makes it necessary to declare that the editors are solely responsible for the present text of the document'. The guideline values contained in the document have not been adopted by the WHO or by any other official body, although this does not have any effect on their underlying scientific validity as determined from the available research data.

The WHO guideline values in the 1980 and the 1995 WHO documents are shown in Table l. The differences between the 1980 and 1995 documents are compared critically in the NPL report, particularly in relation to speech interference and sleep disturbance, although it is stressed that both of these documents represent the views of the then panels of experts, as interpreted by the different editors of the documents, whilst separated by fifteen years of development, expectations and Appraisal.

The WHO documents do not have any official status. The guideline values in each case are based on a consensus reached by an invited group of international experts in the field, which lends them credibility, but, in such a complex field, there will be disagreement between experts. Any attempt at formal ratification of the guideline values by any form of international voting would face difficulties, although both documents have value as a careful and detailed analysis of the available literature. The guidelines provide useful guidance as to the lower threshold levels below which residual noise impacts can probably be considered as negligible.

Conclusions

The author's conclusions are

- Given the present state of knowledge, it would be unwise to base future environmental noise standards and regulations on what are at present hypothesised non-auditory health effects until future research can make the present confused situation clearer.
- To ensure that non-auditory health effects are included in future standards, research is required. This must be carefully designed, not only in terms of its planning and execution, but also in terms of setting precisely defined and achievable objectives.
- The WHO documents give threshold values below which noise effects should be negligible, although many people are already exposed to levels in excess of the WHO precautionary values without suffering adverse effects.

THE CROWD ROARS

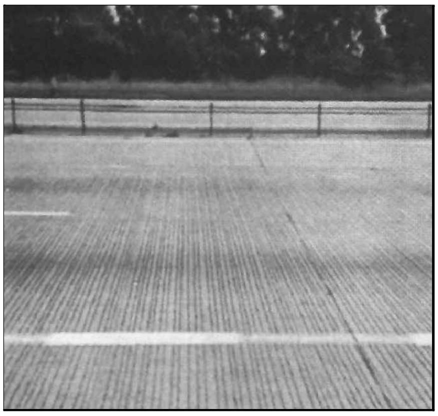
A Premiership soccer crowd celebrating a goal roars as loudly as a Harrier jet taking off tests by environmental health officers at an Ipswich Town game have shown.

Thin layers - less noise

Mike Wright, of W.S. Atkins, reviews the latest developments in road surfaces and calls for a revision to the UK noise prediction method and further testing

When considering mitigation measures for a scheme, some account must be taken of the benefits of new technology.

Calculation of Road Traffic Noise (CRTN) is now 11 years old and remains one of the most comprehensive and reliable methods of predicting road traffic noise. However, it is now starting to show its age because there are new ways of reducing noise.



Random groove concrete on A46 Kenilworth bypass prior to resurfacing

Recent developments have been most evident in new types of road surfaces. While CRTN allows you to calculate for concrete, bituminous and porous asphalt surfaces and can take into account surface texture in the first two types, it takes no account of the different types of porous asphalt that can be laid. The method does not even consider thin surface overlays because they were not commercially available in 1988 when it was published. These products are a much cheaper alternative, and are thinner and stronger than porous asphalt. Not surprisingly, they are rapidly gaining popularity in the UK.

A question asked regularly is just how you calculate levels of noise from new surfacing products. CRTN is the method prescribed in the Noise

Insulation Regulations 1975 (as amended in 1988). CRTN has no provision to allow any reduction in noise for thin surface overlays. There is also no provision to use any greater or lesser corrections to the basic noise level for porous asphalt other than those given in Section 16 of CRTN. The short answer is that no calculations made in accordance with the Regulations can take into account current technology, and an update is long overdue.

Table 1. A quick guide to the categories of thin surfacing
UTHMAL (Ultra Thin Hot Mix Asphalt Layer) is a hot bituminous mixture spread with a paving machine directly on a sprayed bond coat.
Brands include Safepave and Conbifalt.
VTSL (Very Thin Surface Layer) is a thin paver laid Polymer-Modified Asphalt Concrete bonded to the road with a thin tack coat.
Brands include Brettpave, Hitex, Axoflex, Masterflex It and ULM. Hybrid versions of the above include such brands at Tuffgrip. Colrug, Thinpave and Euro-Mac.
Thin SMA (Stone Mastic Asphalt) is a reduced thickness layer of interlocking crushed rock aggregate with a filler and binder. This has been developed from full thickness SMA used in Europe.
Brands include Masterpave, Viatex SMAtex, Brettmastic, Axofibre and Megapave.
Other materials not described here are Microsurfacings - thick slurry mixtures comprising a fine-graded aggregate and bitumen emulsion.
Brands include Ralumac, reditex and Permatex.
There are also Multi-Layer Surface Dressings such as Surphalt.
(PSV refers to polished stone value. UK practice is to use a higher value than past practice on the continent. This ensures a long life with good skid resistance).

When considering mitigation measures for a scheme, some account must be taken of the benefits of new technology. In the case of noise, the use of quiet surfaces can be a very important part in dealing with noise impact. The use of porous asphalt may not always be justified and thin

Table 2. Manufacturers and TRL data compiled by WSA

System	Noise Benefit
Safepave Thin Wearing Course System (Tarmac - Associated Asphalt) 10-mm aggr. (UTHMAL)	Light vehicles = 2.2dB(A) reductions; Heavy Vehicles = 0dB(A) Compared to NRA at 90km/hr (1)
As above	Light vehicles = 1.1-1.8dB(A) reductions; Heavy vehicles = 1.7 to 2.5dB(A). Compared to bushed concrete at 90km/hr (1)
As above, 14-mm aggregate (UTHMAL)	Light vehicles - 3dB(A) reduction; Heavy vehicles = 1.7 to 2.5dB(A). Compared to brushed concrete at 90km/hr (1)
As above, 10-25mm thick (UTHMAL)	40% reduction (~ 2dB) claimed. Compared to HRA (3)
Masterpave (Tarmac - Associated Asphalt) 35mm thick, 14mm PSV gritstone (SMA)	Cars at 110km/hr = 5.1dB(A) reduction; Heavy vehicles at 90km/hr = 3.7dB(A). Compared to HRA (1)
Tuffgrip (Hanson Aggregates) 25mm thick, 14mm open texture grade. Can be 20-40mm thick (Hybrid)	Light vehicles at 90km/hr = 3.8dB(A) reduction; at 110km/hr = 4.6dB(A). Heavy vehicles at 90km/hr = 3.2dB(A). Compared to HRA after 5weeks (1)
As above	Light vehicles at 90km/hr = 2.9dB(A) reduction; at 110km/hr = 3.7dB(A). Heavy vehicles at 90km/hr = 2.8dB(A). Compared to HRA after 10 months
Megapave (Mid-Essex Gravel) 25mm thick, 10mm granite with bituminous binde, 4% voids (SMA)	774 veh/hr, 9.3% heavy vehicles at 65km/hr - LA10 2.6 dB; 706 veh/hr, 8.7% heavy vehicles at 65km/hr - LA10 3.3dB; Compared to HRA (2)
Axofibre (Lafarge Redland Aggregates) 14 mm aggregate (SMA)	90 and 110 km/hr Light vehicles 3 to 4dB(A); heavy vehicles 3dB(A) lower than HRA after of a similar age (1)
As above	Light vehicles = 6.8dB(A) reduction; Heavy vehicles = 5.9dB(A). Compared to HRA at 90km/hr (1)
UL-M, White Mountain (Asphalt), 10 mm VTSL, 20mm thick	Light vehicles = 4.4-5.3dB(A) reduction; Heavy vehicles = 1.7 to 3.8dB(A). Compared to brushed concrete at 90 km/hr (1)
Hitex (Bardon Aggregates) Thin Polymer-Modified Asphalt	3.7 dB reduction in LA10 compared to HRA'(2)
Thinpave (Bardon Aggregates) Thin Polymer-Modified Asphalt	'4 dB reduction in LA10 compared to HRA' (2)
Smatex Range (Bardon Aggregates) 10-50mm thickness, 6-20mm aggregate (SMA)	'3 or 4 dB reduction compared to HRA'(2)
As above, 14mm aggregate	Light vehicles = 4.6dB(A) reduction; Heavy vehicles = 2.7 dB(A). Compared to brushed concrete at 90km/hr (1)
Colas (Colrug)	'2.8dB reduction compared to HRA'(3)

wearing courses may provide the noise reduction that is needed. Such surfaces are briefly described in Table 1. This list is certainly not exhaustive and new products are regularly being developed. Most of these systems exhibit an indented or 'negative' surface texture similar to that found with porous asphalt.

In the course of my investigations, I have referred to TRL Report 314 Road trials of Stone Mastic Asphalt and other thin surfacings by JC Nicholls. I have also referred to selected unpublished reports supplied by the manufacturers and have produced some general advice in Table 2. This cannot be considered as definitive and some caution is needed when quoting the manufacturers' data. The results have been obtained in a variety of ways and have not always been independently verified. Having said that, it seems that most products when new give a 3 to 4dB reduction over conventional hot rolled asphalt (HRA). Again, I must warn the reader that there are no long-term data to confirm whether these benefits are maintained over the life of the surface and whether they apply in all traffic conditions. However, I have been informed that recent observations indicate that the performance does not deteriorate as fast as porous asphalt. More testing and research is needed to determine this.

Many of these thin surfaces have been in use in Europe for some time and official data are available. However, the specifications of these materials are not necessarily the same. The UK practice is to use a material with a higher polished stone value in order to give a longer life with better skid resistance.

Finally, it is evident that the development of new products is proceeding apace. This survey should be taken as an indication of the situation in Spring 1999. A more detailed table is available on our website at http://www.noise.wsatkins.co.uk or on request. This will be updated from time to time and I welcome all feedback from readers including any recent observations you may have.

Method:

(1) IS011819-1 Statistical Pass-by Method

(2) CRTN- 88 Comparative Method

(3) Other.

Physical Basis for Sound Absorbing Materials Using a Medium with a Complex Density

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The paper gives the results a theoretical and experimental study of human made composite media in the form of a rubber–like material with rigid compact spherical or cylindrical inclusions. It is shown that in contrast to rubber–like materials with voids, which can be described by a complex compressibility, materials with solid compact inclusions can be described by a complex density. On the basis of a material with inclusions of spherical shape, the example is given of the synthesis of a wideband absorber whose properties are practically independent of the static pressure.

The problem of producing human made composite materials is of interest from the point of view of both theory [1–8] and of practical applications. Thus, for example, composite materials which provide effective sound absorption over a wide range of frequencies and static pressures find wide application in measurement technology for lining the walls of various types of high pressure tanks and chambers [9, 10].

The sound absorbing materials used for this purpose are as a rule rubber–like materials with voids of various shapes and sizes [2, 11]. Rubber–like materials are used because while they possess a bulk elasticity, equal approximately to the bulk elasticity of water, they have a shear moduli two orders of magnitude smaller, and the shear loss coefficient can have values of from 0.1 to 1. This relationship between the two moduli makes it possible by means of conversion of the bulk deformations into shear deformations to introduce significant changes in the effective parameters of the original material. This effect is usually achieved by the production of voids to obtain a complex