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"NEIGHBOURHOOD NOISE"

NOISE CONTROL IN NOISE ABATEMENT ZONES

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An important requirement of noise control in a Noise Abatement Zone is to be able to pick out the noise sources which are making a significant contribution to the total noise emitted from the zone. If there is only one major source this may not present any great problem, but if there is a number of sources it may be difficult to decide which of them is causing the noise from the zone to exceed a prescribed noise limit. Some technique is required to assess the contributions of the noise sources in terms of their noise emission and their distance from the places where the noise limits have been prescribed so that, if it is necessary to serve Noise Abatement Orders, these are sent to the factories where noise reduction will be most effective in meeting the noise limits.

Such a technique has been used for several years by a number of oil companies to assess the noise emission from various parts of their refineries and this could form a basis for developing a broader technique which could be applied to other types of industrial or urban areas. The purpose of this paper is therefore to give a brief description of the technique proposed by the Oil Companies Materials Association (OCMA), and to show how it could be used in Noise Abatement Zones; a more detailed description is given in reference (1).

The basis of the method is to calculate the sound power level of each noise source in the refinery and then, by means of sets of attenuation curves, to assess its contribution to the sound pressure level at various points outside the refinery; the noise at these points is the sum of the contributions of the noise sources. Two methods are proposed for assessing the sound power levels of the sources (which is a measure of the power emitted by the source as noise, with units in decibels). The first is used for small sources and is similar to the method used in several international standards for measuring noise from machines; measurements of sound pressure level are made at 5 or more points on an imaginary surface surrounding the machine, averaged, and then combined with the area of the surface to give the sound power level of the machine. This procedure is done for each of the octave bands from 63 Hz to 8 kHz.

The second method is used for large sources and is less familiar. In this, the source is treated as a number of radiating surfaces and one or more measurements of the sound pressure level are made in the near field of each surface. These are combined with the area of the

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surface to obtain its sound power level and the total of these is found for all the surfaces to give the sound power level of the source. The physical basis of making measurements in the near field may be open to question but the method is found to give reasonable results. In refineries, the surfaces may be the walls of furnaces or the sides of banks of cooling fans; in a wider context they might be the walls and roofs of factory buildings. A similar technique is recommended in the German guideline VDI 2571 (reference 2) and in this, different elements of the walls - such as windows and doors - can be treated as separate source elements. However, in this document, the sound power levels are obtained by calculation, using the interior sound pressure levels and the sound reduction index of the surfaces. The accuracy of this method is debatable but it represents a possible alternative to the measurement of sound pressure levels in the near field.

Having then listed the sound power levels of all the sources, the next stage is to calculate the attenuation between each source and the measuring point to assess its contribution to the total noise level. Three types of attenuation are recognised in the OCMA method and are published as curves relating sound power level to sound pressure level at various distances from the source. The first two types of attenuation are for geometric, or inverse square law attenuation, and air absorption (which varies with frequency), and are included in one graph. The third type of attenuation, which is not so widely recognised, is due to the effect of ground absorption, and two graphs are given to make allowance for this. One of these is to be used where there is little screening between the source and the measuring point (for example, where there is a direct view) and the other where there is screening, due to intervening buildings or the lie of the land. These ground effects curves, which are a special feature of the OCMA method, have been derived from empirical observations around refineries and from experimental data published in the literature. It is recognised that they will need refining as more experimental evidence becomes available, but the application of the method so far suggests that they are broadly correct; if anything, the OCMA method tends to overestimate noise levels, so it may be that not sufficient ground absorption is included in the graphs. Some reassessment of these curves may also be necessary for urban areas, where the ground between the source and the measuring site consists mainly of buildings and roads.

To assess the accuracy of the method it is necessary to make comparisons between estimated noise levels from the refinery or plant and actual noise measurements. This is not straightforward because the measured noise can vary widely with the weather conditions and the OCMA method is intended to estimate the noise under conditions which are rather worse than average but not the most unfavourable. Taking these limitations into account, the agreement has been found to be acceptable for a large number of comparisons made at about a dozen refineries.

In adapting the method for use in Noise Abatement Zones there are some special problems to be resolved. One of these is to estimate the attenuation to be applied to noise sources surrounded by high walls or tall buildings. Several methods have been proposed for estimating the screening effects of walls and some experimental observations have been made, but these are mainly valid for distances of a few hundred metres and their reliability at distances

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of about 1 km is doubtful. There is also the very common problem of trying to estimate the noise from one source in the presence of a high background noise due to other sources. This can sometimes be resolved by shutting down neighbouring machines or by making the measurements sufficiently close to the source for the source noise to be sufficiently greater than the background.

In applying the OCMA method to a large number of sources and doing calculations for each octave band, a large amount of effort can be expended and such calculations are performed ideally by a computer. However the method was originally intended for desk calculations and several short cuts have been proposed for making this practicable, so there is no reason why it should not be used by local authorities or consultants who do not have access to a computer.

A final comment must be made on the variation of noise under different weather conditions. This becomes greater as the distance from the source increases and it therefore becomes more difficult to assess the noise from sources at large distances without making large numbers of measurements under different weather conditions; hence the importance of assessing the noise from each source at a relatively short distance. In the OCMA procedure it is recommended that, where a residential noise limit is set for building a new refinery, the calculated noise level at the selected point (or points) should be used to decide whether the construction contractor has met his obligation (the calculation being based on the sound power levels of the various sources in the refinery). The calculation procedure and the appropriate attenuation curves are therefore a part of the contract. From a legal point of view there is considerable difficulty in defining a fixed noise limit for a Noise Abatement Zone and then using measurements to determine whether it has been met or exceeded. It would be preferable to define the noise limit as a point on the cumulative frequency distribution of noise measurements: for example, to say that the noise must not exceed N dB(A) on more than 10 per cent of the occasions throughout a year, or six months. The actual noise from the Zone can be compared with this by making measurements on a suitably large number of occasions and calculating the cumulative frequency distribution, or by a calculation method using attenuation curves such as the OCMA curves, which include an element of weather variation in their derivation. Effectively, this is an extension of the concept of Noise Pollution Level proposed by Robinson except that it is applied to daily noise level variations from a constant source due to weather changes rather than to more frequent variations due to traffic or aircraft. Taking a large number of measurements would be expensive and probably impractical in most cases so the use of estimated noise levels provides the most suitable method. It must be recognised however, in either case, that a certain percentage of measurements will exceed the prescribed legal limit. Admittedly, an occasional loud noise can cause annoyance but it is unreasonable for industrial undertakings to reduce their noise emission to such an extent that a fixed noise limit is never exceeded on any occasion when there might be freak weather conditions (unless the limit is unreasonably high). Introducing a frequency element into the definition of noise limits provides the best means of protecting the population from excessive noise and giving practical guidelines to industry for noise control.

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References:

(1) Procedural Specification for Limitation of Noise in Plant and Equipment for use in the Petroleum Industry. Specification No. NWG.1, issued by the Oil Companies Materials Association, May 1970.

(2) Schallabstrahlung von Industriebauten (Nachbarschaftschutz), VDI.2571. Draft, issued by the Verein Deutscher Ingenieur, Düsseldorf, April 1970. (Translation available from British Standards Institution).