



postnote

July 2009 Number 338

ENVIRONMENTAL NOISE

Noise pollution affects quality of life and has been linked to health problems. The EU Environmental Noise Directive (END) aims to manage noise and preserve quiet areas by engaging the public, local authorities and operators. This POSTnote examines the effects of noise, the END and practical measures for noise management.

Background

Environmental noise is unwanted or unpleasant outdoor sound generated by transport and industry. This POSTnote will not look at neighbourhood noise, which includes burglar alarms, dogs barking and licensed premises, or occupational noise, which is noise experienced in the workplace.

The European Community Green Paper on Future Noise Policy (1996) recognised that environmental noise is “one of the main local environmental problems in Europe” but that it has had a lower priority than other environmental problems, such as air or water pollution. It also recognised that, despite significant reductions in the noise produced by individual sources, total exposure to environmental noise has not changed significantly. For example, the introduction of quieter vehicles has been offset by an increase in traffic.

Environmental noise in the UK is controlled by numerous laws, guidelines and standards covering planning, transport, the environment and compensation. To provide a common approach to noise management, the European Union introduced the Environmental Noise Directive (END) in 2002. This was transposed into Environmental Noise Regulations in England and the devolved administrations in 2006.

Measuring Sound and Noise

The decibel scale and various noise indicators are used to quantify noise exposure levels (see Box 1). However, they are not intuitive and can result in difficulties when communicating noise levels to the public. A sound’s unpleasantness depends upon its loudness, frequency content, duration, intermittence, predictability and source. Individuals find different sounds annoying, so no single measure can predict the reactions of everybody.

Box 1. Decibel Scale and Noise Indicators

Meters measure sound pressure on the decibel (dB) scale. 0dB is the threshold of human hearing, 50dB is around the level of a normal conversation and 120-140dB is the threshold of pain. A 3dB increase is equal to a doubling in sound pressure but, if the sound is steady, will only just be noticed by a human. A 10dB increase equates to a doubling in the perceived loudness. Standards for environmental noise use the ‘A-weighted’ decibel scale [dB(A)] which mimics the sensitivity of the ear to different frequencies.

The environmental noise indicators used vary between countries and industries and depending upon the type of sound that is being measured. They include:

- the **maximum** sound level reached in a period of time;
- the **average** sound level over a period of time. If noisy events are intermittent, the average value may not reflect the actual disruption caused by each event;
- indicators that are **weighted** to account for sound at disruptive times of the day such as evening or night.

The Effects of Environmental Noise

Environmental noise rarely reaches the sound pressure levels associated with hearing impairment. However, noise can cause annoyance, is commonly blamed for sleep disturbance and has been linked by researchers to less obvious effects, such as cardiovascular and mental health problems and reduced performance at work or school. The ways in which noise affects health are not clear. A forthcoming report commissioned by the Department of Health may recommend research areas that could inform future policy.

Annoyance

Annoyance can cause stress and longer term health problems such as hypertension (permanently raised blood pressure). It has been estimated that 55% of the UK population¹ live in dwellings where the outdoor environmental noise level exceeds a guideline value suggested by the WHO,² above which some people become seriously annoyed. On average, annoyance increases as the measured sound level increases but, individual attitudes to the same noise source can vary due to, for example:

- personal factors - including where people are and what they are doing at the time;
- context - in an urban area people might be more accepting of transport noise than in a rural area;
- choice - people who have paid more to live in a quiet area may be particularly sensitive to its disruption.

The Attitudes to Aviation Noise Sources in England (ANASE) study concluded that people were more annoyed by aircraft noise in 2005 than they were in the 1980s,³ although the methodology of the study received some criticism during peer review.

Sleep Disturbance

Evidence on the links between noise exposure and sleep quality is complex. The WHO recommends that sound levels should be kept below an average level of 30dB(A) in the bedroom, or a maximum of 45dB(A) for a single event.² Higher sound levels have been related to reduced quality of sleep and awakenings. It appears that the majority of people will get used to common background noises at higher average sound levels and sleep will not be disturbed. However, the full restorative effects of sleep may be reduced even if people are not awakened.

Cardiovascular Problems

Unusually loud noises cause elevated heart rates and blood pressure, which quickly return to normal once the noise stops. The effects of longer term exposure are not well understood, but it has been linked to a slightly increased likelihood of hypertension, heart disease and heart attack. A recent study estimated that road noise could cause around 100 attacks a year in Greater London: 1.8% of the total incidence.⁴ Separating the effect of noise from other confounding factors, such as air pollution, body mass index, age and smoking is difficult.

Performance and Educational Achievement

Noise has been shown to affect the performance of adults and children in cognitive tasks. The EC sponsored RANCH study investigated the link between children's health and noise in the UK, the Netherlands and Spain.⁵ It found that chronic exposure to aircraft noise can impair children's reading comprehension and memory to some extent. No link was found between road noise and performance. It was suggested that aircraft noise may be more disruptive than road noise due to its "variability and unpredictability". However, previous studies at higher noise exposure levels had found a link between road noise and performance.

Vulnerable Groups

Certain groups of people are more vulnerable to environmental noise. High background noise levels make conversation more difficult for the hearing impaired. Studies have linked a range of psychological symptoms to environmental noise, including anxiety, stress, irritability and mood change. There is no evidence that noise directly causes mental illness, but research suggests that people who are prone to certain psychiatric disorders may be more sensitive to environmental noise.

The European Federation for Transport and Environment (T&E) believes that environmental noise unfairly affects poorer people. A study in Birmingham found that socially

deprived populations experienced slightly higher exposure to night time noise.⁶ Poorer people may be less able to afford houses in quieter areas. However, some people will choose to pay more to live in noisy areas for better access to amenities.

The EU Environmental Noise Directive

The END requires Member States to create strategic noise maps and to generate noise action plans. Noise maps indicate the extent of environmental noise due to road, rail, aircraft and industry. Action plans identify steps to reduce noise where necessary and preserve 'Quiet Areas'. Member States should also inform and consult with the public about noise exposure, its effects and noise management measures, in line with the UN Aarhus Convention, which promotes citizens' involvement in environmental matters (see POSTnote 256). The first round of noise mapping covering large urban areas and major airports, roads and railways was completed in 2007 and the devolved administrations are now at various stages of action planning.

Box 2. Noise Modelling

Sound propagation is affected by many factors including the frequency of the sound (lower frequencies travel further), the shape and size of barriers, the ground surface (concrete reflects sound while grassland absorbs it) and the weather. Both the quality of the input data and the calculation method can affect the accuracy of the model. In England there have been fewer data available for road and rail traffic flow at night to date, meaning that the first set of night time noise maps are less accurate than day time noise maps.

A common methodology for computing noise exposure at airports has been the use of 'average noise contours'. The contours derive from the 'noise profile' of individual aircraft types (the sound pressure at ground level and at a given distance from the airport) and the flight path of each aircraft, tracked using radar. Work has been ongoing to ensure common modelling methods are used across the EU. The UK Civil Aviation Authority believes that its ANCON model is accurate to within ± 1 dB(A). Road and rail noise modelling is more problematic as objects on the ground can shield sound. Guidance in the END was limited and different approaches have been adopted in different countries.

Noise Mapping

The noise maps required by the END indicate the average noise exposure level that would be experienced outside a building.⁷ They have been produced by computer modelling (Box 2), as the cost of directly measuring sound levels nationwide render it impractical. The modelling of sound propagation is complex and it is unlikely that the calculated average exposure levels will always reflect local attitudes to noise.

The purpose of noise maps is to aid prioritisation of action and to allow comparison of noise levels across Europe. Different approaches have been adopted by EU countries so levels cannot yet be fairly compared. Choosing a common methodology is difficult as not all countries have the same quality of input data. Repeated mapping will allow trends to be identified. Noise maps are considered to be sufficiently accurate near major noise sources to allow the areas of highest exposure to be identified for Noise Action Plans.

Noise Action Plans

The Department for the Environment, Food & Rural Affairs (Defra) recognises that more clarity is needed on where the responsibility for noise management lies in England. The Highways Agency, Network Rail, airport operators and planning and environmental health departments in local authorities will have to co-ordinate to meet the requirements of the END. The competent authority is required to assess noise maps, decide if the predictions are accurate and on what action, if any, should be taken.

The END is expected to provide a framework for prioritising action and use of available funds through Noise Action Plans. Local authorities are concerned that these will be ineffective if they are not incorporated into development and local transport plans. In the longer term, Defra intends that the action planning process should help it to draft a Noise Strategy for England, which may also be adopted by the other devolved administrations. A consultation on a national strategy was held in 2001 but as yet no definite timescales have been announced.

Quiet Areas

The END requires Member States to identify and aim to preserve 'Quiet Areas' (Box 3). Research has highlighted the importance of access to quiet areas for well-being in urban areas.⁸ Quiet spaces may help reduce annoyance and stress. A recent survey by Environmental Protection UK found that 91% of people think that it is important to protect quiet areas from an increase in noise.⁹

Some noise experts and policy makers are concerned that the dual objectives of the END - to reduce average noise exposure and to preserve quiet areas - are not wholly compatible. For example, aircraft flight paths are often designed to avoid densely populated areas. In some cases, the only alternative is to fly over quiet areas.

Box 3. Designation of Quiet Areas

In the first round of Noise Action Plans, the END requires Member States to identify 'Quiet Areas' in large urban areas. Eventually it is expected that Member States may also be required to designate Quiet Areas in open country.

Scotland started with parks and national heritage sites and then selected candidate sites based on a set of criteria including land type, noise level and area. Wales asked local authorities to identify quiet open spaces that are of importance to the local community. Their list includes parks, playing fields, allotments and cemeteries, reflecting the fact that many different types of open space may be valued for their quietness. The suitability of the candidate areas will be assessed based on factors such as accessibility.

England and Northern Ireland intend to adopt an approach similar to Wales. The consequences of designating an urban site as a 'Quiet Area' and how this fits in with the other government policies, such as the aim to deliver greener public spaces, are not yet clear.

Noise Management

Environmental noise is already controlled to some extent by planning guidance, noise nuisance and compensation legislation and EU directives on transport noise.

Guidance on Noise Action Plans from the devolved

administrations suggests a number of possible noise management measures but leaves identification of the most appropriate option to the competent authorities. The benefits of implementing noise management should be weighed against costs to the wider community. This section describes ways to manage noise.

Reduction at Source

Transport noise is caused by movement of the vehicles through the air, contact of wheels with a road or track (rolling noise), engine noise and braking. Limits for noise emissions from new aircraft and road vehicles have been tightened progressively. Noise from jet aircraft has reduced by 75% since the 1960s.¹⁰ New aircraft designs can easily meet the current noise standards and so these provide little incentive to improve further on current technology. The main drivers are now local controls (see POSTnote 197).

Noise limits for new road vehicles have been tightened by up to 11dB since the 1970s. Despite this, there has been no significant decrease in road vehicle noise. This has been attributed to:¹¹

- limits not being very stringent when originally set;
- noise from vehicles in-service not being well controlled. In the UK an MOT tester is required to judge exhaust noise subjectively;
- noise certification tests not reflecting all driving conditions. Engine noise has reduced but limits have had little impact on tyre noise, which is now one of the dominant sources. EU legislation on quieter road tyres is expected to be published this year;
- vehicles remaining in-service for many years, so that the full benefit of tightened limits takes time to realise.

Guidance for Action Plans encourages steps such as wider use of quieter road surfaces, traffic flow management, continuously welded rails (which eliminate noise as train wheels move over joints) and operational procedures, such as those adopted around airports (Box 4). T&E believe that future revisions of the END should include explicit limits for transport noise.

Box 4. Operational Procedures in Aviation

Operational procedures can affect the aircraft noise experienced by the community surrounding an airport (see POSTnote 197 on Aircraft Noise). One procedure that has been recently introduced is Continuous Descent Approach, where the aircraft descends smoothly rather than in stages. While the main benefits are in fuel and CO₂ savings, noise on the ground can be reduced by up to 5dB for locations between 15-40km from the airport.

New navigation systems allow aircraft to follow flight paths with a much higher accuracy than was previously possible. This allows airport operators to decide whether to concentrate noise over a single population or to share it. The stability of Noise Preferential Routes (NPRs) for aircraft arriving at and leaving airports is valued by those looking to purchase a house, as it allows them to make informed decisions. A review of airspace is required to accommodate new navigation systems and further changes would be needed for a proposed third runway at Heathrow. Some NPRs may have to change. At some airports, operational restrictions or curfews (bans on night flights) may be operated, to give local residents periods of relative quiet.

Shielding and Insulation

Buildings can shield other more noise-sensitive buildings or spaces, such as schools or hospitals, from major noise sources. New developments can be laid out to ensure that each building has one 'quiet side' to accommodate noise-sensitive rooms such as bedrooms. In noisy areas, buildings can be built or fitted with noise insulation and acoustic double glazing.

Noise barriers are structures such as fences or earth mounds that are built between a noise source, such as a road or railway, and a building or open space. Their effectiveness can vary widely, depending upon design. In 1999, the Highways Agency identified 79 sites where there were particularly serious noise issues. An annual budget of £5m was ring-fenced for the installation of noise barriers at these sites. Ten sites still have to be addressed and four new sites have since been identified where noise barriers will be installed during 2009/2010.

Planning

Defra intends that the identification of noise management areas and Quiet Areas will raise the profile of noise issues among local planning authorities. Planning can be effective at addressing the local impact of new developments. Approaches that planning authorities can take towards managing noise include:

- land-use planning to ensure sufficient separation between noise sources and noise-sensitive areas;
- conditions for new developments, including sympathetic timing of operations or requirements for shielding or insulation.

The planning process gives an opportunity to explain the potential impact of a new development on the local noise climate and for public consultation on potential management measures. The Planning Act (2008) aims to make the planning process more efficient, particularly for large infrastructure projects that will benefit the entire country (Box 5), but environmental and community groups are concerned that changes will result in less consultation and in local noise issues being overlooked.

Economic Measures

Economic measures can help to reduce noise:

- airports can impose additional fees on noisy departing and arriving aircraft;
- congestion charging can reduce traffic and noise, although this can be offset by increased traffic speeds;
- the Land Compensation Act (1973) allows householders exposed to increased noise levels due to new or improved highways or airports to receive compensation, either for loss of value to their property or to cover the cost of sound insulation.

Public Information and Consultation

Noise maps, as specified in the END, show only the average noise exposure. Other indicators can improve public understanding of potential noise impacts.¹²

Examples include the number of movements that exceed a given sound pressure, the number of hours of respite from noise or, for airports, flight paths and their distribution.

Most large transport operators have a system for handling complaints. Guidance for Noise Action Plans states that Defra will review these systems. Some airport operators also liaise with the public on noise issues via local consultative committees, but these have no authority to enforce action. The Department for Transport has guidelines on their operation. The Aviation Environment Federation approves of these guidelines but feels they are not always put into practice by airport operators.

Box 5. Wind Farms

Wind farms are often subject to planning delays due to fears about potential noise from local residents. Government guidelines for noise from wind farms reflect the fact that they are mostly built in quiet rural areas. Generally, people do not experience noise problems, although there have been complaints about noise from wind developments in the UK. Issues can often be resolved by simple steps like limiting the turbine's speed of rotation. Industry worries that lengthy planning processes and the current guidelines could endanger the government's 2020 renewable energy target for onshore wind.

Overview

- Environmental noise affects a large proportion of the population.
- Individuals can react very differently to the same noise. Some individuals are more likely to be annoyed or to suffer health effects than others.
- The EU Environmental Noise Directive aims to manage and, where necessary, reduce average noise exposure levels and to preserve Quiet Areas by engaging the public, local authorities and operators.
- Noise can be managed by reducing it at source, and by planning, shielding or insulation, while attitudes can be influenced by effective community liaison.

Endnotes

- 1 Skinner, C.J. & Grimwood, C. J., *Applied Acoustics*, vol 66 (2005), pp 231-243
- 2 The World Health Organisation, *Guidelines for Community Noise*, 1999
- 3 DfT, *Attitudes to Noise from Aviation Sources in England*, 2006
- 4 www.london.gov.uk/mayor/strategies/noise/docs/technical-report2.pdf
- 5 Stansfeld, S.A. et al, *The Lancet*, vol **365** (2005), pp 1942-1949
- 6 Brainard, J.S. et al, *Urban Studies*, vol 41 (2004), pp 2581-2600
- 7 noisemapping.defra.gov.uk
- 8 Gidlof-Gunnarsson & Ohrstrom, *Landscape and Urban Planning*, vol **83** (2004), pp 115-126
- 9 Environmental Protection UK, *ICM Poll on Transport Noise*, 2009
- 10 DfT, *The Future of Air Transport White Paper*, 2003
- 11 International Institute of Noise Control Engineering, *Noise Emissions by Road Vehicles – Effect of Regulations*, 2001
- 12 Omega, *Indices to Enhance Understanding & Management of Community Responses to Aircraft Noise Exposure*, 2009

POST is an office of both Houses of Parliament, charged with providing independent and balanced analysis of public policy issues that have a basis in science and technology. POST is grateful to Katy Milne for researching this briefing, to the EPSRC for funding her parliamentary fellowship, and to all contributors and reviewers. For further information on this subject, please contact the co-author, Dr Martin Griffiths, at POST. Parliamentary Copyright 2009

The Parliamentary Office of Science and Technology, 7 Millbank, London, SW1P 3JA; Tel: 020 7219 2840; email: post@parliament.uk

www.parliament.uk/parliamentary_offices/post/pubs2009.cfm