anticipated.

4.2 Living Rooms

From Figure 4.2 it can be seen that for 52 living rooms in houses of predominantly brick construction, 19 achieved an ANA of less than 35. There is generally much greater variation in the layout of living rooms with many being open to both the hallway and the kitchen area. Some may only have one external wall and be shielded by adjacent buildings while others may be at the rear of the house and have three external walls. It is also common for the living area of the houses in the study area to be under a skillion roof. Nine of those with low ANA occurred where the aircraft noise level was >91 dB(A), that is where the measures have involved the more extensive work and where a higher ANA would be anticipated.

4.3 Kitchens

There is less data on the ANA for the kitchens for both the pilot study and the houses of predominantly brick construction in the review. However it is clear that the ANA achieved for the kitchens is much less than for the other rooms of the houses. There is considerable variation in kitchens with many being open to the living area. It is also common for the kitchen to be under a skillion roof and be part of an extension of lightweight construction to the original brick house. For only three of the houses was the ANA for the kitchen found to be 35 or greater. The ANA was less than 30 for a number of houses where the aircraft noise level was >91 dB(A), that is where the measures have involved the more extensive work and where a higher ANA would be anticipated.

4.4 Change in ANA

The Menu allows for more extensive treatments for the houses with higher aircraft noise level. Figure 4.4 shows the cost of the treatment for houses of predominantly brick construction versus the change in ANA. The scatter in the data shows that there is no clear relationship between the cost, which relates to the extent of the treatment, and the change in ANA. In fact, two houses having the lowest costs for the work achieved almost the highest improvements in ANA. Similar scatter was obtained from the comparison of the change in %ANA versus cost.

4.5 Houses of Mainly Lightweight Construction

Only a small number of these houses have been treated using the same Menu as for the houses of mainly brick construction. Thus the only treatment to the walls was the sealing of vents and other openings and no attempt was made to increase the ANA for the walls themselves. The values for ANA for all rooms were generally lower with most being less than 35.

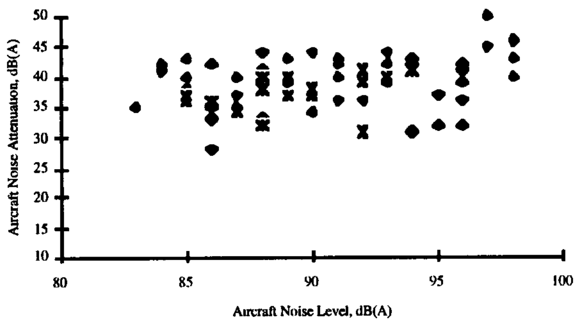

Figure 4.1 ANA for bedroom 1 following the treatment in:
* the houses in the pilot study and
◆ the houses of mainly brick construction

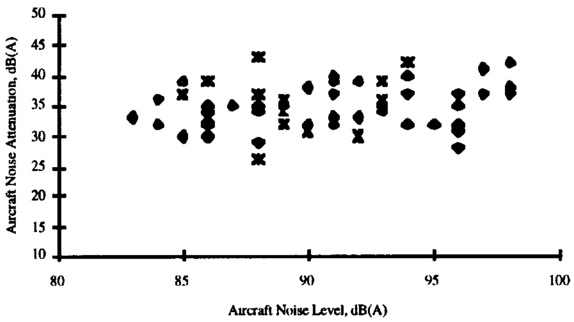

Figure 4.2 ANA for living room following the treatment in:
* the houses in the pilot study and
◆ the houses of mainly brick construction.

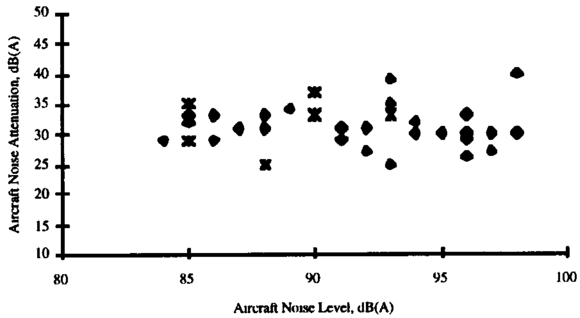

Figure 4.3 ANA for the kitchen following the treatment in:
* the houses in the pilot study and
◆ the houses of mainly brick construction

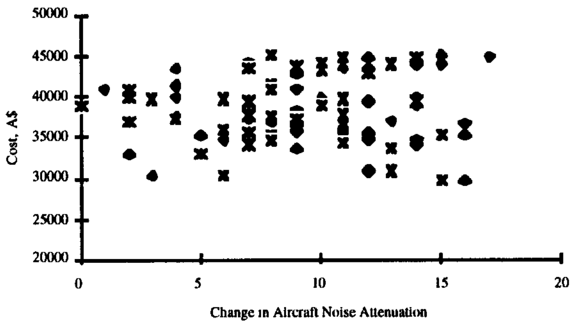

Figure 4.4 Cost of the treatment versus change in ANA for the houses of mainly brick construction:
◆ bedroom 1 and * living room.

5 REASONS FOR HIGH AND LOW ANA

It is important to understand and address the reasons for low values of ANA as although the work has been done, the anticipated improvement has not been obtained. It is also important to understand the reasons for high values of ANA as there may be an opportunity to simplify the extent of work and hence disruption to the residents.

Only some rooms in some houses achieved outstanding values for ANA. For bedroom 1, the highest value for ANA of 50 was obtained for a house is in the middle of a row of single storey terrace houses with the flight path to the rear of the property. Bedroom 1, at the front, is well shielded by the other rooms of the house and by the adjacent houses. The rear yard area, where the external measurements were made, is a small reverberant space. Thus all the factors which would contribute to a high value of measured ANA were present. Also the three highest values for ANA for bedroom 1 were achieved for houses in the same part of the street with the same orientation to the flight path. It should be noted that the living room and kitchen for these houses did not achieve outstanding values.

The bedrooms generally achieved reasonable values for ANA. For most of the houses examined, the lower values of ANA occurred where the construction was a little different to a typical bedroom which would comprise brick external walls, small windows, door and be under the pitched roof. Many of the living rooms and kitchens achieved low values for ANA. Some of the common reasons for this were the poor sealing and framing for patio doors, faulty seals on external doors, inadequately treated exhaust fans, air conditioning ducting penetrating skillion roof/ceiling and lightweight construction for the external walls.

6 CONCLUSION

A review of the effectiveness of the insulation treatments used in the Residential Insulation Scheme as part of the Sydney Airport Noise Amelioration Project has been undertaken and the acoustic data obtained from measurements in houses before and after treatment have been analysed.

It was found that, in general, the Menu is a balanced and equitable means for choosing the appropriate measures and, given the constraints of applying the remedial measures to existing homes, the overall improvement that has been achieved is good. For the houses of predominantly brick construction, the values of ANA for the bedrooms was generally in the range that would be expected from the findings in the pilot study with most being above 35 and a couple even above 45. The values of ANA for the living rooms and kitchens were considerably lower with only a few being close to 40. For the houses of lightweight construction, the items in the Menu needs to be reconsidered to take into account the lower noise reduction for untreated lightweight walls.

The Menu provides for greater treatment for the houses with higher aircraft noise. However there was no clear trend showing an increasing change in ANA, increasing change in %ANA or increasing cost with increasing aircraft noise level. In fact the average ANA after treatment for the houses in the highest category was only 2 dB(A) greater than for those in the lowest category.

Lack of attention to detail, such as the correct installation of seals, appeared to be the main reason for low values of ANA. Attention to detail is vitally important in order to achieve the potential noise reduction and these details should be carefully checked during the inspection process.

7 REFERENCES

1 *Sound Insulation of Residences Exposed to Aircraft Noise*, Australian Operational Support Services, Dept Administrative Services, AGPS, 1995.

2 Narang PP and Butler KR, Reducing aircraft noise impact by sound insulation of houses, Acoustics Australia, 24, 3 (1996), 97-103.

3 *Aircraft Noise Intrusion- Building Siting and Construction*, AS 2021 Standards Australia, 1994

8 ACKNOWLEDGMENT

The permission of the Department of Transport and Regional Development to present some of the findings from the review of the noise insulation program is gratefully acknowledged.