inter•noise 96
25th Anniversary Congress – Liverpool

INCE: 13.2

NOISE CONTROL OF IN-USE VEHICLES - NEW NORWEGIAN LEGISLATION

T Berge

SINTEF Telecom and informatics Acoustics, N-7034 Trondheim, Norway

1. INTRODUCTION

Vehicle noise emission regulations have been effective for approximately 25 years in most European countries. These are regulations aimed for type approval tests, e.g. for new vehicles with noise limits depending on vehicle category. The type approval test is based on ISO 362, a test procedure measuring vehicles under full acceleration at a distance of 7.5 m.
The noise limits according to this test have been tightened considerably over this period. For passenger cars, the limit has been reduced from 84 dB(A) to 74 dB(A) and for the heaviest trucks, the limit has come down from 91 to 80 dB(A). At the same time, the test procedure has been moderately changed, which effectively have tightened the regulations. However, the reduction in actual road traffic noise levels has been much less, only 1-2 dB(A) under certain driving conditions. For highway conditions, even an increase in noise levels can be found. What are the reasons for this limited effectiveness of regulations? This has been thoroughly discussed by an international working party established by I-INCE in 1992. Their final report [1] identified the main reasons. Among them; lack of realism and representativity of driving conditions in the type approval test, increased influence of tire/road noise and lack of control of vehicles in-use. In this paper noise regulations of vehicles in-use will be discussed, including new Norwegian legislation and a special instrumentation developed for measuring noise from vehicles in-use.

2. NOISE REGULATIONS FOR IN-USE VEHICLES

Most countries have no effective control of vehicles in use. However, in some parts of Australia, there are certain limits and to some extent, noise measurements of vehicles in-use are conducted [2]. In some European countries, the police have performed roadside control, mainly to check motorcycles fitted with noisy exhaust systems. But no regular control of vehicles has been introduced.

For some categories like motorcycles and heavy trucks, there has been fashion trends to remove the original muffler system and replace with mufflers with very little noise reduction. Thus the considerable amount of time and money spent by the manufacturer to comply with noise regulations, gave almost no benefit to the general public.
Within the European Union, action has been taken to change this situation. In the EU Directive 77/143/EEC, regarding roadworthiness tests for motor vehicles, there is a paragraph regarding nuisance. This directive lists all vehicle components included in the periodical control, among them; noise. How this control shall be arranged is not specified. However, the measurements shall be performed according to the stationary test procedure described in the directive 92/97/EEC, which is based on the procedure outlined in ISO 5130 [3].
Norway is not a formal member of the European Union, but has signed an economical agreement with the Union, and thus has to comply with most EU-directives, including those for noise control. In Norway, the Public Roads Administration has chosen to arrange periodic controls in the following way:

- From 1.10.1992 all individual licensed vehicles must have a reported noise level at the corresponding ¾ of maximum engine speed, included in the registration document. The noise level is measured according to the stationary test procedure in 92/97/EEC. The measured value shall be given either by the manufacturer, or by an independent laboratory.
- From 1.1.1997, all the Norwegian Public Roads traffic stations throughout the country, shall carry out noise tests of vehicles in-use, based on the stationary test procedure, to check against the level in the registration document. The vehicle will fail if the level is more than 5 dB(A) above the level given by the manufacturer, or 2 dB(A), if the initial level is measured by a laboratory.

All garages approved by the authorities for periodical technical control of vehicles, must also include measurements of stationary noise levels.
Presently, only heavy trucks, buses and delivery vans are called in for this control, every second year. But, from 1998, passenger cars will also be included. For the time being, motorcycles and mopeds are not part of this control system.
This means that in Norway only vehicles licensed after 1.10.92 can be tested for noise, since there are no initial stationary noise levels available prior to that date. An exception is, however, if a used vehicle is imported. Then, a stationary noise test must be performed, and these vehicles can later be checked against that noise level.

Other countries within the EU can choose other approaches. E.g. in Sweden, the Authorities have proposed different noise limits, depending on vehicle categories and on production year. As an example, passenger cars manufactured before 1982, must comply with a stationary noise level of maximum 100 dB(A). For cars produced between 1983 and 1990; 96 dB(A), from 1990 to 1997; 93 dB(A). From 1998, the limit will be 90 dB(A), with a tolerance of 5 dB(A). Motorcycles and mopeds are included in the regulations.

3. NOISE MEASUREMENTS

Passenger cars:
In figure 1, we have compared results from Norwegian measurements on vehicles

in-use from two periods. One investigation performed in 1980, covering 50 vehicles produced in the years 1977 to 1980, and then in 1994, covering 66 models produced in 1993/94. As expected, there has been a reduction in the noise levels (an average reduction of 2.4 dB(A)), even if the spread of levels is about the same. The measurements in 1994 were compared with the levels given by the manufacturer and labelled in the license papers. For all these cars we had the kilometerage for each car available. In figure 2, the difference between the measured value and the value given by the manufacturer is shown as a function of kilometerage. Negative values means that the measured values are lower than the manufacturers level. According to these results, there is no correlation between the kilometerage and the difference between the two levels. But within a kilometerage of less than 25000 km, one should not expect any increase in exhaust noise levels. Bearing in mind that the authorities have given a tolerance of up to 5 dB(A) during an in-service control, it is interesting to see that we found a larger difference for 3 of the cars tested. And for one particular car, the difference was even as high as 17 dB(A)! There are no obvious reasons found for this yet.

Motorcycles:

In 1995 and 1996, measurements on 28 motorcycles have been performed, as part of a compulsory type approval test for used motorcycles imported to Norway. The motorcycles cover the production years from 1972 to 1993, with the majority from 1987 to 1993. The motorcycles are tested, both during full acceleration (ISO 362, distance 7.5 m) and at the stationary test (ISO 5130, distance 0.5 m). The results are given in figure 3, where we have compared the results from the two tests. The figure shows no significant correlation between the two tests, thus the stationary test do not give any information on whether the motorcycle will pass or fail at the full acceleration pass-by test.

4. DISCUSSION OF THE TEST PROCEDURE

The test procedure ISO 5130 was developed in the late 1970's and adopted as a formal standard in 1982. The standard has not been revised since then. The equivalent test procedure can be found in the 92/97/EEC, with one deviation. ISO 5130 states that the final noise level shall be an average of three measurements, while in the EU-directive states the highest level of the three values recorded shall be the result.

It has been clearly demonstrated that there is no correlation between the pass-by test and the stationary test for most vehicle categories tested. This could lead to the conclusion that this stationary test procedure is unsuited to ensure that the type approval noise levels is met also when a vehicle has been in-service for some years. This maybe true, but on the other hand, we do also know that the type approval test is not well correlated to real traffic situations, and thus one of the reasons of the limited effectiveness of noise emission regulations. It still remains to see if the extensive use of periodical control of vehicles in-use based on a stationary test can improve this situation.

However, the present test method was developed at a time where the exhaust noise was clearly one of the main noise sources on a vehicle. Over the last 15 years, considerable work has been done to reduce this noise. And, as a result, other noise sources can influence the noise level, even at a microphone position

0.5 m from the exhaust tail pipe. This is definite the case for vehicles with a rear engine, like cars from Porsche. As the exhaust noise component now has been reduced compared other sources like engine or in-take, there is a need to revise the stationary test procedure based on ISO 5130. Both the microphone position and the engine rpm conditions (3/4 of max. power engine speed down to idling) should be revised. A larger distance from the vehicle (3 to 5 m) and a run-up cycle from idling up to a defined rpm can be one proposal. A larger microphone distance gives the opportunity to include all noise sources, but of course, has a disadvantage concerning background noise, and space needed to perform in-use control.

5. INSTRUMENTATION

According to the new Norwegian regulation of periodical technical control of vehicles in-use, the noise levels of a vehicle shall be checked every second year. This means that quite a number of vehicles have to be measured each day, either by a garage or by Governmental traffic stations. To make this measurements more easily and efficient, new instrumentation has been developed by Norsonic as and SINTEF, through a project sponsored by the Norwegian Publics Road Administration. The instrument is called Norsonic Vehicle Noise Meter 117, and besides being a traditional Type 1 sound level meter, it has a measuring mode dedicated to the stationary test procedure. Its main feature, however, is that the engine speed is measured acoustically from the microphone used for measuring the noise level. The microphone signal is fed through a computer and advanced signal processing, including FFT and Cepstrum analysis, is utilised to estimate the correct engine speed [4].
The benefit is that no physical connection between the engine compartment and an external measuring device is needed for measuring the engine speed. This is time saving, especially for some heavy trucks, where the cab has to be tilted to be able to connect any devices to measure the engine speed. Normally, in diesel engines the engine speed has to be measured either using an optical device to detect rotation, or a pressure sensor to detect pulses e.g. from the diesel pump. On several new diesel engine types for heavy trucks, the fuel injection is electronically governed, and there is no way to detect the engine speed using the pressure sensor. An acoustical detection is about the only possibility for external measurement of the engine speed, as required by the EU-directive.

Using the Norsonic 117, the whole procedure will then be: 1) place the microphone in the correct position, 2) pre-set the required engine speed, 3) increase the engine speed up to the correct level 4) release the throttle and let the engine speed down to idling.
The maximum noise level is recorded during 4). Steps 3 and 4 are then repeated two more times (if the deviation between the levels is less than 2 dB(A)). If everything works well, the whole procedure takes maximum 2 -3 minutes pr. vehicle. In some special cases, there can be difficult to get a good acoustical detection of the rpm signal. The 117 is therefore also, equipped with normal tacho inputs. Another special feature of the instrument is a HELP function describing the complete procedure, including figures showing the correct microphone position for different configurations of exhaust tail systems.

Appropriate interface connections makes it easy to make changes in the software, without opening the instrument. Thus any changes of the procedure can easily be adapted in the instrument. The interface can also be used for print-outs of stored data, or for transfer of recorded measurements to a PC.

6. CONCLUSIONS

As part of EU-regulations, Norway has introduced noise control of vehicles in-use, effective from 1.1.1997. From that date the vehicles will be tested, using the stationary test procedure based on ISO 5130. They will be tested against an initial noise level, and a corresponding rpm, stated in the license paper following each vehicle.

Measurements performed on different types of vehicles shows, however, several weaknesses with the procedure, e.g. no correlation with pass-by type approval levels. There is a need to revise the procedure, both the position of the microphone and the engine performance during the test. Ideally, vehicles with high noise levels during normal driving conditions in real traffic should also rank highest during a stationary noise test.

Special instrumentation to perform stationary noise measurements has been developed. A special feature of the instrument is the acoustical detection of the engine speed, using the sound level from the microphone for the noise measurement as input signal. This gives a considerable simplification of the test and makes it possible to measure a large number of vehicles over a short time period.

References

[1] Ulf Sandberg, Report by the I-INCE Working Party on the Effect of Regulations on Road Vehicles. Noise News International, Vol.3 No.2, June 1995.

[2] C.Eiser,W.Scott, Noise Control via Legislation for In-use Vehicles: The New South Wales Experience. Proc. of Inter-noise 94, Yokohama, Japan, 1994.

[3] ISO 5130:, Acoustics-Measurements of noise emitted by stationary road vehicles - Survey method. First edition - 1982-02-15. International Organization for Standardization, Geneva.

[4] O.H.Bjor, S.Sørsdal, Acoustical detection of vehicle rotation speed. Proc. Of the 15th International Congress on Acoustics, Trondheim, Norway, June 1995.

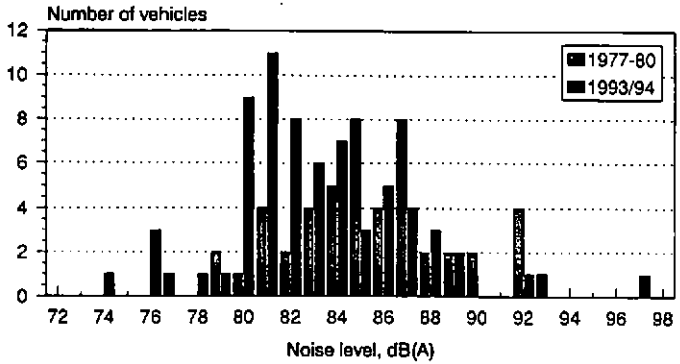

Figure 1. Stationary noise measurements (ISO 5130) on passenger cars.
1977-80 models: average: 85.4 dB(A), st.dev: 3.6 dB(A)
1993/94 models: average: 83.0 dB(A), st.dev: 3.8 dB(A)

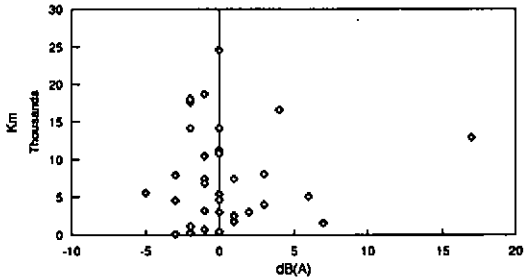

Figure 2. Passenger cars (1993/94 models). Measured noise level minus level from license paper, as a function of kilometerage.

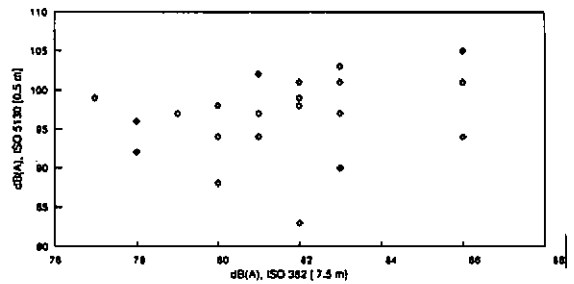

Figure 3. Noise measurements on motorcycles. ISO 362 levels vs. ISO 5130 levels.