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A LABORATORY COMPARISON OF SUBJECTIVE RESPONSE TO MILITARY AND CIVIL AIRCRAFT FLYOVER NOISE

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INTRODUCTION

Low altitude military aircraft flyover noise has emerged as a focus for public attention in recent years. There has been a considerable amount of research into community response to civil aircraft noise over the last 20 to 30 years, but military aircraft flyover noise has not received the same level of attention. The primary objective of this study was to make a subjective comparison of the relative noisiness of the two generic types of aircraft in order to suggest whether or not it would be possible to apply civil aircraft data to the assessment of military aircraft flyover noise in the future.

APPROACH

There are a number of difficulties associated with field surveys of comparative response to different noise sources. It would be very difficult to find a range of sampling areas exposed to appropriate levels of both civil and military aircraft noise simultaneously, and the alternative of directly comparing questionnaire responses obtained in areas exposed to civil and military aircraft noise separately has a number of methodological problems. These problems can be overcome by using laboratory presentations of recorded civil and military aircraft flyovers which can then be directly compared using subjective rating techniques. The laboratory study cannot determine how individuals would respond to real-life exposure, but the potentially confounding effects of situational variables in the field can be avoided or experimentally controlled.

The variables which were considered in the study were limited to the type of aircraft (civil or military); the maximum level, onset rate, and duration of the flyover; and subject knowledge of the aircraft type. In practice, there are a number of military aircraft types which have similar civil counterparts. The differences that do exist between generic civil and military aircraft flyovers are determined by engine types and power to weight ratios, and the way in which the aircraft are flown. B747s, for example, are rarely flown in the same way as Tornados or Jaguars on low altitude training flights, and it is unlikely that an average member of the public could reliably differentiate between civil and military aircraft types at heights of several thousand feet and above by sound alone.

Two experiments were carried out; the first to investigate the effect of generic type knowledge, and the second to investigate the effects of onset rate and duration of the flyover. Both experiments should only be considered as pilot studies as the available resources limited the number of volunteer subjects that could be accommodated. Full details of the procedures and statistical analyses can be

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found in "Comparison of subjective response between military and civil aircraft noise - a laboratory study", by Denise Kee, an MSc dissertation submitted at the Institute of Sound and Vibration Research (ISVR) in October 1990.

Experiment 1 - Type knowledge

Eight volunteer subjects sat in the ISVR simulated living room and listened separately to eight flyover sounds reproduced through an array of loudspeakers mounted in the ceiling, and in accordance with a Latin Square experimental design. Two separate but reasonably well matched recordings of each of the following aircraft types were selected as follows;

B747 take-off from Heathrow	recorded at 95 and 97.5 LAmax
Concorde take-off from Heathrow	recorded at 121 and 122 LAmax
F111 take-off from Upper Heyford	recorded at 94 and 94 LAmax
Tornado in low level flight	recorded at 121 and 125 LAmax

All recordings were made using a spaced pair of omnidirectional instrumentation quality electret microphones onto DAT cassettes. They were reproduced in stereo using an interlaced array of ceiling loudspeakers to give a more convincing indoor flyover effect. The Tornado flyovers represented typical high level military flyovers, whereas Concorde flyovers represented high level military-like civil flyovers. The B747 flyovers represented lower level civil flyovers, whereas the F111 flyovers represented lower level civil-like military flyovers. The high level flyovers were reproduced at 90 LAmax indoors, and the low level flyovers were reproduced at 80 LAmax indoors, to simulate outdoor to indoor attenuation.

The main objective of the first experiment was to investigate the effect of type knowledge. The subjects were correctly informed as to the generic type of aircraft (civil or military) for half of the flyovers and told the opposite for the remaining flyovers. The spoken information was reinforced with photographs of military fighters and large civil airliners. None of the subjects questioned the information that they were given.

A 0-9 numerical category rating scale was used, labelled "not noisy at all" to "extremely noisy" at each end, to determine relative subjective noisiness for each condition.

Experiment 1 - Results

The main effects of generic type, type knowledge, and level were all statistically significant, and the higher order interactions were either not significant or meaningless.

Figure 1 shows the effect of type knowledge. In general, the subjects scored significantly higher noisiness when told that the flyovers were of military types. Figure 2 shows the effect of generic type. The civil aircraft were found to be noisier than the military aircraft at the lower noise level, but there was a non-significant trend for this difference to be less at the higher noise level. The data indicates a bias against military aircraft flyovers amongst the volunteer subjects (mainly students) used in the experiment, and it also suggests that the civil aircraft were actually noisier (at the lower noise level), when this bias is balanced out. It seems unlikely that any of the subjects could actually determine generic type from the acoustic cues alone.

Experiment 2 - Flyover onset rate and duration

A different set of sixteen volunteer subjects sat in the ISVR simulated living room and listened separately to sixteen flyover sounds in accordance with a Latin Square experimental design. A B757 flyover recording and an F111 flyover recording were selected as being representative of typical civil and military aircraft, and then electronically modified as necessary to produce the sixteen experimental sounds. Considerable care was taken to avoid making the modified flyovers sound noticeably artificial. The recordings were reproduced at full length (with -10 dB durations of around 5 seconds) and with the onset and offset truncated to about 1 second (separately and together) using an audio processor. They were reproduced at maximum levels of 90 and 100 dB(A) indoors. The effect of type knowledge was controlled by casually informing the subjects that all the recordings were of civil aircraft at Heathrow. This meant that the previous eight subjects who took part in experiment 1 could not be used again to avoid any possibility of type knowledge bias. None of the subjects questioned this information. The same numerical category rating scale was used as in experiment 1.

Experiment 2 - Results

The main effects of type, level, onset time and offset time were all statistically significant. Higher order interactions were either not significant or meaningless. Figure 3 shows the effect of rise time. The flyovers with truncated onsets were rated less noisy, although the difference was less at the higher level. Figure 4 shows the reduction in the effect of truncated onset against level, and shows a non-significant trend for it to become negative above about 106 dB(A). Figure 5 shows the effect of offset time. As for onset time, the flyovers with truncated offsets were rated less noisy, although in this case there was no evidence of an interaction with level. Figure 6 shows that the civil aircraft was rated as more noisy than the military aircraft.

DISCUSSION AND CONCLUSIONS

Experiment 1 indicated that given type knowledge is an important factor in terms of relative noisiness, irrespective of the truth. Experiment 2 indicated that relative noisiness increases with duration, but there was a suggestion that this might reverse at higher noise levels. This could be due to a possible startle effect influencing noisiness ratings at higher noise levels. In general, the civil aircraft tested were rated more noisy than the military aircraft tested. The B747 in particular had a strong tonal content, which could have been responsible for this. There was no evidence of any differences between the noisiness ratings for the two generic types of aircraft that could not be explained by an observed bias against military aircraft, by the known relationship between event energy and noisiness (i.e. longer durations are rated noisier), by a possible startle effect for short onset times at higher maximum levels, and by tonal content in the civil aircraft flyovers.

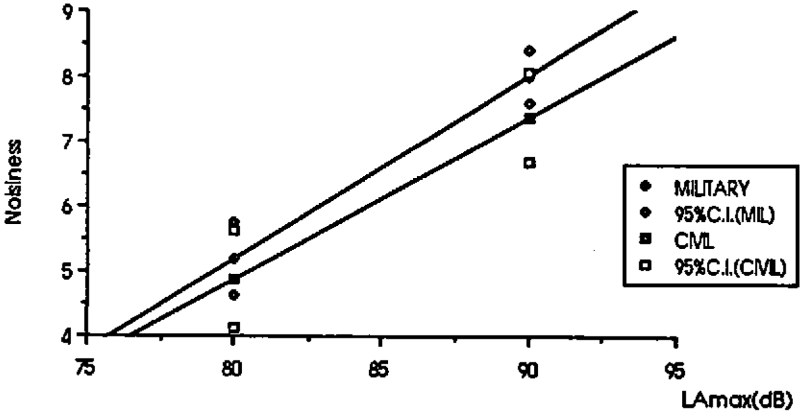

FIG. 1 NOISINESS AGAINST WHAT SUBJECTS WERE TOLD

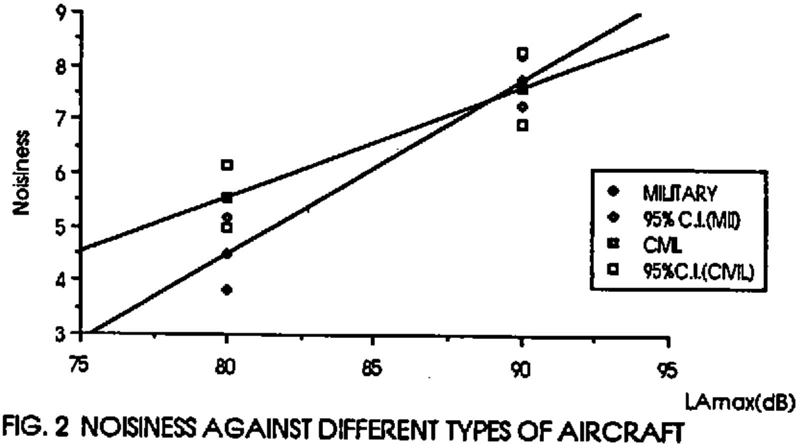

FIG. 2 NOISINESS AGAINST DIFFERENT TYPES OF AIRCRAFT

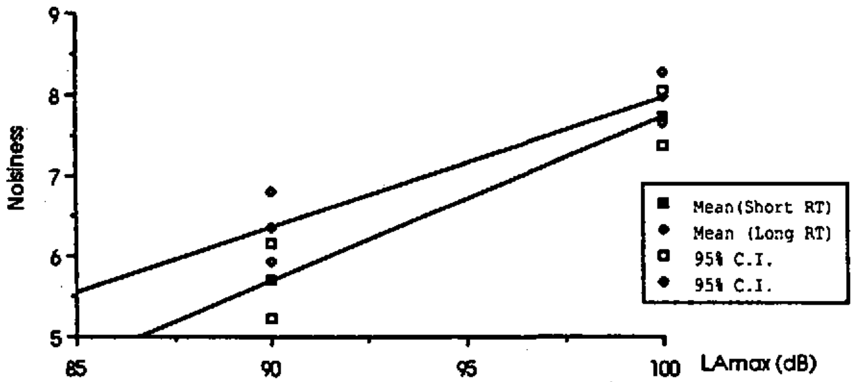

Fig. 3 Comparison of Rise time

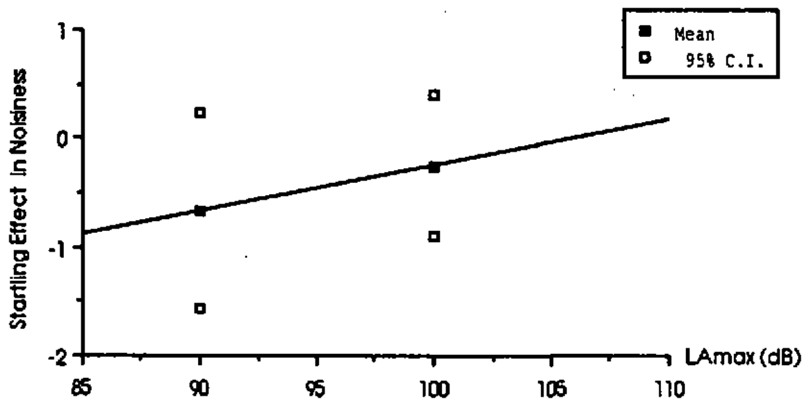

Fig.4 Graph showing the Startling Effect

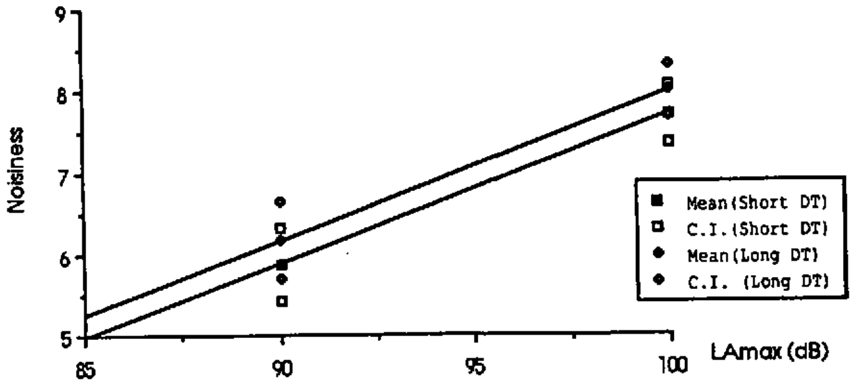

Fig. 5 Comparison of Decay Time

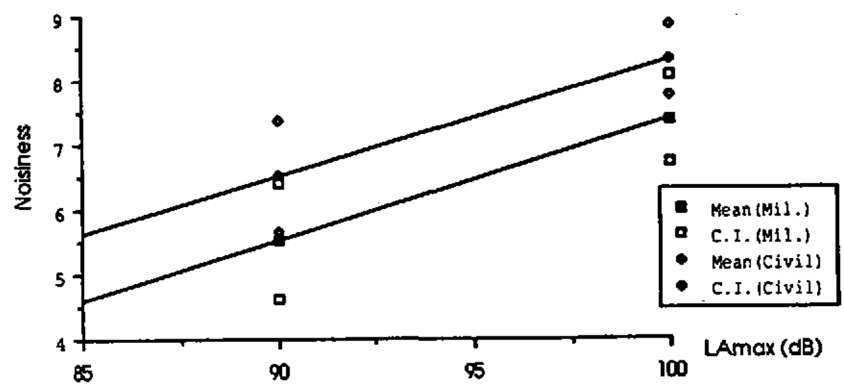

Fig. 6 Comparison of Aircraft Types

THE UNITED STATES AIR FORCE OCCUPATIONAL HEARING CONSERVATION PROGRAM

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The purpose of this paper is to provide an overview of the United States Air Force's (USAF) Hearing Conservation Program. Historically, the USAF published the first comprehensive regulation concerning occupational noise exposure in 1956. On 24 Oct 1974, the Occupational Safety and Health Administration, a division of the US Department of Labor, proposed an occupational noise requirement. From this proposal the United States Hearing Conservation Amendment was eventually approved and published on 21 August 1981.

To fully understand the consequences of noise-induced hearing loss, a basic understanding of the anatomy and physiology of the human auditory mechanism is necessary. The ear, consisting of outer, middle, and inner parts, is sensitive to frequencies of 20 to 20,000 Hz.

Routine exposure to high intensity noise, which often results in overall body fatigue, frequently produces a noise-induced hearing loss. This type of disorder usually results in a bilateral, sensorineural (nerve), predominantly high frequency, permanent, hearing loss. This disorder is slowly progressive and often does not result in subjective complaints by the individual until the more advanced stage. The person involved often complains of tinnitus (ringing in the ears) and an inability to understand speech even though spoken loudly. The hearing loss is most prominent at 4,000 Hz. Therefore, since ambient noise centers in the low frequencies, the inability to understand speech is particularly difficult when the affected person is in a noisy environment. Frequently, the degree of hearing loss on the audiogram (hearing test) is inconsistent with the degree of difficulty experienced by the hard-of-hearing person.

The employment of hard-of-hearing workers in areas characterized by high intensity noise has been discussed for decades. Individuals, military or civilian, can be disqualified for employment in hazardous noise areas if they are:

1. Found to be highly susceptible to noise-induced hearing loss.
2. Unable to wear hearing protection.
3. Found to have a severe/profound unilateral hearing loss.
4. Found to have a severe hearing loss and utilize a hearing aid.
5. Display extreme apprehension about working in hazardous noise.

Disposition of new, hard-of-hearing employees is made only after a thorough medical examination by a physician and an audiologist. A complete history is taken at the time of examination to determine the individual's occupational safety habits. A chronic outer and/or middle ear infection characterized by a discharge, or a congenital or surgical deformity of the ear canal, may prevent the worker from successfully utilizing hearing protection. The requirement to use noise, to temporarily occupy the non-test ear in cases of unilateral hearing loss, can not be accomplished by a technician and must be administered carefully by an audiologist.

Extreme care must be taken with employees with severe hearing loss to insure that residual hearing sensitivity is not lost, thereby reducing the amount of benefit derived from a hearing aid.

The successful management of any occupational hearing conservation program depends greatly on the effectiveness of each member of the team. The team members consist of:

- Employee	- Physician	- Personnel
- Supervisor	- Safety Office	- Maintenance
- Employer	- Industrial Hygiene	- Union
- Program Manager	- Lawyer	

The USAF Occupational Hearing Conservation Program consists of 9 elements:

1. Identify and Evaluate the Problem: To implement a successful program the noise must be adequately identified. The area, not just the noise source, must be evaluated by calibrated noise survey equipment (A-weighted scale). In addition to a sound level meter, a frequency analyzer, tape recorder, personal dosimeter, or impact noise recorder may be used. A recommendation to purchase new or relocate existing equipment may be made. A review of temporary and permanent hearing loss among the shop employees may also be accomplished.

2. Engineering/Administrative Controls: Once the problem has been defined, efforts should be undertaken to design out the noise in production then reduce or eliminate it at the source or pathway. Generally a high degree of costly expertise is required. Care must be taken not to compromise operation. Administrative controls can reduce risk by rotating shifts to limit the duration of exposure.

3. Post Areas, Label Equipment, Inform Employees: Standardized signs should be used. Employees must be informed in writing.

4. Provide Hearing Protection: Stringent inspections for the proper and routine use of hearing protection must be strictly enforced. The different types of hearing protection are: earplugs, earmuff, combination earplug/earmuff, custom earplugs, helmet, wax cotton, and headband. Each employee is given an opportunity to select the type of device he/she would prefer to use. The difficulties encountered in the use of hearing protection can be related to temperature, sabotage, cost, earmuff cushions and tension,

size, use with respirators, and most important comfort. Stereo radio or cassette headsets are not authorized for use in noise hazardous areas. Visitors to hazardous areas are provided earmuffs.

5. Occupational Health Education: By far the most important element in the USAF Hearing Conservation Program. Each required annual training session consists of information on:

- Identification of hazardous noise
- Noise in the workplace
- How the ear works
- How noise damages the ear
- The USAF Hearing Conservation Program
- Hearing protection
- Off duty noise exposure

6. Audiometric Monitoring: All hearing tests are administered by certified technicians following a case history and otoscopic examination. Referral to a USAF Audiology Diagnostic Center is made when significant threshold shifts are observed or the test results suggest the presence of non-organic behavior (faking a hearing loss). Standard Department of Defense forms are used. Following each examination, the employee is provided counseling and a pamphlet about the program. The following types of hearing tests are administered in support of the program:

- Reference Hearing Test: The employee must not have any active ear disease and have worked in a noise-free environment for at least 155 hours prior to the test. This test will be used as a baseline for subsequent examinations.
- 90 Day Follow-up: Is administered within three months of the reference hearing test and validates the reference. More importantly, it is used to identify hypersensitivity. During this test the examiner can insure that the hearing protection device is adequate and hopefully educate and motivate the worker.
- Annual Hearing Test: There is no noise-free period required before this examination. A temporary threshold shift would indicate a need for additional follow-up.
- 15 and 40 Hour Noise-Free Follow-up Examinations: When a threshold shift is observed on the annual examination, the worker is then scheduled for these additional hearing tests to validate and confirm the presence of permanent hearing loss.
- Detailed Follow-up Examinations: Occasionally a threshold shift is observed whereby a referral to an Audiology Diagnostic Center is not indicated. Therefore, the worker is scheduled for detailed follow-up examinations at three-month intervals. If a decrease in hearing is observed on any of these examinations a referral is made.
- Stringent Monitoring: The exposure levels of all workers can not always be determined. Therefore, workers considered to be hazardously exposed are monitored more frequently, especially when

individuals in their job specialty show a high incidence of hearing loss.
Termination Hearing Test: To set the legal bounds of liability, a hearing test is administered when an employee leaves the military or separates from Federal service.

7. Follow-up and Disposition: Following referral to one of the USAF Auditory Diagnostic Centers, an employee may be recommended for removal from further exposure to hazardous noise. Every attempt is then made to find suitable employment for this individual in a non-hazardous noise area.

8. Inspect for Compliance: Second only to education, this element of the program is most important. Frequent unannounced inspections of workers,, supervisors, signs, records, and hearing protection devices must be accomplished. Disciplinary actions for violations must be clearly defined.

9. Record Keeping and Reports: The following reports and test results are kept for 30 years beyond separation:

- Audometric findings
  - Test results, date and conditions, name, social security number, job location, examiner's name, certification number, audiometer serial number.
- Noise surveys
- Audiometer calibration (biologic and physical)
- Sound levels inside test booth
- ENT evaluations
- Administrative correspondence (removal from job)
- Group data (shop or job specialty)

In summary, although occupational hearing loss is one of the most common injuries in the workplace, the benefits of an effective hearing conservation program are significant. In addition to the obvious, the prevention of hearing loss, studies have shown a decrease in on-the-job injuries, emotional stress, and an improvement in worker-employer relationship. In successful hearing conservation programs, there is typically a reduction in the loss of trained, experienced employees and the cost of job related injury compensation. Furthermore, there is generally a decrease in absenteeism and an increase in productivity.

MILITARY AIRCRAFT NOISE

Air Commodore J S Hall MSc MB BS FFOM DIH DAvMed

HEALTH EFFECTS

1. You have heard how the United States Air Force address the potential hazard of noise induced hearing loss from exposure to the very high noise levels generated by military jet aircraft engines. In the Royal Air Force, we have our own hearing conservation programme but do not yet have a software progamme, although we are moving slowly down that path. Although occupationally derived noise induced hearing loss is clearly by far the most important health problem associated with military jet aircraft noise, I want now to broaden the discussion and will touch on one other occupational noise problem before addressing the topic of environmental exposure.

2. In the early days of the prototype Tornado, people working inside our hardened aircraft shelters when the aircraft engines were running, complained of vague symptoms of abdominal discomfort, headache, nausea and "the morning after". This was thought to be due to the relatively high low frequency component of Tornado engine noise and the German Air Force supplied - and still do - leather body belts to counteract these symptoms. I understand that their continued supply may reflect more a perceived need for goodwill than a clearly defined clinical requirement. It is said that motorcyclists find them very comfortable! Subsequent work with the full production Tornado showed that the particularly high low frequency peak demonstrated earlier had gone and we decided against the provision of body belts. However some individuals are particularly sensitive to body cavity resonance from low frequency sound and so we do get complaints from time to time, but since recorded levels are well below Von Gierke's criteria we are confident there is no risk to health from this particular effect. Although the principal symptom - that of chest wall vibration - has been associated with most of our noisier jet aircraft for a great many years,

the Tornado appears to have been singled out for special attention and it is relevant that the spectrum of that aircraft has a low frequency bulge and, of course, the "A" weight is said to under represent the annoyance from low frequency noise. The thoracic cavity is not the only one to resonate, I well remember during one early trial experiencing maxillary antral resonance from a wavelength of 1-2 paces in length. Not an unpleasant experience by any means!

3. I want to spend my remaining time with a necessarily superficial consideration of environmental health issues. Military fast jet aircraft are noisy and various constraints and operational requirements have not enabled us to take advantage of the technology used to quieten civilian aircraft. Most work in connection with aircraft noise has been directed toward civil aviation. Most military airfields are in rural locations and their pattern of activity is different from that of civil airfields in days and hours of operation and in their variability. For example, although far less flying is carried out at the weekend, high intensity activity occurs during exercises. Peak noise levels and operating characteristics are also very different. Furthermore, as you have already heard low level flying training is essential if the RAF is to remain an effective deterrant. Such training is now conducted over most of the country in order to reduce the burden in any particular areas as would be the case if it were to be restricted to certain parts of the country. Noise levels directly underneath the aircraft are quite high and also differ from those of civil aircraft in frequency, onset and delay times and special characteristics. It is quite clear that the noise from aircraft flying at 250 feet above ground and at 420 knots will startle many people. It may also startle horses, which could throw their passengers who might sustain injuries.

4. As for the other environmental effects, I shall summarize in a very general way some of those reported health effects of noise on man that I have come across and which I think are relevant in the military aircraft noise context and which I hope will reinforce our view of the need for additional research, thereby preparing the ground for the next speaker who will underline the difficulties of such research.

5. There can be no doubt that noise annoys many, can create stress and therefore has the potential to affect health in the broadest sense. What is uncertain is the level at which noise contributes to disease other than noise induced hearing loss and even in that condition there is considerable variation in individual susceptibility. Man produces a number of physiological responses to noise but there is no clear, incontrovertible evidence that repeated elicitation of these responses leads to irreversible changes and permanent health effects. For example, most physiological reactions that have been reported are less than the reactions caused by mild exercise and laughing and such normal response to repeated stress is not harmful to the healthy heart.

Hearing.

6. We have no evidence that living near a military airfield poses a risk of developing noise induced hearing loss. We have inadequate knowledge of the effect of noise from fast jets at low level on hearing. Some authors have suggested that a single brief exposure to noise from this source in excess of 115dB(A) has the potential to damage hearing. They have largely derived this figure from impulse criteria and others, who believe that equal energy principles are perfectly satisfactory have suggested that a level of 130dB(A) might be a better estimate. We think it highly unlikely that there is any risk to hearing from a single overflight under normal operating conditions. Although there have been suggestions that repeated exposure might have some effect, there is so far little in the way of solid evidence.

Noise and Communication, Performance and Behaviour.

7. A great deal of work has been done in these areas and I hesitate to make detailed comment since much of it is outside my strictly medical background. However I do sometimes wonder how far we can extrapolate data gathered in the laboratory, particularly using unrepresentative noise, to a local community living near a military airfield. One specific area

which has aroused concern is the potential effect of repeated exposure to such as military aircraft taking off in close promimity to a school. At present, our sound insulation grant scheme does not apply to schools. Some authors have reported that bright children can resist auditory distration for 30 months or so and then show reduced ability to resist and suffer attentional deficits - which may interfere with the development of such as reading and puzzle solving skills. Others suggest greater effects on the less bright children. However, in this context I cannot resist referring to one particular noise dosimetry study of children during a normal school day which recorded 8 hour LAeqs of 75dB! Nevertheless, we really do need more information before coming to firm conclusions.

Noise Induced Sleep Disturbance.

8. Much of the work I seem to have come across in this field has been carried out on young adults in a laboratory setting. Although I am well aware of the difficulties associated with doing otherwise I do wonder how relevant are some of the conclusions to real life. Estimates of acceptable background noise have ranged from 30-60 dB(A) and many estimates have been made of the number of allowable peaks during the night and the most disruptive time for those peaks.

9. It seems clear that night time noise can affect the pulse rate, electroencephalogram and the amount of time spent in rapid eye movement sleep (REM) - even without waking. Indeed, exposure to noise during sleep can induce changes in the amount of time spent in REM sleep. Although noise in the early and middle part of the night is said to be the most disturbing, it is possible to compensate for evening noise disturbance by sleep later on during the night. Habituation does occur, though only by improved ability to sleep during noise and not to the physiological changes I mentioned earlier. Noise induced sleep disturbance can also adversly affect mood and sense of well-being but I am not aware of any good evidence of any real effect on the subsequent performance or health of those affected, although the number of those reporting tiredness after a night's sleep is said to increase at exposures above 65 dB(L Aeq). It is also said that there is increased need for a good night's sleep after a noisy day.

One particular worker, after an extensive review of the literature, was unable to find a reliable basis for the calculation of annoyance for noise induced sleep disturbance and could find no more distinct threshold than for daytime annoyance. Most of our problems in this respect arise from the airfield environment. Our aircrew must include a proportion of night flying in their training, although this is really hours of darkness flying and can be carried out in the early evening during the winter. We also avoid ground engine running at night unless operationally necessary - this can be a particularly tiresome source of disturbance. We recognise the problem in our compensation scheme if night flying is a particular feature at the airfield in question and, under certain circumstances, allow an extension of the compensation contour.

Non-Auditory Effects of Noise.

10. The most frequently reported physical response to noise (other than hearing loss) is a rise in blood pressure, but the rise is small, it is not clear whether a rise in the short term is of any significance in the long term and there is insufficient dose response data. Some workers have found an increase in the number of hypertensives living in noisy areas and others an increase in the number of patients with hypertension or other cardiovascular disease among those living nearest to a civil airfield - and incidentally, a greater use of sedatives and tranquillisers. A rise in blood pressure has also been reported on exposure to other stresses, whether mediated by an increase in cardiac output or a rise in total periperal resistance. Such changes vary from stress to stress and are all short term and I sometimes wonder if task demand may have a greater effect on blood pressure than noise. One study considered aircrew referred for cardiovascular workup to one particular centre over a 23 year period. They had been exposed to cockpit noise levels ranging from 87-115dB(A), their audiograms were examined and no relationship was found between noise exposure and blood pressure levels. However, I believe there is still no definitive answer on the relationship of noise to blood pressure and thus there is a need for research to consider noise as a potential risk factor in the long term development of cardiovascular disease. Other studies have shown changes in blood cortisol, cholesterol and

stress hormone levels in response to noise, but the long term significance of these findings is uncertain and the reported changes have been variable.

11. Although concern is often expressed for the effect of outside agencies on pregnancy, there is no clear evidence of any ill effect from noise. This view is supported by a study of 23,000 pregnancies which did, however, show some negative effects from long working hours, shift and heavy work. One study suggested that on average, children born to mothers living near a civil airfield were just a few grams lighter than those born to mothers from quieter areas. Even so, this had no effect upon subsequent growth rates. It has been suggested, on empirical grounds, that pregnant women should not be exposed to more than 90 dB(L Aeq), but background intra uterine noise levels have been recorded at 70-85 dB and abdominal wall attenuation is of the order of 25-30 dB. As for the psyche, some correlation has been reported between noise sensitivity and neurotic depression.

Community Response.

12. Noise annoyance may be the most widely researched of those responses I have skated over today and was well recognised as long ago as 720BC by the Sybarites who passed zoning laws. Noise undoubtedly causes annoyance but there are very many variables, ranging from the nature of the neighbourhood and it's inhabitants to individual sensitivity to noise. I have mentioned some physiological responses that have been demonstrated but what is less certain is whether or not increasing annoyance leads to increasing health risk. I fear I am left with more questions than answers, for example, what is the scientific basis for man's reaction to noise and what is the social impact of noise on families? Do we really know enough about the effects of pre-existing noise on newcomers to an area or the effect of a change in the pattern, type and level of noise on people already living in a particular area? In the case of low flying military aircraft, are there any long term effects from repetitive startle? Just some of the confounding variables that should be considered include:

a. Age, sex, race, social class, leisure activities, occupation.

b. Family health history, presence or absence of diabetes, obesity or stress, and information of general health.

c. Use of alcohol and cigarettes and nature of dietary habits.

d. Nature of the area, type of housing, length of time in the area, presence or absence of air or other pollutants, presence or absence of other noise and the pattern of the noise exposure that is of interest.

Despite our general concern there is still much we need to learn though it may be reassuring to reflect on what I think is still said to be true that most noise complaints arise from domestic noise from such as children, dogs and radios.

13. The majority of studies on the effects of noise on general health that have so far been undertaken have been incomplete and contain many uncontrolled variables and therefore we believe the problem has still not been adequately addressed. Because of continued allegations of ill effects and very few suggestive findings, good, well controlled research must be encouraged and supported. I believe there is a clear need for long term research into health effects, both in the neighbourhood of military airfields and among those who are regularly exposed to noise from low flying aircraft. I do not underestimate the difficulty of such research and Bob Kull will be going in to bat on that subject.

In the meantime it remains for me to wish researchers in this field the very best of fortune!