VTI notat

Nr: TF 52-19

Titel: **NORMALIZED TRAFFIC NOISE SPECTRA. DATA OBTAINED AT VTI IN 1982-84 COMPARED TO SOME OTHER DATA**

Författare: **Ulf Sandberg**

Avdelning: TF
Projektnummer: 52007-2
Projektnamn: Studier rörande alstring, förekomst och reduktion av miljöpåkänningar från fordon

Uppdragsgivare: VTI

Distribution: Fri

Väg- och transport-
forskningsinstitutet

1. BACKGROUND

Traffic noise frequency spectra which are normalized to certain traffic conditions, road surfaces, etc, are useful when evaluating effects of e.g. noise reduction of building facades, windows, noise barriers etc.

This paper supplies some data collected by the Swedish Road and Traffic Research Institute (VTI) which could contribute to the establishment of standardized traffic noise spectra and compares the data with corresponding spectra from other sources.

2. TYPE OF MEASUREMENTS

The spectra from VTI given below are based on the so-called Statistical Pass-by Method (SPB) where frequency spectra from individual vehicles (in actual traffic) passing a roadside microphone are recorded at the moment of peak A-weighted level. Special tests have been made to ascertain that such peak noise spectra are not significantly different from L_{eq} spectra.

The spectra shown are averages representing around 200 vehicles at each site measured in 1982-1984. The sites included here are such which have a smooth, dense asphalt surface typical of urban roads/streets in Sweden, as well as high-volume highway surfaces. It is designated AB12T or AB16T in Sweden. New as well as old and worn surfaces are included.

Since spectra are different from various vehicle categories, the VTI data here have been normalized to a vehicle mix of 10% heavy and 90% light vehicles. Also *within* the heavy and light vehicle groups, a normalized mix of vehicles within these categories have been used.

3. RESULTS: NORMALIZED SPECTRA

The table below summarizes the results. In the table, also values from Ref. 1 (UK data, Nordtest data and TG1) have been included for comparison. In addition, data from Ref. 2 have been included. The VTI results are A-weighted and normalized in order to have a level of -8 dB at 1000 Hz which corresponds to the levels used in Ref. 1. The speed range is 30-60 km/h for the urban case (where both constant speeds and accelerations are included) and 60-130 km/h for the highway case (only constant speeds).

The Japanese results (Ref. 2) are of special interest since they are measured rather recently and they are based on sound power measurements rather than just peak levels. Here, they have been processed from Ref. 2 (Fig. 5) by adding together contributions from cars (90%), medium vehicles (5%) and heavy vehicles (5%) on a power basis.

Table 1. A-weighted normalized traffic noise spectra (dB)

Frequency Hz	Urban			Highway		
	UK data	Nordtest A1	VTI data	Spectrum adopted by TG1	VTI data	Jap. data
50	—	—	-33	—	-42	
63	—	—	-26	—	-34	
80	—	—	-23	—	-28	
100	-22.7	-20	-21	-24	-25	
125	-21.3	-20	-20	-23	-25	-26
160	-19.1	-18	-18	-22	-23	
200	-16.0	-16	-16	-19	-21	
250	-15.9	-15	-15	-17	-18	-17
315	-15.6	-14	-14	-15	-16	
400	-14.2	-13	-12	-14	-15	
500	-12.9	-12	-11	-12	-11	-12
630	-11.1	-11	-10	-11	-10	
800	-9.4	-9	-9	-9	-9	
1000	-8.3	-8	-8	-8	-8	-8
1250	-8	-9	-8	-8	-8	
1600	-9.1	-10	-8	-9	-8	
2000	-11.1	-11	-9	-11	-10	-10
2500	-12.3	-13	-11	-13	-12	
3150	-14.6	-15	-13	-16	-14	-15

The UK data are based on recordings at 1 m from house facades at 11 sites on busy roads near London with 48 km/h speed limit.

The NORDTEST A1 spectrum is based on 18 measurements from Copenhagen and Gothenburg with traffic speed of 50 km/h and approximately 10 % heavy vehicles.

The VTI data are based on measurements 10 m from center of the roads at two urban sites and six highway sites.

The Japanese data are based on power level measurements 7.5 m from the lane on one highway site at 60 km/h (824 vehicles)

4. DISCUSSION

The VTI values differ from the other spectra by max. 2 dB. This is a rather close fit, considering all variables involved. However, there seems to be a systematic difference (if such limited data can be used to make such a judgement), namely that the VTI data have 0-2 dB *higher* levels at high frequencies and at 400-630 Hz while the VTI data have 0-2 dB *lower* levels at the lower frequencies (only at highway conditions). This could be caused by the choice of road surface type for these sites since only smooth-textured surfaces are included. The Japanese data, which are valid for the same type of road surface (Ref. 5), are in line with the VTI data although measured quite differently.

However, present trends in vehicle noise, with tyre/road noise becoming more and more prominent, a development which will be even more pronounced with the new EC limits from 1994-95, suggest that the frequency range of 1-3 kHz may become more important.

Normalized traffic noise spectra are influenced by factors such as:

* Vehicle mix (% heavy vehicles)
* Driving condition (constant speed, acceleration or deceleration)
* Speed
* Road surface type
* Road surface condition (wear, etc)
* Dry or wet road
* Warm or cold climate (if studded tyres are used)
* Driver behaviour (VTI have demonstrated how levels are different in Sweden, USA and Italy, probably due to driver behaviour)
* Vehicle construction (what emission limits they are meant to meet)

This makes it very difficult to assign a standard spectrum to traffic noise. As a minimum, spectra should be different for driving condition/speed, such as indicated in Ref. 1. However, it can be argued that a "wet road spectrum" is equally motivated. In some countries, a "studded tyre spectrum" is also highly motivated. With the increased use of drainage asphalt surfaces in some countries (like the Netherlands) a spectrum adapted to a drainage surface would also be motivated. Such a spectrum would be very different from the ones shown here.

VTI has data also for cases such as the ones discussed above. It should also be pointed out that the introduction of new emission limits (80 dBA for heavy trucks and 74 dBA for cars, for example) in this decade may warrant a modification to the spectra discussed here. Especially we can expect that vehicles will be more optimized for low A-weighted levels while the low frequencies will remain unattenuated, or perhaps even increased.

This raises another question: That of the frequency range. Since it is assumed that the normalized spectra shall also be useful for evaluating conditions indoors, it is becoming more and more unfortunate that frequencies lower than 100 Hz are not considered. This has many reasons, e.g. difficulties to measure correctly at such low frequencies. However, we must start now to prepare for an extension of the frequency range down to 50 Hz. Therefore, the VTI data include also these low frequencies.

For example, by using data of Ref. 3 for noise insulation, and the VTI traffic noise spectrum data at 50-100 Hz, it is easy to show that there are cases where the indoor A-weighted level will be dominated by 50-80 Hz. With additional sound propagation and screen attenuation spectral influences, this will be even more obvious. Window No. 25 in Ref. 3 and the VTI urban spectrum will, for example, give a dominance of approx. 6 dB for 63 and 80 Hz over other frequencies.

VTI has recently conducted extensive measurements of noise emission from heavy trucks meeting both the 84 dBA and the 80 dBA requirements. There are plans to analyze these data in order to see if the introduction of the low-noise trucks appears to influence the frequency spectrum. We suspect that it is likely that low frequencies are not reduced as much as the medium and high frequencies when the vehicle fleet is changed in the future.

According to Ref. 4, the Nordtest spectrum has been preliminary selected for urban traffic. According to Ref. 1, the "TG1" spectrum has been selected for highway traffic. The selected spectra are rather well chosen but it could be questioned if they take proper account of the projected traffic noise with more and more tyre/road noise. In the time remaining until a definite decision is necessary, the group should consider carefully if the spectrum should be adjusted slightly at high and low frequencies in order to take the recent and projected development into account. Quite obviously, the low end must be extended.

5. THE PROBLEM OF STANDARD SOURCE HEIGHT

A problem connected to the normalized spectra, and of special importance when evaluating noise screens and noise propagation from roads, is the vehicle noise source height. This problem must be addressed. Also here, we expect that the problem is influenced by factors such as the ones described above.

For example, it is felt that data shall be collected regarding the exhaust outlet height for trucks.

The problem is very complicated since the source height is connected with the spectrum. For example, the exhaust outlet will give another spectrum than the tyre/road noise. The former may be a source much higher located than tyre/road noise.

This author is well aware of that data on source heights, especially modern data, are rare. New measurement technologies may, however, be employed in order to study the noise emission as a function of height above road level. A multi-national experiment on this should be designed.

6. REFERENCES

[1] CEN/TC 226/WG 8/TG 1/ N13: **Traffic noise spectra for consideration at Brussels Meeting**. From G R Watts, TRRL (1991).

[2] YOSHIHISA, K.; TATSUDA, K.; TACHIBANA, H.: **Sound power levels of road vehicles measured by the square-integrating technique**. Proc. of Inter-Noise 91, Sydney, 1991 (pp 353-356)

[3] Andersen, B.: **Facaders lydisolation over for vejtrafikstøj (Sound isolation of facades for road traffic noise)**. In Danish. Report No. 37, Lydteknisk Laboratorium (1982), Lyngby, Denmark.

[4] Personal communication with Eric Westöö, Swedish Road Administration.

[5] Personal communication with Koichi Yoshihisa, Meijo University.

Väg- och transport-
forskningsinstitutet

Forskar för ett liv i rörelse.

Statens väg- och transportforskningsinstitut har kompetens och laboratorier för kvalificerade forskningsuppdrag inom transporter och samhällsekonomi, trafiksäkerhet, fordon, miljö samt för byggande, drift och underhåll av vägar och järnvägar.

Adress	*Telefon*	*Fax*	*Telex*
581 95 Linköping	013 – 20 40 00	013 – 14 14 36	50 125 VTISGI S