NOISE CONTROL : DETERMINING THE BEST OPTION

1 THE APPROACH

Enclosures … and silencers … and possibly barriers, or even lining the roof with acoustic absorbent. In most cases, these techniques represent the limit of the noise control technology that is considered. Whilst in some cases one or more of them may be the solution, how do you find out whether there are alternative options that are more practical and lower cost?

The problem is that unless a high degree of specialised engineering expertise is available, it is difficult to make a judgement of what constitutes the best solution in each case. However, there is a simple approach that non-experts can use to determine - at least in outline - the best solution to any noise problem. If you want or need to reduce the noise from a machine or process, then following this systematic approach to noise control can remove the guesswork from determining the most practical and cost effective solutions to particular problems.

The underlying message from this approach could be summarised as: Noise is a health and safety issue, but noise control is an engineering problem.

2 THE PROCEDURE

Machines and processes should not be regarded as monolithic "noisy units", but as collections of noise sources, each of which generates noise in a particular manner.

The procedure that <u>must</u> be followed to determine the best solution involves the following steps.

(i)   List all potential noise sources (within each machine or process).

(ii)   Rank the sources.

(iii)   Develop noise control measures for the major sources.

These steps are considered in more detail below.

2.1 List Noise Sources

The first step is to list all the potential noise generating sources and then to break down the list into two broad categories as shown below:-

SOURCES OF AERODYNAMIC NOISE *cause noise by direct disturbance of the air*		SOURCES OF MECHANICAL NOISE *cause mechanical vibration which is transmitted through the machine structure to the external surfaces which vibrate and radiate noise*	
1	FANS	1	IMPACTS (a) Presses (b) Mechanical Handling
2	COMPRESSED AIR (a) Air Jets (b) Pneumatic Exhausts (c) Air Motor Exhausts	2	ROTATING MACHINES (a) Gears (b) Pumps (c) Bearings (d) Electrical Machines
		3	FRICTION FORCES AND OTHERS (a) Cutting Tools (b) Brakes
3	COMBUSTION		

Example: electrical hand-drill source list and categorisation.

Aerodynamic   *Mechanical*

fan   *gears*
windage   *out-of-balance*
                                                                 electrical forces
                                                                 bearings
                                                                 commutator

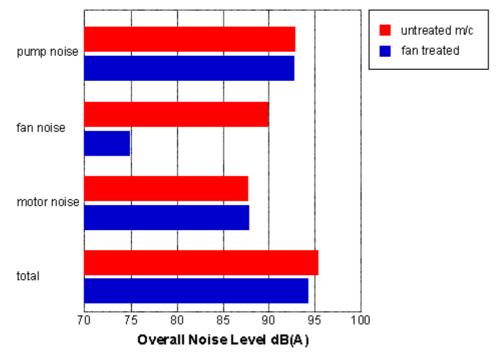Once this listing and categorisation is complete, your next step is to rank the contributions from each source.

2.2 Rank Sources

Ranking the sources involves establishing the relative contributions from each source to the total noise produce by the machine or process. Unless this has been done the choice of noise control measures is based on guesswork. To achieve effective noise control you must tackle the dominant sources first. If the dominant sources are not treated first, the effect of any noise control measures will be disappointing as they are likely to be limited to a maximum reduction of less than 3 dB. Taking a case where there are 3 sources on a machine:-

1   pump generating 93 dB(A)
2   fan generating 90 dB(A)
3   motor producing 88 dB(A)

Total noise is therefore 95.6 dB(A) as shown below:-

Ranked Sources

If it is assumed that the fan is the noisiest source (due to the subjective impression caused by tonal content) without carrying out the ranking process, and a silencer is fitted, then the result is as shown above. A 15 dB reduction in the fan component only produces a 1 dB overall noise reduction as it is not the dominant source. Used properly, the ranking process allows the overall noise reduction to be estimated in advance before spending money on modifications.

The main ranking techniques are:-

(i)   *Listen*   :   associate the characteristics of the noise with an understanding of the machine operation.

(ii)   *Alter operating characteristics*   :   change speeds, feeds, load etc and note effect on noise.

(iii)   *Timing* :   associate noise with parts of machine cycle.

(iv)   *Isolate* :   run each source separately or temporarily cover all sources (barrier mat or even cardboard) and uncover each in turn. Make sure you can do this safely.

(v)   *Frequency*   :   features of the frequency spectrum can be a powerful diagnostic tool.

This simple process (listing and ranking) ensures that the correct sources will be treated in the correct order.

Example: *An automatic circular saw used to cut long lengths of aluminium extrusion generated 105 dB(A). An expensive enclosure was fitted over the saw - with no effect on overall noise level as the dominant noise radiator was the component length outside the enclosure. The simple diagnostic test of cutting a very short length of extrusion would have demonstrated that the noise level dropped substantially, proving that the saw was only a minor source and that the enclosure would provide no benefit.*
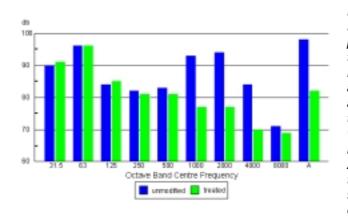
3   OPTIONS AND COSTS

Once categorisation, listing and ranking of the noise sources has been carried out, you can consider noise control techniques in detail. There are only a limited number of plant noise control techniques available:-

Noise control at source   :   engineering modifications that alter the process of noise generation. Limited only by the experience and imagination of the engineer.

Silencing   :   for aerodynamic sources there are a range of conventional and unconventional "silencers" available.

Vibration isolation   :   introduce a vibration "break" to prevent the transmission of mechanical energy.

Vibration damping   :   extract and dissipate the energy in vibrating surfaces.

Enclosure   :   prevent the transmission of sound by introducing a barrier.

Barriers   :   place a partial barrier between source and receiver.

At this stage noise control engineering expertise may be required in order to cost the options for each of the ranked sources and to predict the likely noise reduction for each option. The most important factor is that you consider all the options for the dominant noise sources.

Once the above steps are complete, it is then possible to define with some accuracy the costs involved in achieving decreases in noise levels.

Note that whilst the direct costs of developing and putting in place modifications are quite easy to assess, there are also likely to be indirect costs that should be taken into account. These include the effects on production and ease of maintenance both of the machine itself and of the noise control measures.

Example : Hammer mills. Enclosures costing £40,000 were proposed for 4 hammer mills used in the manufacture of nappies. However, there was concern not only at the cost, but also the space and access limitations. Diagnosis proved that the dominant source of the noise was actually vibration from the hammers radiated by the web infeed. A vibration damper was designed for the web that reduced the noise from 98 dB(A) down to 82 dB(A) at a cost of around £4,000. Normal operation and access were unaffected.

4   CONCLUSIONS

It is possible to define with some accuracy the best noise control options for any project by following a simple procedure to determine the dominant source within the noisy plant. If the range of options is limited only to high cost conventional techniques (enclosure etc), the risk is that either nothing will be done (risking hearing damage for employees) or that industry will spend substantially more than necessary. The key to cost effectiveness is to approach noise control as an engineering problem and to follow a simple diagnostic and ranking procedure to target modifications precisely where they will do most good - wielding a noise control scalpel rather than a chainsaw.

This sheet was produced by the Engineering Industry Noise Task Group (see http://www.hse.gov.uk/noise/who.htm).
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