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A review of the application of

Planning Policy Guidance Note PPG 24

to General Aviation airfields,

with proposals for improved guidance

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1. INTRODUCTION

1.1. The assessment of noise arising from General Aviation (GA) activities has a profound influence on the ability of GA to develop and flourish. In the majority of planning decisions for new or expanding GA land uses, aircraft noise is a principal factor determining whether planning permission is granted. The national and local policy framework in which GA noise is assessed consequently has a strong influence on the extent to which GA facilities are allowed to develop.

1.2. GA planning applications are often controversial, with public debate centred on the noise issue. Local Planning Authorities (LPAs) thus come under particularly intense public scrutiny when making their decision on whether to grant permission. This scrutiny is accompanied by the difficulty of understanding a highly specialist and technical subject which will almost certainly be unfamiliar to the decision makers on the planning committee, and may well also be outside the experience of the Authority's officers who advise them. The result is that LPA decisions are likely to be unduly based on subjective and emotive opinions, with little objective analysis.

1.3. The primary source of technical guidance on the subject available to LPAs is Planning Policy Guidance Note PPG 24, 'Planning and Noise'. This gives guidance on all noise-related planning issues, so has to apply to a wide range of situations. Its usefulness in the particular case of noise from GA development is regrettably limited. It does not cover the subject in sufficient depth to allow a definitive assessment of GA noise issues. More detailed guidance is available in the technical literature, but LPAs tend either to be ignorant of it or unsure how to apply it.

1.4. LPAs refuse permission to around two-thirds of all GA development proposals. Yet of the refused planning applications that proceed to appeal, over half are successful. It is clear that LPAs are too often acceding to the views of vociferous objectors and making the wrong decision. It is left to the Appeal Inspector to reach, hopefully, a more considered decision. In some eyes the LPA may emerge from this as the champion of the local residents' cause. But in reality they are imposing a burden on those residents who, through their local taxes, have to fund the Council's unsuccessful case at a public inquiry.

1.5. The burden of LPAs' poor decisions does not rest at local taxation. The high cost of mounting a successful case at a public inquiry puts off many worthy applicants for GA developments from mounting an appeal. Even where an appeal is successful, that cost has in some cases fatally harmed the economic viability of a project. Over the years, this has unnecessarily restrained enhancement of the GA network across the country to the detriment of the business and social benefits that GA brings.

1.6. Over the last twenty years or so a methodology for assessing noise from GA activities has evolved, based on the PPG 24 guidelines supplemented by the guidance available in the technical literature. Some elements of the methodology are well established and are routinely accepted, while other elements remain the subject of debate. The methodology is not published as a single cohesive procedure, which makes it relatively little known beyond those who are regularly concerned with assessing GA noise.

1.7. The purpose of this report is to identify how changes to PPG 24 could establish a definitive framework for GA noise assessment and control. It sets out the methodology that has evolved to date, identifying those elements that are widely accepted and those where debate remains, pointing the way forward to resolving those remaining questions. Improved methods for controlling noise levels through planning conditions are proposed, that are more refined than those currently advocated by PPG 24.

1.8. The intention is to allow the assessment of GA noise within the LPA planning process to be based far more than it is at the moment on objective analysis using a nationally recognised assessment framework. It is to be hoped that this will lead to better informed planning decisions at LPA level, and a reduction in the proportion of GA planning cases that are unjustly turned down by LPAs.

2. THE PPG 24 GUIDELINES

2.1. The principal guidance governing the way in which noise is controlled by the planning system is contained in Department of the Environment Planning Policy Guidance Note PPG 24 "Planning and Noise", published in September 1994. This sets out the Government's policies on the considerations to be taken into account in determining planning applications for developments, including airfields, near noise-sensitive properties and advises on the use of conditions to minimise the impact of noise.

2.2. The guidance is very specific in setting standards for acceptable noise levels affecting proposed new residential development affected by aircraft and other transportation noise sources. It defines a series of four noise exposure categories (NECs), in terms of the daytime $L_{Aeq,\ 16\ hour}$ and night time $L_{Aeq,\ 8\ hour}$ noise levels. These categories range from the lowest (category A) for which noise is not a determining factor, up to category D at which planning permission should normally be refused.

2.3. However "*The NEC procedure is only applicable where consideration is being given to introducing residential development into an area with an existing noise source, rather than the reverse situation where new noise sources are to be introduced into an existing residential area. This is because the planning system can be used to impose conditions to protect incoming residential development from an existing noise source but, in general, developers are under no statutory obligation to offer noise protection measures to existing dwellings which will be affected by a proposed new noise source. Moreover, there would be no obligation on individuals with an interest in each dwelling affected to take up such an offer, and therefore no guarantee that all necessary noise protection measures would be put in place.*" (PPG 24, Annex 1, paragraph 4). Proposed new houses subject to aircraft noise in NEC B, for example, might well be granted permission subject to a requirement for sound insulation measures whereas airfield development resulting in those same noise levels at existing houses would probably be refused.

2.4. But PPG 24 does not explicitly state the criteria that should be applied to new noise sources, in marked contrast to the very specific guidance it gives for new noise-affected dwellings. As the Inspector at the Hanley William Airfield public inquiry [7] in May 2000 noted, the result is that "*The approach taken (by acousticians), perhaps understandably given the absence of specific advice in PPG 24, (is) to trawl through various technical publications and other appeal decisions to see if any common denominators emerge*" (decision letter paragraph 55).

2.5. This situation leads to a need for very specialist knowledge, which most LPA officers do not have, to assess noise from proposed new or expanding airfields in a consistent way. The result is that planning applications are determined very inconsistently, often on the basis of inadequate or incorrect technical advice. This is a subject on which PPG 24 could and should be giving detailed guidance.

2.6. The advice that PPG 24 does give is a general approach to the control of potentially noisy development (paragraph 10):

"*Much of the development which is necessary for the creation of jobs and the construction and improvement of essential infrastructure will generate noise. The planning system should not place unjustifiable obstacles in the way of such development. Nevertheless, local planning authorities must ensure that development does not cause an unacceptable degree of disturbance. They should also bear in mind that a subsequent intensification or change of use may result in greater intrusion and they may wish to consider the use of appropriate conditions.*"

2.7. The use of conditions is advocated by PPG 24 as a means of enabling development proposals to proceed where otherwise it would be necessary to refuse permission (paragraph 15). Such conditions are required to be necessary, relevant to planning, relevant to the development being permitted, enforceable, precise and reasonable. Examples of planning conditions that might apply to airfields are given in Annex 4 of PPG 24.

2.8. These conditions include restrictions on the use of an airfield by limits on the number of movements, the hours of use, the weight and type of aircraft, and the number of "touch and go" movements. Although commonly in use, these are blunt and indirect tools for controlling noise which allow no flexibility to the airfield operator in devising a noise control regime. Limits set in this way are often based on worst-case assumptions about the noise that the aircraft will cause, when in reality most of those flying are relatively quiet. This leads to the limits on airfield being unnecessarily restrictive.

2.9. Direct controls on noise levels, for instance by setting a limit for L_{Aeq}, allow an airfield operator to balance the number of aircraft movements against the noise that each individual aircraft creates. This encourages the use of quiet types of aircraft and conversely penalises the use of noisier ones. More aircraft can fly from an airfield whilst keeping noise within the acceptable bounds, which makes better use of existing airfields and relieves the pressure to create new ones.

2.10. There is no guidance in PPG 24 on how suitable limits for its example conditions should be arrived at. This, together with the indirect nature of the conditions, makes it difficult to ensure that a well balanced and objective noise control regime is put in place. A better, more direct and objective system is needed.

2.11. PPG 24 notes that, of the various indices that have been developed to describe noise, the equivalent continuous noise level L_{Aeq} has emerged as the best general purpose index for environmental noise (Annex 5, section 2). For the assessment of noise from aircraft, PPG 24 observes that noise exposure contours in terms of L_{Aeq} over the period 0700 to 2300 are used for major aerodromes (Annex 3, paragraph 6). For small airfields having less than about 30 movements per day, it advises that local planning authorities should not rely solely on L_{Aeq} and that they should be aware of the public perception of such aircraft noise levels in some circumstances as being more disturbing than similar levels would be around major airports (Annex 3, paragraph 7). PPG 24 does not add further detail on the additional assessment methods to be used for small numbers of movements, an omission that needs to be remedied.

2.12. Although PPG 24 does not propose specific noise limits for airfield development, it does observe that 57 dB(A) L_{Aeq} over the period 0700 to 2300 relates to the onset of annoyance as established by noise measurements and social surveys (Annex 2, paragraph 4). In the context of assessing new housing development affected by existing aircraft noise (Annex 1) it uses this value as the limit for the lowest category for which "*noise need not be considered a determining factor in granting planning permission, although the noise level at the high end of the category should not be regarded as a desirable level*". Even though it is not proposed as such in PPG 24, this level of 57 dB(A) has become the starting point for setting noise limits applying to new or expanding airfields. For example, the Government's 2002 consultation document on airport development [12] assesses the impact of new and expanding aerodromes in terms of the numbers of people subject to noise exceeding 57 dB L_{Aeq} as the onset of significant community annoyance.

2.13. PPG 24 notes at paragraph 18 that "*the background noise level in some parts of suburban and rural areas is very low, and the introduction of noisy activities into such areas can be especially disruptive*". But guidance is lacking on the extent to which such considerations should affect the assessment of noise levels.

2.14. The Rural White Paper [8] of November 2000 places a greater emphasis than PPG 24 on the preservation and enhancement of peace and tranquility in rural areas. It states at paragraph 9.4. under the heading of 'Promoting tranquillity' that "*It is not just its physical features which gives the countryside its unique character; there are also less tangible features such as tranquillity and lack of noise and visual intrusion, dark skies and remoteness from the visible impact of civilisation.*"

2.15. On the specific question of noise it goes on to say "*There will always be sources of noise in the countryside, and many of these – such as noise from harvesting and livestock – are themselves representative of activities which have long been central to the rural way of life. But protecting the countryside from further intrusion of noise is not a luxury. It is about preserving and promoting a feature that is genuinely valued by residents and visitors alike.*"

2.16. Regarding certain designated areas which might be particularly sensitive to noise, PPG 24 states:

"Special consideration is required where noisy development is proposed in or near Sites of Special Scientific Interest (SSSIs). Proposals likely to affect SSSIs designated as internationally important under the EC Habitats or Birds Directives or the Ramsar Convention require extra scrutiny…. Special consideration should also be given to development which would affect the quiet enjoyment of the National Parks, the Broads, Areas of Outstanding Natural Beauty or

Heritage Coasts. The effect of noise on the enjoyment of other areas of landscape, wildlife and historic value should also be taken into account."

As with the question of background noise, no quantitative guidance is given to expand on the basic principle of giving special consideration to SSSIs.

2.17. Proposals for GA developments may include a workshop or maintenance facility. This type of activity has the potential to generate noise that is quite distinct from the noise of aircraft, being more industrial in character. The method recommended by PPG 24 (at paragraph 19 of Annex 3) for assessing noise from industrial and commercial developments is that set out in British Standard BS 4142: 1997. A rating level is calculated from the one-hour L_{Aeq} noise level, corrected where appropriate to account for the character of the noise. The likelihood of complaint is indicated by the difference between the rating level of noise from the new development and the existing background noise. A difference of around 10 dB(A) or higher indicates that complaints are likely. A difference of around 5 dB(A) is of marginal significance. This aspect of noise assessment is precise and well established. Although there is often debate amongst acousticians about how the procedure might be improved, it works adequately as it stands and is widely accepted.

3. PLANNING APPEAL DECISIONS

3.1. It might be hoped that planning appeal decisions would provide useful clarification of the approach that should be adopted when considering noise from GA airfields. In some cases they certainly do, but many are too easily dismissed as pertaining only to the circumstances of a specific case rather than taking a wider viewpoint.

3.2. One case where the approach to controlling noise from GA was set out in a generalised manner was at Little Gransden Airfield [6] in 1999 where the Inspector observed (paragraph 158 of the decision letter) :

"*Having regard to all the evidence, both objective and subjective, it is necessary to arrive at a balanced conclusion on noise. The gist of advice in PPG 24 is that the planning system should be used to minimise the adverse effects of noise without placing unreasonable restrictions on development. The aim is to ensure that development does not cause an unacceptable degree of disturbance. It is clear that the yardstick is not 'nil disturbance'. This makes sense, having regard to the findings reported in the 1988 DTp study regarding the relation between annoyance and levels of noise below about 50 dB(A)* L_{Aeq}."

3.3. The 1988 Department of Transport study, to which the Little Gransden Inspector referred, investigated community disturbance caused by general and business aviation operations at five airfields [1]. It is discussed in more detail at section 4 of this report. It found that community disturbance from GA flying is largely unrelated to aircraft noise level if that level is below about 50 dB(A) L_{Aeq}, but that above 50 dB(A) L_{Aeq} the noise disturbance increases noticeably.

3.4. Since the publication of the 1988 Department of Transport study, a criterion of 50 dB(A) L_{Aeq} has been accepted by several inspectors as a gauge of the likely level of community annoyance from aircraft noise. For example at Turweston Airfield [4] in 1993 the Inspector described it as *"a reasonable criterion against which the acceptability of the proposals might be assessed"* (decision letter paragraph 5). At Egginton [3] in 1992 the Inspector commented *"It seems to me that an $L_{Aeq,\ 16\ hour}$ level of 50 dB(A) is a useful benchmark for assessing the likely level of community annoyance from the proposed airfield as indicated in the DTp 1988 study … Certain dwellings could be subject to L_{Aeq} levels above 45 dB(A) and several above 50 dB(A) in some circumstances but these remain relatively low in terms of likely annoyance as identified in the above study"* (decision letter paragraph 236).

3.5. The 1988 Department of Transport study also considered the differences in the disturbance caused by GA aircraft noise compared to other sources of aircraft noise. It found that GA noise was more disturbing than noise from air transport, the difference being equivalent to a 5dB(A) increase in the noise level. At the Little Gransden Airfield Inquiry this adjustment was applied to the 57 dB(A) L_{Aeq} 'low annoyance' criterion from PPG 24, as a result of which "*…an L_{eq} of 51 or 52 dB(A) was set as a threshold of nuisance … Levels of this kind have been adopted in many other aviation noise situations and it seems to me that they represent a good starting point… In my view, it is important to keep in mind the small difference between a 52 dB(A) threshold and the figure of 50 dB(A), below which research has indicated that indications of annoyance do not necessarily diminish in accord with reducing noise levels.*" (decision letter paragraph 141).

3.6. The reasons cited in the 1988 study for this difference in tolerance of general aviation noise compared to commercial air transport noise rest mainly on public perceptions of the need for the flying activity. The research suggests for example that a light aircraft being flown for pleasure is regarded as more annoying, at like-for-like noise levels, than would be a commercial aircraft taking fare-paying passengers on holiday. Such a conclusion begs the question of how a person witnessing an aircraft from the ground can tell the purpose of the flight. A light aircraft may be going on a pleasure flight, it might equally be a flight for business purposes, or even a politician on the canvassing trail at election time; the person on the ground has no way of telling. The research does not seem to be saying that it is the character of the GA noise itself that causes the lower tolerance, but rather the often erroneous presumption that the activity is unnecessary and self-indulgent.

3.7. The fact that such prejudiced perceptions have caused acceptable noise limits for GA aircraft to fall to the region of 50 or 52 dB(A) L_{Aeq}, from a level of 57 dB(A) for air transport, warrants investigation. It may be that the reasons why GA noise is perceived as more annoying are not reasons that warrant it being treated more harshly than air transport noise in planning policy.

3.8. The applicability of the 1988 study to the case of rural airfields has at times been questioned. None of the airfields included in the study were rural, and their localities were affected by other noise sources such as road traffic so were not tranquil. There has been an increasing tendency over recent years for planning inspectors to give weight to the promotion of rural tranquillity, having regard to the PPG 24 advice. At Crowfield in 1993 [5] the Inspector compared the noise levels due to aircraft with the underlying quietness of the area, and concluded that this would make the aircraft noise seem more noticeable and intrusive (decision letter paragraph 11.20). At Little Gransden Airfield the Inspector decided that "*a consideration of background noise levels is a worthy element of the overall analysis*" and that a sense of rural tranquillity "*could easily be despoiled or destroyed by intrusive aircraft noise events*" (decision letter paragraph 147). Both of these inspectors addressed the matter by imposing conditions on a planning consent.

3.9. By contrast at Hanley William Airfield in 2000 [7] the Inspector concluded that the proposed conditions, similar in principle to those imposed at Little Gransden Airfield, were inadequate to address the planning objections (decision letter paragraph 82). A primary objection in his view was the "*unacceptably disturbing*" aircraft noise which would be "*easily perceived by local residents*" in "*an area of low background noise levels*" (decision letter paragraph 57).

3.10. The majority of proposals for new or expanding GA airfields are situated in rural areas. There is a lack of suitably large tracts of land for new GA airfields anywhere other than in rural localities. Many expanding airfields are also rural, perhaps with origins as grass strips used by farmers for crop spraying aircraft. The need to promote rural tranquillity has become well established and is gaining further prominence through the Rural White Paper. But it is difficult to reconcile a decision such as Hanley William where any flying activity was deemed unacceptable, with others such as Crowfield and Little Gransden where the matter was addressed by planning conditions. The issue needs to be addressed by national policy guidance if it is not to risk degenerating into a piecemeal and ill-considered denial of future GA airfield development in rural areas.

3.11. Another of the issues raised by PPG 24, that of not relying solely on L_{Aeq} where this is based on less than 30 movements per day, has now been accepted at a number of public inquiries as signifying a need to also consider the instantaneous maximum noise level L_{Amax}. Sometimes comparisons are made between the L_{Amax} noise level and the background noise. The issue is thereby inter-related with the question of rural tranquillity. But this approach offers little more than confirmation that the aircraft will be clearly audible, which does not in itself signify a loss of amenity or annoyance. There is no clear guidance on acceptable levels of L_{Amax} during the day. There is rather more guidance on night time noise, based on sleep disturbance criteria, but at most GA airfields there is no flying at night so it is not an issue.

3.12. As a consequence of this lack of guidance there is little correlation between the L_{Amax} / background noise comparison and the flying activity that is eventually permitted, even though it might loosely have been used to justify the decision. At Crowfield the Inspector concluded that there would be a “very large” increase over the background noise of between 30 and 50 dB(A) (decision letter paragraph 11.31), yet permitted 20 aircraft movements (i.e. 10 take-offs and 10 landings) per day. At Little Gransden Airfield the Inspector noted that background noise levels would be exceeded by a “considerable amount” approaching 40 dB(A) on occasions (decision letter paragraph 147), yet permitted 30 take-off movements per day. At Hanley William Airfield the Inspector did not quote a numerical increase but concluded that the noise would be “easily perceived” by nearby residents (decision letter paragraph 57) and refused planning permission.

3.13. The Inspector at Little Gransden Airfield considered evidence on the relationships between the $L_{Aeq,\ 16\ hour}$ and L_{Amax} noise levels, and sought parity between the two measures at the trigger point of 30 movements per day suggested in PPG 24. He concluded that the L_{Amax} noise limit applying to most flights should be 76 dB(A) although it would be acceptable for a few aircraft movements to exceed this noise level (decision letter paragraph 145).

3.14. But at the subsequent Hanley William Airfield inquiry the Inspector considered the same criterion and stated “Whilst the recorded L_{Amax} levels may be less than the criterion suggested (76 dB(A)) I do not consider this divergence to be decisive when considering the nature of the locality surrounding the appeal site.” (decision letter paragraph 57). The Inspector also had difficulty accepting an assessment based on a combination of L_{Aeq} and L_{Amax}, preferring to dismiss the L_{Aeq} index entirely. This discounts the use of L_{Aeq} in favour of L_{Amax} to a much greater extent than PPG 24 does, where the advice is that L_{Aeq} is the best index for environmental noise and that for low numbers of aircraft movements it should not be *solely* relied upon.

3.15. Quite why the trigger point for considering L_{Amax} should be 30 movements per day is not explained in PPG 24. The number seems to be arbitrary. There is also nothing in PPG 24 to suggest that parity between L_{Amax} and L_{Aeq} criteria at 30 movements per day should be used to set the L_{Amax} limit. Taking the Little Gransden figures, it is illogical to say that while 30 occurrences per day of aircraft causing just under 76 dB(A) L_{Amax} might be deemed acceptable, a single occurrence of just above 76 dB(A) L_{Amax} could not be allowed. The ultimate limit for L_{Amax} should be higher, but there is scant guidance in the literature on what that limit should be.

3.16. A factor that is not mentioned in PPG 24, but which has gained prevalence at public inquiries into GA activities, is to take account of a perceived heightened sensitivity arising from a new airfield or a sudden large increase in flying activity. Residents in the locality are considered to be potentially more sensitive to such sudden changes than they would be to a slow growth, or maintenance of the status quo. A reduction of the L_{Aeq} criterion by 3 dB(A) is sometimes made on account of this, and is referred to as the Wisley factor in recognition of the airfield to which it was first applied. The origins of the 3 dB(A) correction are unclear - it appears to have been set arbitrarily when first used. The time is ripe for the use of the Wisley factor to be reviewed in terms of the principle of whether it should be applied at all and, if it should, then what the correction should be.

4. RESEARCH INTO AIRCRAFT NOISE ANNOYANCE

4.1. A Department of Transport consultation into the use of L_{Aeq} as the means of assessing aircraft noise is described in a 1990 report by the Civil Aviation Authority [2]. The report notes in its section 3.5 that since the early 1960s aircraft noise had been assessed using the Noise and Number Index (NNI) and that 35, 45 and 55 NNI were generally accepted as corresponding respectively to low, moderate and high annoyance. While observing that there is no unique relationship between NNI and L_{Aeq}, the report establishes an approximate relationship between them and concludes that 57 dB(A) $L_{Aeq,16hour}$ is equivalent to the 35 NNI level representing low annoyance. This corresponds with the 57 dB(A) $L_{Aeq,\ 16\ hour}$ threshold for the onset of annoyance that is described in PPG 24.

4.2. Much of the research which has been carried out into the effects of aircraft noise, including the 1990 report into the use of L_{Aeq}, has been addressed at large aerodromes. The question arises as to whether the conclusions drawn for such aerodromes are applicable at smaller airfields where there are notable differences in the characteristics of the noise such as the near absence of night flying, irregular timing of take-offs, and a predominance of propeller-driven rather than jet aircraft. A study published in 1988 by the Department of Transport [1] investigated these differences. It sought to establish whether the relationship between noise and annoyance is the same for general aviation and air transport operations, whether attitudes to a particular aerodrome or to particular modes or types of flying affect an individual's annoyance, and whether annoyance is affected by concentrations of flying at certain times of a day or on certain days of the week or season. The research combined noise and social surveys at five general aviation aerodromes (Elstree, Wycombe, Shoreham, Southampton and Biggin Hill).

4.3. The study found that annoyance from general aviation was greater than from air transport, for any particular L_{Aeq} noise level, and this equated to a 5 dB(A) difference between the two for corresponding degrees of annoyance. Non-acoustic factors were found to play an important role. Higher annoyance from noise was found to be associated with feelings that aerodromes were bad with respect to low flying, community relations and in handling complaints, feelings that aircraft might crash and opinions that leisure flying is unimportant. Aircraft noise annoyance was found to be particularly closely associated with flying school activities and leisure flying, and was more strongly influenced by the noise due to flying at weekends than on weekdays.

4.4. The study found that below noise levels of about 50 dB(A) L_{Aeq}, there was little annoyance from GA flying activities. The degree of annoyance did not fall further at noise levels below this, while above this level the degree of annoyance increased as the noise increased.

4.5. The 'Transportation Noise Reference Book' [9] summarises the research into the effects of low background noise on perceptions of aircraft noise at section 3.4.3 and does not find "... *a consistent tendency for annoyance judgements to vary with ambient noise level*". It goes on to say "*The only large-scale survey designed to study ambient noise effects found that aircraft noise annoyance was not affected when road traffic noise was also present*". It concludes that "*people will be just as likely to be, for example, 'very annoyed' by aircraft noise in a quiet location as in a noisy road traffic noise environment*".

4.6. This indicates that there is not a thoroughly researched justification for the increasing tendency to apply stricter criteria for aircraft noise in quiet rural environments. But with the large-scale survey that is referred to having taken place at Toronto International Airport, the research evidence has a very limited relevance to the somewhat different circumstances of rural GA airfields. Consequently the research evidence regarding any heightened noise disturbance on account of a GA airfield being in a tranquil rural location is inconclusive.

5. APPLICATION OF THE GUIDANCE

5.1. A combination of the guidance in PPG 24, the conclusions of planning inspectors, and the published scientific research, leads to the basis of a method for assessing aircraft noise from GA airfields.

5.2. The starting point is the threshold for the onset of annoyance specified in PPG 24 of 57 dB(A) $L_{Aeq,\ 16\ hour}$. Current practice is to reduce this by 5 dB(A) on account of the heightened sensitivity to GA noise compared to other forms of aviation, as identified in the 1988 Department of Transport study. The resulting criterion is 52 dB(A) $L_{Aeq,\ 16\ hour}$. That is just above the 50 dB(A) noise level that is noted in the Department of Transport study as the point at which reaction to GA aircraft noise changes from a low level of annoyance unrelated to the actual noise level, to a rising annoyance in line with increasing noise level.

5.3. If and when PPG 24 comes to be updated, it should clarify whether 52 dB(A) $L_{Aeq,\ 16\ hour}$ is the criterion that should continue to be used for GA noise. In making that policy decision, the government will need to satisfy themselves that the reasons for making the criterion for GA more strict than that for air transport are warranted. The available research points to those reasons being related to potentially erroneous perceptions of the need for GA, rather than being about the character of the noise itself. The criterion should be set at 57 dB(A) $L_{Aeq,\ 16\ hour}$ if there is deemed to be no material difference between GA and air transport noise.

5.4. The tendency to apply a 3 dB(A) penalty to new or rapidly expanding facilities, known as the Wisley factor, needs thorough research if it is to become enshrined in government advice. It has only gained a degree of respectability on account of its age and occasional use, rather than any provenance from well-founded research. Any tendency for people’s sensitivity to noise to be heightened on account of it being a new source is likely to diminish and eventually disappear over time, as they become accustomed to it, making the fundamental principle of applying such an allowance questionable. The choice of 3 dB(A) as the amount of the correction is entirely arbitrary, yet is in danger of becoming a self-perpetuating fixture in GA noise assessment.

5.5. Another question on which further research is required is whether the normal criteria for GA noise should be made stricter in tranquil rural areas. This is an issue that is likely to gain increasing importance as the provisions of the 2000 Rural White Paper take effect. A similar question arises for AONBs, where PPG 24 requires the facility of quiet enjoyment of the countryside to be preserved. The published research is at present inconclusive. It offers no clear justification for making any such allowance, although there has been a tendency for planning inspectors to do so in recent years.

5.6. At present, virtually any rural area or AONB is ripe for being described as 'tranquil' despite there being common sources of noise for instance from road traffic, military aircraft and gardeners mowing their lawns. Strong objection is often inequitably taken to GA noise disturbing this 'tranquillity', which can unjustly weigh against a GA planning proposal. The definition of a tranquil area needs to be established, and needs to be distinguished from the broad range of only moderately quiet rural areas. The essence of tranquillity might be described as a situation where natural noise sources (for example birdsong) predominate over man-made noise sources.

5.7. The account to be taken of tranquillity and AONB status in setting the noise criteria for GA will depend on the individual circumstances of the area concerned. In the most sensitive cases where a high priority is placed on preserving absolute tranquillity, a refusal to permit any GA activity may be appropriate. But such circumstances are likely to be very rare and, more generally, a reduction of the GA noise criteria in tranquil areas would be the reasonable solution. Research is needed to determine how much reduction is appropriate.

5.8. The question of aircraft noise affecting SSSIs and special wildlife habitats is not one that can be addressed in a generalised way, as it will depend very much on the reasons for the particular designation and an analysis of the way in which noise may have a deleterious effect. For example an SSSI that is designated on account of its flora is unlikely to suffer any direct effect from aircraft noise, and the main issue is likely to be a potential loss of quiet enjoyment which should be considered in much the same way as an AONB might be. Likewise an SSSI that is designated on account of its fauna would only need special consideration if the aircraft noise were to have an adverse effect on that particular fauna.

5.9. In combination with an $L_{Aeq,\ 16\ hour}$ criterion it is necessary to also have a criterion for L_{Amax} where the number of aircraft movements is low, and this will apply to the majority of GA airfields. This is an area where the opinions of different planning inspectors vary widely. Some appear to be swayed by comparisons between the L_{Amax} and the background noise level, even though such comparisons demonstrate merely that the aircraft can be clearly heard.

5.10. The purpose of additionally setting an L_{Amax} criterion is to guard against the situation that an $L_{Aeq,\ 16\ hour}$ criterion alone might allow a small number of very noisy aircraft to fly from an airfield. If for example an L_{Aeq} criterion resulted in up to 30 movements of aircraft each causing 76 dB(A) L_{Amax} to be possible, that same L_{Aeq} criterion might also permit a single daily movement of an aircraft causing 91 dB(A) L_{Amax}. Whereas the former case might be acceptable the latter is unlikely to be, on account of the high maximum noise level even though it only occurs once per day.

5.11. The approach to setting an L_{Amax} criterion that was accepted by the Little Gransden Airfield Inspector was to consider the relationship between L_{Amax} and L_{Aeq} for the case of 30 movements per day. That is the level of activity below which PPG 24 indicates that L_{Aeq} should be used as the sole criterion. The relationship between L_{Amax} and L_{Aeq} noise levels is not exact, but it is a good approximation that for 30 movements per day having an average L_{Amax} noise level of 76 dB(A), the resulting overall noise level would be 52 dB(A) $L_{Aeq,\ 16\ hour}$. As this is the average of the L_{Amax} noise levels, some individual aircraft could be a little noisier while others could be a little quieter. Consequently the Inspector adopted a criterion of 76 dB(A) L_{Amax} but recognised that it would be acceptable for a few aircraft movements to exceed this noise level.

5.12. That still does not reach the point where an overall limit on L_{Amax} can be specified, although it suggests that the limit would be higher than 76 dB(A). What is really needed is for research to show how people react to noise from individual aircraft movements during the day. This should aim to provide an overall L_{Amax} noise limit. Such a limit would apply to all new planning consents for GA airfields and not just those having small numbers of movements, and would in effect constrain the types of aircraft that could use an airfield.

5.13. The preferred method of planning control should be by conditions specifying the allowable $L_{Aeq,16\ hour}$ and L_{Amax} noise levels at existing, defined, noise sensitive properties. The means of ensuring compliance with such conditions are discussed in section 6 of this report.

5.14. For the current method of setting planning conditions couched in the terms recommended by PPG 24, it is necessary to evaluate the aircraft types and numbers of movements that are equivalent to the L_{Aeq} and L_{Amax} criteria. This will depend on where the nearest noise-sensitive properties are in relation to aircraft taking off, landing or flying in the circuit. Even at the smallest of GA airfields, there are likely to be two circuit paths and two directions of take-off and landing depending on the direction of the wind. There are also likely to be more than one departure and arrival route depending on the direction of the aircraft's destination. There may be more than one type of aircraft operating each with its own characteristics of speed, climb rate and noise level. Aircraft do not "run on rails", and some divergence from the "straight ahead" routes must be considered in the calculations. This all combines to produce a complex computational exercise, best carried out by a computer model such as the United States Federal Aviation Administration's INM software which is described in Appendix 2 of this report. The use of this model is widespread in the assessment of noise from United Kingdom GA airfields, and in many other countries throughout Europe, America and the rest of the world.

5.15. Use of the computational model enables a maximum aircraft weight (MTWA or maximum take-off weight authorised) to be established for an airfield, which ensures that the L_{Amax} criterion is not normally exceeded. One method of setting planning constraints is to then assume that all aircraft using the airfield are at the maximum aircraft weight and noise level. The corresponding limit on number of movements would be calculated on that basis to ensure that the $L_{Aeq,\ 16\ hour}$ criterion was not exceeded. For example it may have been decided to apply criteria to a proposed new airfield of 76 dB(A) L_{Amax} and 49 dB(A) $L_{Aeq,\ 16\ hour}$. The model might show that a criterion of 76 dB(A) L_{Amax} would be met by a weight limit of 2,000 kg MTWA, and that 15 movements of this size of aircraft would cause 49 dB(A) $L_{Aeq,\ 16\ hour}$. Planning conditions might them be set stipulating the 2,000 kg MTWA and 15 movements per day limits. However the airfield operator may not wish to fly aircraft as heavy as 2,000 kg MTWA, in which case a lower weight limit could be set in order to permit a greater number of movements.

5.16. For airfields where a wide variety of aircraft fly, the adoption of the worst-case scenario imposes a great penalty in terms of the permitted number of movements. This can be alleviated by having two separate weight limits, the upper one applying to all the permitted movements with a lower one which only a small number of those movements may exceed. A condition of this type is proposed in PPG 24 (Annex 4, example 6) and was applied at Little Gransden Airfield.

5.17. Such methods of control, although commonly applied, are not ideal because they offer no incentive to airfield operators to make the aircraft they fly any quieter. In turn this offers no incentive to aircraft manufacturers to design quieter aircraft. There are distinct benefits to be gained by applying methods of controlling noise from GA airfields that directly assess the noise that is generated on a day to day basis, and actively encourage the use of quieter aircraft. That is why direct limits on $L_{Aeq,\ 16\ hour}$ and L_{Amax} are to be preferred to the limits on aircraft weights and numbers that are currently advocated by PPG 24.

6. MONITORING COMPLIANCE WITH NOISE LIMITS

6.1. A number of regional and international airports throughout the world have noise monitoring systems installed that enable a continuous check to be made on aircraft noise levels. These systems can be very sophisticated, often being linked with the radar tracking of aircraft and incorporating noise analysis techniques that differentiate aircraft noise from other noise sources.

6.2. Such systems are rarely if ever applied to GA airfields, not least because of their cost. To be fully effective they require the setting up and maintaining of a number of noise monitoring sites around an airfield. Ideally they also require radar tracking to establish the position of the aircraft at the time of measurement, which most GA airfields do not have installed.

6.3. Nevertheless the principle of using noise monitoring as a means of controlling noise from an airfield has clear attractions. The more traditional method of control in terms of types of aircraft and numbers of movements does nothing to encourage the use of quieter aircraft. It results in the under-utilisation of airfields where mainly quiet aircraft are flown because the restrictions are likely to have been set on the basis of the noisiest aircraft likely to use the airfield, with a correspondingly low limit on the number of movements.

6.4. A simplified monitoring system can be set up with just one or two measuring positions quite close to the runway. Suitable positions might be under the take-off path at each end of the runway, at a suitable distance from the runway to satisfy safety requirements. Clearly the noise at the monitoring position will be somewhat higher than at the noise sensitive properties, as it is much closer to the aircraft as it passes by. A relationship between the noise level at the monitoring position and the noise level at houses in the vicinity can be established by calculation, using the INM model. Assumptions will need to be made about the flight paths that will be used, but this is little different to the assumptions that have to be made when arriving at limits on numbers of movements.

6.5. A trial of such a system has been carried out at Little Gransden Airfield. Supplied by Cirrus, the monitoring equipment comprised a single microphone at the side of the runway, linked to a computer in the airfield control room. The computer display showed the cumulative amount of noise measured at the microphone during the day, as a percentage of the total allowable. It also maintained historical records of the noise on previous days, and provided a verifiable means of planning enforcement that could for example be transmitted to the Local Planning Authority by modem link or the Internet.

6.6. The system worked well in trials but regrettably suffered from vandalism shortly after its existence became public knowledge, having been placed near a public footpath that crossed the runway.

6.7. The technology is already available to make such a means of planning enforcement work in place of the traditional limit on numbers of movements. It may not be economically feasible for the smallest airfields. Also for those airfields where there is unlikely to be a wide variation of types of aircraft flying, the benefits are only marginal and are unlikely to offset the cost of the system. But for larger airfields with a wide variety of aircraft flying, the system has potential.

6.8. A variation of this method of planning control would be to use a system based on the certificated noise levels of aircraft as a measure of their noise output. A certain cumulative total per day would be permitted. That cumulative total could be determined by reference to the INM aircraft noise prediction model, in much the same way that the cumulative total at the end-of-runway monitoring position is determined. The noise from each aircraft likely to use the airfield, expressed as a percentage quota of the allowable total, could be listed in a database with a running record kept at the control room of the cumulative total caused by the day's take-offs. An example of this type of calculation is shown in Appendix 4 of this report.

6.9. A potential difficulty with this method is that a number of GA aircraft were made before the noise certification requirements came about, and may not have a certificated noise level. For these aircraft their noise levels would have to be established by measurement similar to the certification tests. Also the method relies on the diligent calculation of noise quotas, which may not be an acceptable burden particularly at small recreational airfields.

6.10. National planning guidance needs to be flexible enough that it will allow planning control to develop beyond the established methods, for example in the ways outlined above, where the circumstances are right.

7. RECOMMENDATIONS FOR REVISION OF PPG 24

7.1. It is recommended that a successor to PPG 24 should set out the GA noise assessment method in detail. A greater degree of consistency in planning decisions relating to GA airfields could be expected as a result. At present it is necessary to trawl through past planning appeal decision letters and published research in order to determine an assessment method, and many planning authorities are unaware of this process. Certain elements of a standard method for assessing noise from GA airfields have become established in the last decade or so, but these fail to be recognised in the current PPG 24 guidance notes. PPG 24 is primarily addressed at the situation of new housing being built near to existing noise sources, and its guidance for the case of new noise sources such as GA airfields affecting existing housing is only given in general terms.

7.2. The method should set noise criteria in terms of the $L_{Aeq,\ 16\ hour}$ noise index, in combination with L_{Amax}, both determined outside the most affected noise-sensitive properties. Planning conditions should normally be set that specify these values.

7.3. The procedure for monitoring compliance should ideally be by direct measurement of the noise level. Individual circumstances will determine whether it is best to do this by permanent noise monitoring stations, or by intermittent monitoring using mobile instrumentation. Equivalent noise limits will need to be set at the measurement positions, to ensure that noise reaching sensitive properties does not exceed the specified criteria.

7.4. If noise measurement is not feasible, perhaps on grounds of cost or because there are no suitable measuring positions, then an alternative means of monitoring compliance would be by reference to the certified noise levels of the aircraft being flown. A permissible total noise quota for an airfield would be set, equivalent to the specified criteria at noise sensitive properties. A running total of the certified noise levels of the aircraft flown each day from an airfield would be kept, to ensure that the quota was not exceeded.

7.5. For those airfields wishing to keep administration of noise control at its simplest, the current system of control through limits on numbers of movements and aircraft weight may offer the best solution despite its inflexibility.

7.6. The basic criterion that has come to be used for GA noise is 52 dB(A) $L_{Aeq,\ 16\ hour}$ at noise sensitive properties. Clarification is needed in government policy of whether that is the correct criterion. There is a case to be made for setting the criterion at 57 dB(A) $L_{Aeq,\ 16\ hour}$, the same as for air transport noise, if it is considered that there is no material difference between GA and air transport noise. The available evidence suggests that differences in reactions to GA noise compared to air transport relate to potentially erroneous perceptions of the importance of the activity rather than any inherent characteristic of the noise itself.

7.7. Reductions of this criterion due to the noise source being new, or an area being quiet, have sometimes been made but there is little justification to support such reductions. More research is needed to clarify whether these factors have a role to play in setting noise criteria, and how they should be taken into account, not just for GA but also for noise sources in general.

7.8. Special consideration of noise affecting areas of low background noise is established in the existing PPG 24, and the 2000 Rural White Paper promotes rural tranquillity. But the definition of such areas is unclear. It would be clearer to instead refer to areas where natural noise sources such as birdsong currently predominate over man-made noise sources.

7.9. A study should be carried out into precisely how the criteria should be adjusted in areas of rural tranquillity, in AONBs, and at other designated areas where quiet enjoyment of the countryside is a recognised feature. The desire for peace and quiet in such areas must be balanced against the need for GA airfields. National policy guidance is needed if the issue is not to be decided, as it is at the moment, in a piecemeal and inconsistent way.

7.10. By setting a criterion for L_{Amax}, the need to give special consideration to airfields having small numbers of movements is adequately addressed and no longer need be mentioned in the PPG. Research is needed to decide on the appropriate L_{Amax} limit at noise-sensitive properties for daytime GA noise. The current system of assessment leads to the avoidance of noise exceeding 76 dB(A) L_{Amax} for most flights, so a figure rather higher than this value should be expected as an absolute limit.

7.11. Clarification is needed in the policy guidance that noise from workshop and maintenance facilities should be assessed using the British Standard BS 4142 method, in common with other noise of an industrial nature.

7.12. Overall these recommendations will enable a greater consistency in planning decisions relating to noise from GA airfields, and should reduce the number of local planning authority decisions on airfield proposals that proceed to an appeal. This will benefit the aviation community and local taxpayers alike, and will help to secure a more certain future for the important facilities that GA provides.

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APPENDIX 1 : SELECTED GLOSSARY OF ACOUSTICS TERMINOLOGY

L_p — Mathematical shorthand for sound pressure level. Since the human ear perceives noise in a logarithmic way, it is normal to measure noise on a logarithmic decibel (dB) scale. This is defined as:

$$L_p \text{ (dB)} = 10 \log_{10} (p / p_0)^2$$

where L_p is the sound pressure level (dB), p is the sound pressure (Pascals) and p_0 is a reference pressure of 20 μPa.

dB(A) — The internationally recognised unit for measuring overall noise as heard by the human ear. It is defined in a similar manner to the dB measure, except that the 'A' suffix indicates the frequency content of the noise has been weighted to simulate the varying sensitivity of the human ear to noise at different frequencies.

L_{Amax} — The maximum instantaneous sound pressure level reached during the occurrence of a noise, expressed in units of dB(A). For aircraft noise it is normal for L_{Amax} to be measured using a "slow response" time weighting.

$L_{Aeq,T}$ — The average sound pressure level (in terms of equivalent total sound energy) over a period of time T of a varying noise. Defined mathematically as:

$$L_{Aeq,T} = 10 \log_{10} [\ 1/T \int_T (p / p_0)^2 \, dt\ ]$$

For daytime noise from transportation noise sources, PPG 24 uses a reference time T of 16 hours. The sound pressure level is normally expressed as an A-weighted value, for example 85 dB(A) $L_{Aeq,16\ hour}$ would indicate a sound level having a logarithmic average of 85 dB(A) over 16 hours. The relationship between the noise level and its duration is that a halving of duration represents a 3 dB(A) difference on the L_{Aeq} scale, so for example a noise of 85 dB(A) lasting for 8 hours out of the 16 hour day would equate to 82 dB(A) $L_{Aeq,\ 16\ hour}$. If it only lasted 4 hours it would equate to 79 dB(A) $L_{Aeq,\ 16\ hour}$ and so on.

APPENDIX 2: THE INM AIRCRAFT NOISE PREDICTION MODEL

The Integrated Noise Model (INM) is the United States Federal Aviation Administration's computer software used to predict noise impact in the vicinity of airports. The calculation method, which is described in detail by the technical manual [10] for the program, is summarised below.

Sound created by an aircraft is actually a flow of energy, which can be evaluated as a sound power with units of Watts. This power originates from the aircraft's engines, although it is such a small proportion of the total engine power that it has negligible effect on the aircraft's flying performance.

As this sound power radiates away from the aircraft it becomes spread over a wider and wider area. If, for example, the sound were to radiate uniformly in all directions then at a particular distance r the area over which the sound was spread would be the surface area of a sphere of radius r, which is $4 \pi r^2$. The intensity (power per unit area) of the sound at that distance would then be $W / 4 \pi r^2$, where W is the sound power of the noise source.

In most, perhaps all, examples of aircraft noise the sound does not radiate uniformly in all directions. A more involved analysis is then required involving integral calculus. The basic physical principles are however similar.

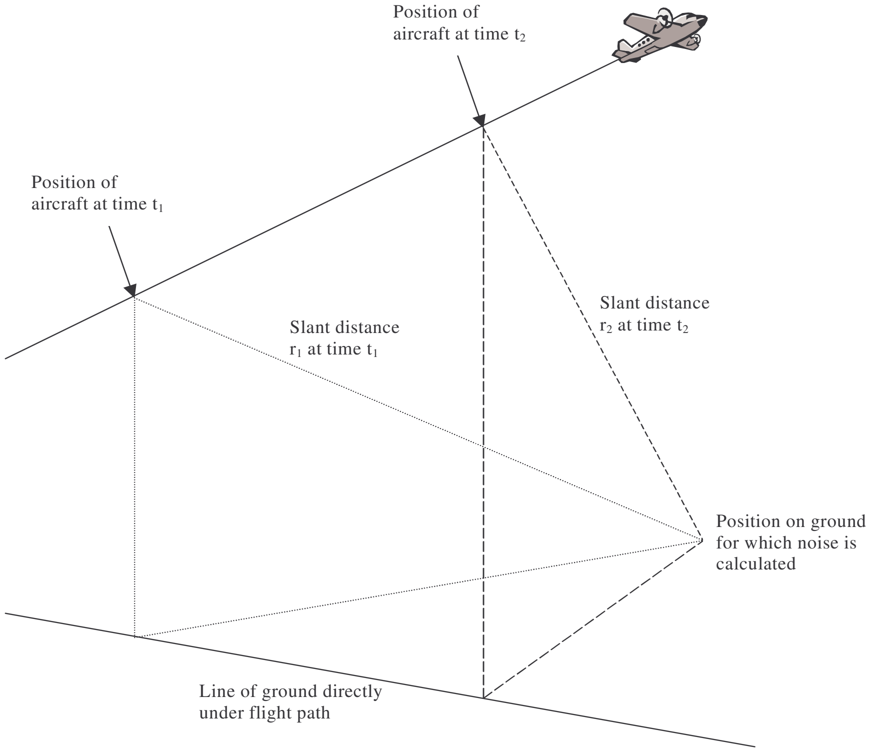
It is sound pressure, rather than sound intensity, that is heard by the human ear and is measured by a microphone. It is therefore more convenient to define noise levels in terms of sound pressure. Intensity and pressure are related because the product of sound pressure (p) and particle velocity (u) is equal to the sound intensity (I), provided the pressure and velocity are in phase which is true in most circumstances. Furthermore, the particle velocity u is itself related to the sound pressure p by the factor ρc where ρ is the density of air and c is the speed of sound. Bringing all this together results in the following relationship:

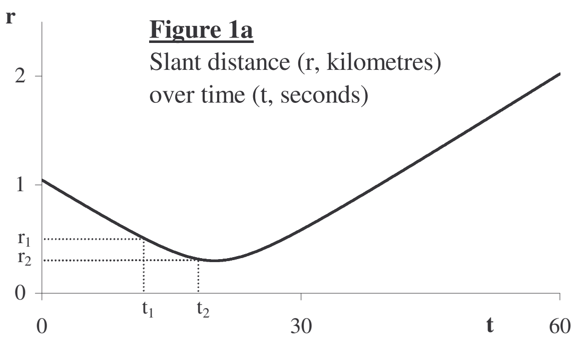
$$I \text{ (at radius } r) = W / 4 \pi r^2 = p^2 / \rho c$$

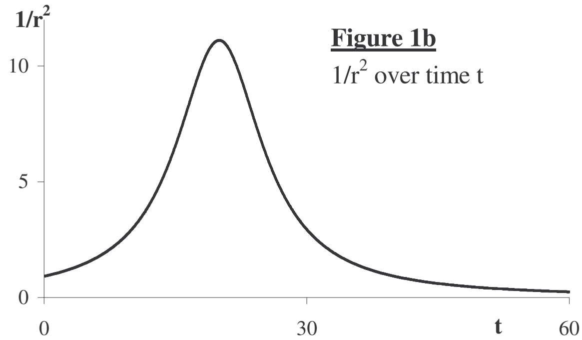
This leads to the important conclusion that the sound pressure p is inversely proportional to the distance r from the noise source. In other words, if the distance from the noise source doubles then the sound pressure will halve.

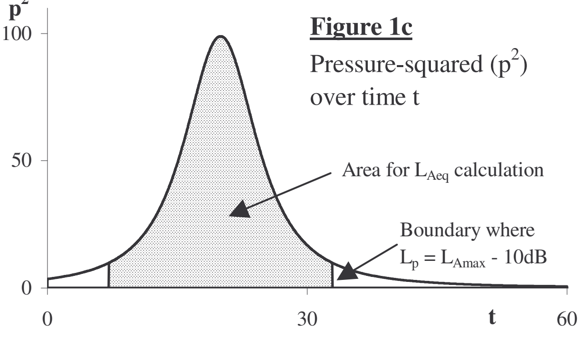
To make a rudimentary prediction of how the sound pressure at a certain location on the ground varied as an aircraft passed over, a starting point would be to draw a graph of how the distance r between the aircraft and the ground location varied with time, as illustrated at Figure 1a. This graph is then redrawn to show the variation of $(1/r^2)$ with time, Figure 1b. On the basis of a geometric analysis alone, this would correspond to the variation of the sound pressure squared, p^2, with time if multiplied by the factor $(W\rho c/4 \pi)$.

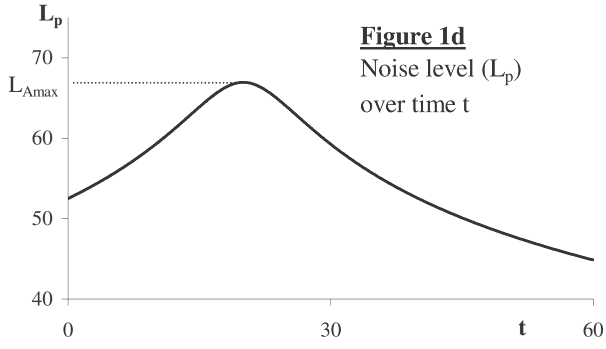
FIGURE 1: NOISE LEVEL CALCULATION











However there is rather more to aircraft noise prediction than this relatively straightforward exercise in three-dimensional geometry. In practice there are various complications affecting the calculations. For instance, the sound power *W* of the noise source may not be constant, as engine loadings and settings change during the course of a flight particularly during the takeoff and landing phases. The sound is likely to be radiated more in some directions than in others from the aircraft. The value of ρc is dependant on air pressure and temperature so may not be constant, especially over a change of altitude such as occurs between an aircraft and the ground. The sound energy travelling through the air is partly "absorbed" so that the resulting intensity and pressure are reduced, the amount of this "absorption" being dependant on factors such as the frequency content of the sound and the humidity of the air. The human ear does not respond uniformly across the frequency range, and an 'A' weighting adjustment is normally applied to account for this.

Figure 1c shows how the pressure-squared graph might look once these other factors are taken into account.

Because the human ear senses sound exponentially, it is appropriate to plot the logarithm of pressure-squared as a measure of noise level. When this is done by using a reference pressure of 20 μPa and a multiplying factor of 10 then the familiar decibel scale of sound pressure level (L_p) emerges, as shown in Figure 1d. Mathematically it is expressed as:

$$L_p = 10 \log (p^2 / p^2_{ref}) \qquad \text{where } p_{ref} = 20\ \mu\text{Pa}$$

The common measures of aircraft noise may be demonstrated on these last two graphs, Figures 1c and 1d.

The maximum instantaneous noise level L_{Amax} is the highest level reached by the sound pressure level line, in Figure 1d.

The L_{Aeq} is derived from the area under the pressure-squared graph, in Figure 1c. Mathematically this is expressed as the integral $\int p^2\, dt$ and is a combination of the level and duration of the noise. The number of times it recurs (*N*) during the assessment period (*T*) is also taken into account with the full calculation formula being:

$$L_{Aeq} = 10 \log \left(\{N/T\} \int p^2 / p^2_{ref}\, dt \right)$$

In situations where a number of different aircraft and / or flight paths are flown, the L_{Aeq} values of each flight are combined together using the logarithmic summation rule:

$$\text{Total } L_{Aeq} = 10 \log \left(\sum 10^{\{L_{Aeq\ (individual\ flight)} / 10\}} \right)$$

L_{Aeq} and L_{Amax} noise levels may be predicted in this way for many different positions on the ground. It can be convenient to do this on a regular grid of points and to then plot lines joining points of equal noise level. The result is a series of noise level “contours” showing pictorially how the noise level varies over an area of land.

The INM computer model automates the noise computation process. It requires the input of quite detailed information such as the three-dimensional path of each flight, the location of the runway, the type of aircraft being flown, its operating conditions, and the positions on the ground where noise levels are required. Data on ground topography can be included. The program will automatically generate contours if required.

A substantial database within the software has noise data for many types of aircraft, but it betrays its origins as a calculation method developed for air transport operations by having only limited data for small aircraft of the types common to GA airfields. For instance it has just two generic categories for single-engine propeller-driven aircraft, one covering those with a fixed pitch propeller and the other for those with a variable pitch propeller. This generalisation may not result in significant loss of overall calculation accuracy in situations dominated by noise from much larger jet aircraft. But at GA airfields where small propeller-driven aircraft make up the majority of the fleet, it is desirable to make finer distinctions between the noise levels of the different types of aircraft.

One method of adjusting the INM predictions to better represent the noise from specific propeller-driven aircraft is to make use of noise certification data determined in accordance with ICAO Annex 16 regulations [11], as part of the aircraft’s certificate of airworthiness procedures. This is described in Appendix 4 following. Alternatively, and particularly for aircraft predating the ICAO noise certification procedures, noise measurement tests may be carried out under carefully controlled circumstances to determine how the noise level from the aircraft in question compares to the INM categories.

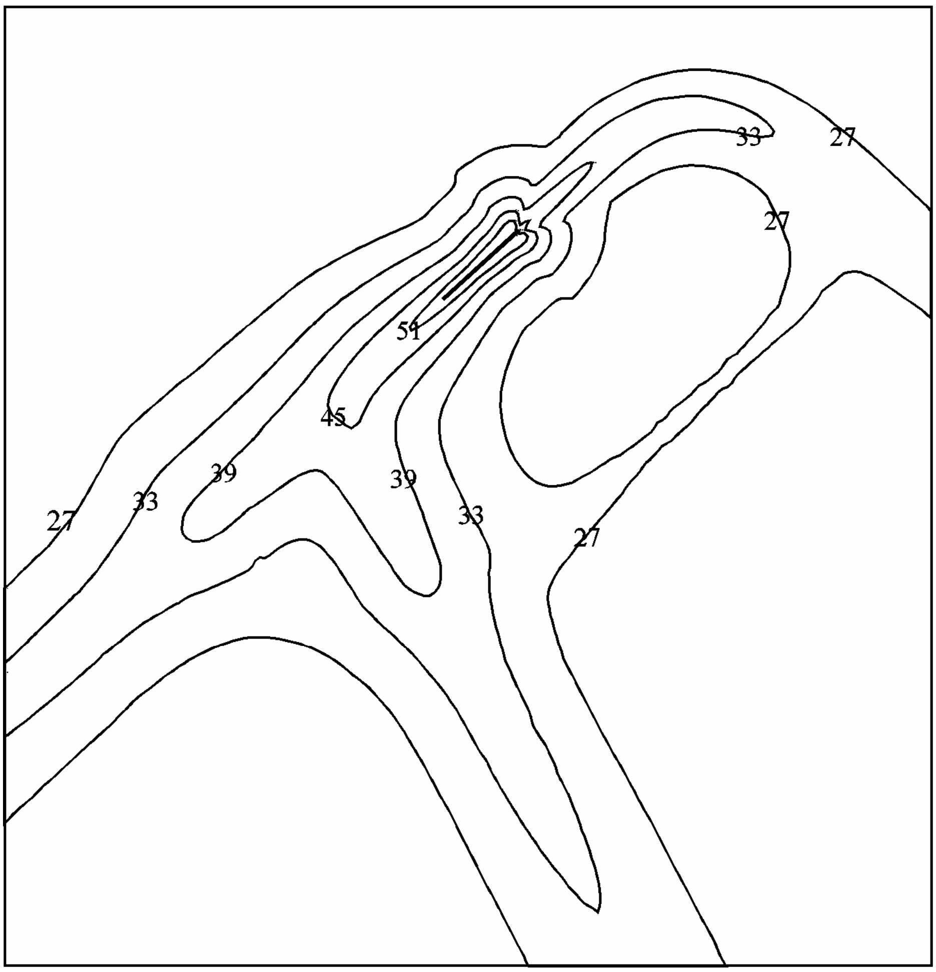
An example of INM calculated noise contours is shown in Figure 2. It is a hypothetical case involving various take-offs, landings and circuits. The contours are marked at intervals of 6 dB and represent $L_{Aeq,\ 16\ hour}$ noise levels at the ground. The short straight line in the centre of the contours is the runway.

In a real-life study these contours would be superimposed on a map of the airfield locality, to determine the impact on noise-sensitive properties. The calculation model would be used to investigate a number of scenarios in terms of flight paths, types of aircraft and numbers of flights, in order to assess the noise impact of flying activities.

The INM model has already become the standard for predicting noise from new and expanding airfields in the UK. Its popularity derives partly from its authority, which comes from the fact that it is been developed by the FAA in the United States. It also has the merit of being readily available at reasonable cost, from the FAA’s agents, for widespread use.

A potential alternative to INM is the Civil Aviation Authority's ANCON model. Slight differences can occur between the results of the two methods, as might be expected from calculations relying to some extent on empirical data, and no doubt there are advocates for each being the better model. However the main reason why ANCON has not become common in the assessment of GA airfields is that it is not offered outside the CAA as a ready-to-run computer program.

<u>FIGURE 2 : EXAMPLE NOISE CONTOUR PLAN FROM INM</u>



APPENDIX 3: ICAO CERTIFICATION DATA APPLIED TO NOISE PREDICTION

ICAO noise certification procedures

The ICAO certification procedures for the noise of propeller driven aircraft of up to 9 000 kg weight are set out in Annex 16, Volume 1 of the Convention on International Civil Aviation. Two different standards are set out, in Chapters 6 and 10. For older aircraft, no rules apply. The standard to be applied depends primarily on the date that the application for a certificate of airworthiness (C of A) for the prototype was accepted, but also depends in some cases on the date that the certificate of airworthiness for the individual aeroplane was issued.

No rules apply where the C of A application for the prototype was accepted before 1 January 1975, provided the C of A for the individual aircraft was issued before 1 January 1980. If it was issued after that date then Chapter 6 applies.

Where the C of A application for the prototype was accepted between 1 January 1975 and 17 November 1988, Chapter 6 applies. For applications accepted after 17 November 1993, Chapter 10 applies. During the transition between 1988 and 1993, either Chapter 6 or Chapter 10 could apply.

Chapter 6 noise test

The Chapter 6 test comprises a level overflight at a height of 300 metres, at the highest power in the normal operating range and at stabilised airspeed with the aeroplane in cruise configuration. The $L_{Amax,\ slow}$ noise level is measured for at least four overflights (more than four if necessary to achieve the required statistical confidence levels), and the results are averaged.

A correction is applied to account for differences between the engine power achieved at the test and the power that would be achieved at settings corresponding to the highest power in the normal operating range by an average engine of the type under reference conditions. A correction is also required for differences between test and reference conditions for the propeller helical tip Mach number.

A performance correction is applied, based on the rate of climb and climb speed capabilities of the aeroplane. It is intended to credit those higher performance aeroplanes that can climb at a steep angle and fly at a low power setting.

Chapter 10 noise test

The Chapter 10 test comprises a take-off with the aeroplane at the maximum take-off weight. Take-off power and configuration is used from brake release until a height of 15 metres above the runway is achieved. After that the landing gear is retracted, flap settings are adjusted to normal climb configuration, and the best rate of climb speed is made with the engine(s) at the maximum continuous power setting.

The $L_{Amax, slow}$ noise level is measured at a position under the flight path 2,500 metres from the brake release point. At least six tests are required (more than six if necessary to achieve the required statistical confidence levels), and the results are averaged.

Corrections are applied to the measured noise levels to account for differences between test and reference conditions for atmospheric temperature and humidity, the noise path length from the aeroplane flight path, the propeller helical tip Mach number, and the engine power.

Application to noise prediction

The ICAO noise certification provides a noise level for the aircraft in terms of $L_{Amax,slow}$ under very specific conditions: either for an overflight at 300 metres, or a take-off measured at 2500 metres from the brake release point.

Comparisons can be made between the certification data for a specific aircraft, and the noise levels predicted by the INM computer model for a "certification" type of overflight or takeoff.

The built-in INM category covering single engine, fixed pitch propeller aircraft predicts a noise level of 73.8 dB(A) $L_{Amax, slow}$ for a take-off, measured at the "certification" point 2500 metres from the brake release point. At the next INM category which is for single engine, variable pitch propeller aircraft the take-off noise level predicted at the "certification" point is 78.5 dB(A) $L_{Amax, slow}$. By comparison, the maximum noise level permitted by the ICAO test is 76 dB(A) for aircraft up to 600 kg in weight.

This puts the INM figures at the upper end of the noise levels to be expected from aircraft that have ICAO noise certification, making INM reassuringly conservative for the purpose of making generalised predictions of noise impact. Where ICAO test data is available it can be used to refine the INM predictions, and in most cases this can be expected to lower the predicted noise levels.

Where the cause of the difference is that the aircraft engine / propeller is quieter than assumed by INM, a simple correction to the INM basic noise level is all that is needed to compensate for the difference. Other reasons for the difference may require more detailed adjustments to the INM model, for example the rate of climb on take-off that is assumed by INM may need adjustment for some types of aircraft. Each case needs to be considered on its own merits, with the most appropriate refinements made to suit the information available.

Older aircraft that predate the ICAO tests and do not have a certification noise level may need to undergo noise tests, if the INM basic noise data is not considered adequate. An example of a case where testing would be desirable (in the absence of certification data) would be a gliding site where a tug aircraft was to be used regularly throughout the day. Accurate knowledge of its noise level would be critical to determining the overall impact of the airfield on the locality. The noise level of the aircraft could depend quite critically on its engine power, propeller type, silencing system etc. so generic data from other tug aircraft could not be relied upon.

In contrast, at airfields where a wide variety of aircraft fly, a detailed knowledge of the noise level of every single aircraft is unlikely to be necessary to gain an adequate assessment of the overall noise impact. A more generic approach based on broad categories of aircraft is likely to be sufficient.

Where tests are required it may not be feasible, or even desirable, to completely follow the ICAO test procedure bearing in mind that it requires the noise measurement to be as far as 2.5 km from the brake release point. Alternatives could include the older ICAO fly-over test, or a takeoff measured at a convenient point under the aircraft as it climbs. The method can be tailored to the needs of the assessment at the airfield in question. Whatever the method used, it is likely to require accurate measurement of the flight path as well as accurate measurement of the noise level.

APPENDIX 4: NOISE QUOTA AS A MEANS OF CONTROLLING NOISE

The option of using a noise quota as a means of controlling noise levels from an airfield relies on a knowledge of the ICAO certification noise level of each aircraft flying.

A noise prediction will have been set up using the INM model, to examine the various possible combinations of flight paths and aircraft movements. From this analysis, a limit on numbers of aircraft movements will have been established to achieve the required degree of control over the noise impact on the locality, most likely based on a worst-case combination of flight paths being taken.

This analysis will have been based on assumptions about the individual aircraft noise levels. For example it might have been assumed that all aircraft are of the single engine fixed pitch propeller type defined in the INM model, equivalent to a certification noise level of 73.8 dB.

The analysis might show, for example, that 8 take-offs are permissible for aircraft with a certification noise level of 73.8 dB. But if the certification noise level of the aircraft were lower, more take-offs could be permissible whilst achieving the required overall L_{Aeq} noise level in the locality.

The noise quota system quantifies this principle in a method that can cater for a range of different aircraft noise levels. Firstly it is necessary to determine the noise quota Q for a day's flying. This is determined from the results of the INM analysis where L_{model} is the certification noise level assumed in the INM model, and N_{model} is the number of flights permissible at that noise level. The quota is then defined as:

$$Q = L_{model} + 10 \log (N_{model})$$

In the example above, the value of Q is 82.8 dB.

The certification noise level L_{cert} of each aircraft then needs to be converted to a percentage of this noise quota, in the following way:

$$\text{Percentage} = 100 \times 10^{(Lcert - Q) / 10}$$

For everyday use, a ready-reckoner of certification noise levels and the corresponding percentages of the overall quota could be used.

Continuing the above example, three aircraft might take off with certification noise levels of 71.8 dB, 72.1 dB and 69.9 dB. The percentage values for these aircraft are respectively 7.9%, 8.5% and 5.1%. Together they will have taken 21.5% of the noise quota for the day.

An airfield using this as a method of noise control would have to know the certification noise levels of all aircraft regularly using it. Occasional visitors without certification data for their aircraft could be accommodated by using an assumed certification noise level based on the aircraft weight, equal to the maximum allowed in the ICAO requirements.