IN ROOM EXTERIOR PASS BY NOISE

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1. INTRODUCTION

The need to lower the noise emission of vehicles is given by new environmental awareness and by more stringent acceptance levels for the ISO 362[1] pass-by noise qualification procedure in 1996. The vehicle manufacturers will meet these new standards, but the costs of doing so will be considerable.

Passing the ISO 362 test used to be an exhaust optimization task. Currently, due to the lower levels, multiple noise sources in the vehicle compose the total pass-by noise level, this implies a considerable increase of the development work required for passing the ISO-test. The specific character of the test forces the development engineers to look for more advanced measurement and analysis techniques suitable for the domain. Next, there are the known environmental constraints on outdoor tests in general, such as rain, wind and snow, which limit the availability of the test track.

2. EXTERIOR PASS-BY NOISE TESTING

The low cost pass-by noise instruments provide the A-weighted peak-level-hold value(s) of the sound level meter(s) to the test engineer. The coordination of initial velocity and kick-down moment are left over to the skills of the test driver (Figure 1).

Other, more advanced systems, use a radar system for both verifying the initial velocity, as tracing it's course as passing-by. Additionally a two-channel telemetry allows to integrate both the verification of the kick-down moment, as the rpm-signal. The major advantage of this measurement system is the considerable increase of the reproducibility of the tests. Other major advantages are that the engineer knows at what position, and at what rpm and velocity, the maximal levels were attained.

Currently there is a trend to expand the capabilities of the telemetry system, so that multiple channels, acoustical and vibrational, can be measured in the vehicle during the pass-by test. Next, the actual time histories of the reference microphones, instead of the A-weighted overall levels, have become the basic data set from which all other functions are derived. The functions that can be derived from this new basic data set are :

- A-weighted overall level as function of position, rpm or speed ;
- order sections as a function of position, rpm or speed ;
- frequency sections as a function of position, rpm or speed ;

These more advanced measurement systems are becoming available, although development continues for aspects as Doppler-effect corrections. Since the time histories are the basic data set, all data throughput processing such as correlation type of processing, is supported. Multiple tacho signals (engine, turbocharger, drive shaft, ...) are supported as reference for order sections in the post-processing of the pass-by data.

Despite all these enhancements, the unpredictable weather influences on the data quality and the tight test planning schedule remain aggravating.

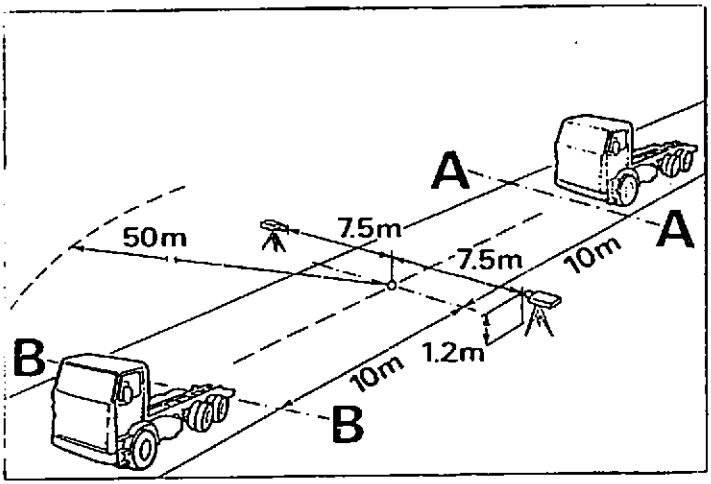

Figure 1: ISO 362, vehicle noise emission measurement

3. IN ROOM EXTERIOR PASS-BY NOISE TESTING

Some manufacturers have built (or planned to) semi-anechoic measurement halls, where the road load on the vehicle is simulated by a chassis-dynamometer. The pass-by sound pressure is reconstructed in the hall, where the vehicle is stationary, by combining signals from two microphone arrays along the vehicle (Figure 2). The results are the A-weighted overall levels of left and right microphone array. This facility allows several additional measurement and processing capabilities since the vehicle is easy accessible, and stationary. Cladding techniques and exhaust redirection methods, combined with near-field measurements have proven to increase the understanding of the pass-by noise sources and parameters.

The first implementations of these systems used multiplexers to minimize the total channel count of the system. Typically, the 2 arrays of 8 to 14 microphones each were reduced to 2 arrays of 3 microphones. However, the short duration of the event, coupled with the amount of switches

for that short period, and the relatively long transients of the microphone power supplies and RMS-integration devices imposed to extend the number of active channels in the multiplexers, to the extent that these multiplexing devices could be left out of the system.

The current strategy of the in-room pass-by measurement systems is to acquire the time series of all microphones as passing by, and process these immediately after the measurement, so that the A-weighted overall level for right and left microphone arrays as a function of position or time are available within 5 to 10 seconds after the measurement. The switching of the microphones, the A-weighting and the positional weighted averaging are performed in software.

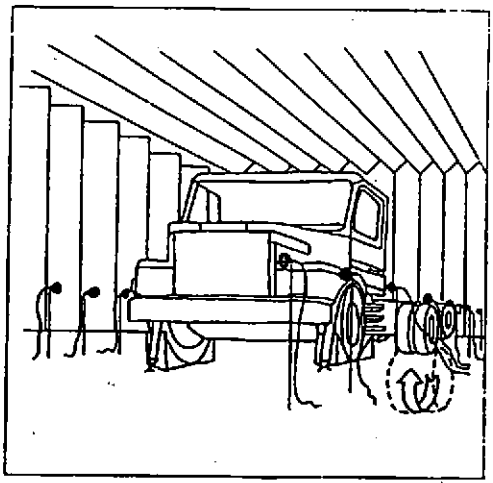

Figure 2: pass-by noise measurement hall

Additional vibrational and/or acoustical channels can be appended to the measurement chain, as are multiple speed signals. The processing that is supported interactively is :

- overall level as function of position, rpm or speed ;
- order sections as a function of position, rpm or speed ;
- frequency and 1/n octave sections as a function of position, rpm or speed ;
- engine speed (rpm) as a function of vehicle position ;
- vehicle speed (km/h) as a function of vehicle position ;
- overall level of each channel as function of position, rpm or speed ;
- time record or frequency spectrum of a channel for a specific microphone position ;
- 1/n octave band spectrum of a channel for a specific microphone position ;
- waterfall of frequency spectra for each microphone array or channel ;
- waterfall of 1/n octave band spectra for each microphone array or channel.

All these functions can be visualized A, B or Linear-weighted. Since the time histories are recorded, additional, more standardized, throughput data processing is possible.

The drawbacks of in-room pass-by noise testing are obviously the cost of the huge semi-anechoic room with chassis-dynamometer(s), the missing Doppler effect, the room response close to the acoustic walls for pure tones.

4. CONCLUSIONS

As the maximal pass-by levels are decreasing, the complexity of the problem is increasing, as are the needs for more powerfull and always accessible pass-by noise test facilities. The intrinsic drawbacks of in-room pass-by noise testing will enforce the engineer to perform verification measurements outdoors according the ISO 362 standard.

Our experience on in-room pass-by noise testing is such that we currently are developing the second generation of measurement systems for that domain which is according the above descriptions.

We believe that these in-room test facilities will become more important in the future since almost all other exterior noise applications as idle noise, sound pressure maps, etc..., can be tackled in this type of facilities too.

5. REFERENCES

[1] INTERNATIONAL STANDARD ISO 362-1981(E), "Acoustics - Measurement of noise emitted by accelerating road vehicles - Engineering method"