A noise label for motor vehicles: towards quieter traffic

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Summary
The EU 'Regulation on the sound level of motor vehicles' calls on the European Commission to assess labelling conditions for air and noise pollution levels, and, if appropriate, to submit a legislative proposal to the European Parliament and the Council. A noise label for motor vehicles can simply be made using existing EU Regulations which establish maximum noise limits for motor vehicles and limits for road noise from tyres. This is for external noise. For interior noise an ISO standard can be used that defines noise levels within a vehicle. A noise label should integrate both types of noise. This paper explores preconditions for a noise label system for vehicles and offers an model for a noise label for vehicles. A labelling system is described for (private) cars which relies on the award of points for interior noise, powertrain noise, and tyre noise. The same methodology can be used for other vehicle categories.
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1. Introduction

There is at present no noise label for motor vehicles. However, this may change. The EU 'Regulation on the sound level of motor vehicles' calls on the European Commission to assess labelling conditions for air and noise pollution levels, and, if appropriate, to submit a legislative proposal to the European Parliament and the Council.

A noise label for motor vehicles would enable consumers to take noise production into account in their purchasing decisions. It would also raise consumer awareness of the noise levels produced by, and experienced within, vehicles. Moreover, the label is likely to encourage manufacturers to develop quieter motor vehicles.

This paper explores preconditions for a noise label system for vehicles and offers an initial model for a noise label for vehicles. After establishing a number of basic principles, it will describe a labelling system for (private) cars which relies on the award of points for interior noise, powertrain noise (engine and exhaust system), and tyre noise. An example is given for a fictitious car. The components of a possible labelling system for other vehicle categories are then summarised. The final section presents a number of discussion points.

2. Basic principles and considerations

For a consumer about to purchase a new car, the acoustic aspect of greatest relevance will be interior noise. Exterior noise could also be a part of the purchasing decision, if only as a sort of 'feel-good factor': "Yes, I do drive a car but it is a *quiet* car". It seems likely that consumers will opt for a quiet(er) vehicle when this information is made more readily available. Manufacturers include interior noise (or the lack thereof) as a selling point in their promotional material. Exterior noise is seen as a mandatory side constraint.

For the other vehicle categories, the situation is more obvious for they usually emit more noise. The primary considerations when purchasing a commercial vehicle such as a van or truck are generally price and running costs. Noise is also an important factor, however, especially if the vehicles are to be used in residential areas (e.g. refuse collection vehicles and delivery vans) or to stock shops in city centres. The driver's exposure to noise will also be a consideration, particularly in the case of heavier vehicles such as trucks and buses.

Interior noise is not taken into account in the 'Whole vehicle type approval'. Manufacturers are therefore not obliged to provide this type of information, and neither is there any statutory

limit for interior noise. Yet, manufacturers offer comprehensive information about interior noise. Reviews in journals and magazines also devote attention to interior noise. Assuming that interior noise is an important criterion for the consumer, it should be an essential component of the label.

For society, however, external noise is the main consideration. To meet the requirements for both interior noise and exterior noise, the two types of noise are given equal weight, whereby the label integrates both.

The Regulation on the sound level of vehicles and the 'Regulation on general safety of motor verhicles' are concerned with exterior noise. However, powertrain noise and tyre noise also affect the interior noise level. A simple noise label can rely on the limits and measurement values established by the two EU Regulations. To keep things as simple as possible, the label could be based on a points system which attaches equal importance to interior noise, powertrain noise, and tyre noise. This answers the requirement of giving equal weight to both interior noise and exterior noise in the assessment and resultant information.

Last but not least, it is essential to ensure that a noise label is readily understood by the general public. In marketing terms, it must be KISS-compliant ('Keep It Stupid Simple'). At the same time, it must offer enough information to support a considered choice, which will entail more than merely a colour or letter coding. A vehicle noise label must be kept as simple as possible, which can be achieved by drawing on the two existing EU Regulations and ISO 5128 for interior noise.

3. A possible noise label for vehicles

The principles outlined above are used to develop a model for a noise label. The model is offered as a 'limbering-up exercise' and to encourage further thought. It describes a simple points-based rating system for private cars. A comparable label could be developed for vans, buses, and trucks, which are considered separately in section 3.3., 'Other vehicle categories'.

3.1. Points rating for private cars

Interior noise, powertrain noise, and tyre noise are to receive equally weight in accordance with the stated principles. In this model each of the three types of noise is assigned a score on a five-point scale, whereby the car can achieve an overall rating of up to fifteen points. All three types of noise are scored in parallel, using the same scale. This results in exterior noise and interior noise being given (approximately) equal weight, maintaining simplicity. It would be possible to group private cars into various subcategories as is the practice with the Energy Label for cars. The model for a noise label here is based on the concept of a single noise label for all private cars, regardless of size.

Interior noise increases with speed and the number of revolutions of the engine at which the vehicle is driven. At present, all manufacturers measure interior noise at a 'steady speed' in accordance with ISO standard 5128. A listing of the recorded noise levels for various vehicles is provided by the Auto Decibel Database. A noise label for cars could be based on a measurement at a steady speed of 100 km/h. This is a constant cruising speed in top gear, at which it should be possible to listen to music or engage in conversation. At present, there is no statutory limit for interior noise. The cumulative frequency distribution shown in Figure 1 indicates that almost all passenger vehicles have an interior level of 71 dB or less (for the points scores see Table I).

Table I. Points scores for the noise (in dB) rating of passenger vehicles (category M1).

Type of noise	0 pts	1 pt	2 pts	3 pts	4 pts	5 pts
Interior[a]	≥72	70-71	68-69	67-66	65-64	<64
Powertrain	72	70-71	68-69	66-67	64-65	<64
Tyre	73-74	71-72	69-70	67-68	65-66	<65

[a] If the manufacturer fails to supply the necessary information, the lowest score (0 points) is awarded.

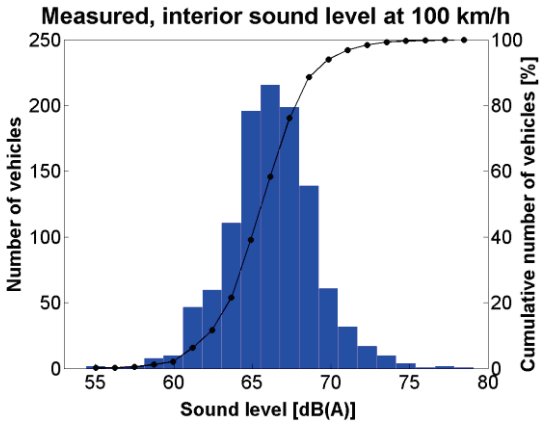

Figure 1. Distribution of measured interior noise levels for passenger vehicles (category M1) at steady speed of 100 km/u.

For powertrain noise, the noise label can use the limits established by the Regulation on the sound level of motor vehicles. For the noise label for cars (category M1), 'Phase 3' limits of the Regulation have been used, which will apply to all new vehicle types produced from 2024 and to all vehicles sold from 2026. The M1 category in the EU Regulation is divided into four sub-categories which have upper limits in the range 68 - 72 dB. The baseline for scoring powertrain noise is then 72 dB. Figure 2 shows the distribution of noise levels of passenger vehicles in the EU. For vehicles in the category M1, the points system for powertrain noise ranges from 72-64 dB (see Table I).

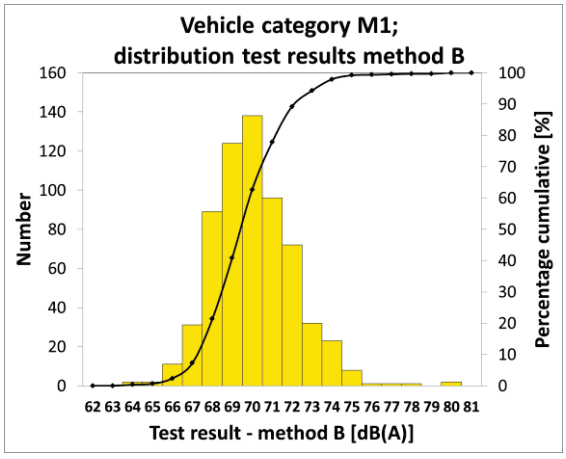

Figure 2. Distribution of test results for vehicles in category M1 (source: EU database).

A score for tyre noise emissions can be awarded on the basis of the limits established by the Regulation on general safety of motor vehicles, Annex II. Passenger vehicles may be fitted with tyres in category 'C1', in which there are five sub-categories, designated A-E with limits from 70 to 74 dB. The majority of C1 tyres currently sold in the Netherlands fall into the 66-72 dB range, see Figure 3. This, suggests that the scoring system could have a baseline of 72 dB (see Table I).

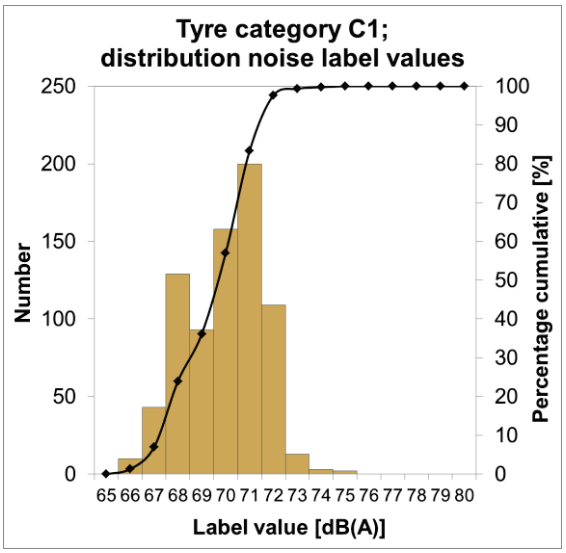

Figure 3. Distribution of noise label values for category C1 tyres sold in the Netherlands in 2013.

3.2. Example for passenger vehicles

Figure 4 shows how the three separate scores for each type of noise: interior, powertrain and tyre, can be integrated to produce a single noise rating and hence a noise label. Figure 5 offers an example of a noise label for a fictitious car.

Noise label	Points total	Description of quality
A	14-15	Excellent
B	12-13	Good
C	10-11	Fair
D	8-9	Satisfactory
E	6-7	Moderate
F	4-5	Bad
G	0-3	Extremely bad

Figure 4. A noise label for passenger vehicles.

Gurka S	**Interior (69 dB)**	**Powertrain (68 dB)**	**Tyre (66 dB)**
Label D Satisfac. 8 pts	Poor[a] 2 pts	Poor[a] 2 pts	Good[a] 4 pts
Remarks: In terms of noise emissions, this model is average for its type and class.	At 100 km/h, the interior noise level is 3 dB above the baseline[b].	The engine and exhaust system produces 4 dB above the baseline[b].	These tyres are quiet tyres, 4 dB lower than the baseline[b].

[a] Score in each sub-category: 5 = Excellent; 4 = Good; 3 = Satisfactory; 2 = Insufficient; 1 = Bad

[b] A difference of -3 dB represents a 50% reduction in the emission of acoustic energy.

Figure 5. Noise label for a fictitious car.

3.3. Other vehicle categories

The Regulation on the sound level of vehicles lists six vehicle categories: passenger cars (M1), minibuses (M2), buses (M3), vans (N1), light-duty trucks (N2), and heavy-duty vehicles (N3). Analogous to the noise label for category M1 vehicles, it should be possible to produce a noise label for each of the other five categories based on the same points system. In this paragraph, the availability of the necessary information is explored relating to each type of noise (interior, powertrain, tyre). In addition, the added value of a noise label for other vehicle categories is considered.

Data on interior noise levels does exist for all vehicles and is in the public domain: manufacturers include it in their promotional materials. However, no database for the other vehicle categories can be found on the internet. In order to arrive at points ratings for these vehicles, it will first be necessary to collect and collate the necessary information.

For interior noise for other vehicle categories, a ‘steady speed’ of 80 km/h seems more appropriate. The interior noise level of these categories at 80 km/h is approximately 65 to 75 dB(A).

For the powertrain noise of other vehicle categories (N2-M3) point scores can also be derived from the emissions limits established by Phase 3 of the Regulation on the sound level of motor vehicles (see Table II). For all categories distribution graphs such as Figure 2 can be used. It should be noted that the distributions are distorted by the small sample size of some vehicle categories, notably minibuses (M2) and light-duty trucks (N2).

Table II. Emission limits and points scores for powertrain noise (dB) for vehicle categories M2-N3

Veh. cat.	**Limits**	**0 pts**	**1 pt**	**2 pts**	**3 pts**	**4 pts**	**5 pts**
M2	69-72	72	71	70	69	68	<68
M3	73-77	77	76	75	74	73	<73
N1	69-71	71	70	69	68	67	<66
N2	74-75	75	74	73	72	71	<71
N3	76-79	79	78	77	76	75	<75

With regard to tyre noise, there is robust information which can be used to design a scoring system (see Table III). Distribution graphs such as Figure 3 have been used for C2 and C3 category tyres sold in the Netherlands in 2013. As in the case of passenger vehicles, the emission limits established by the Regulation on general safety of motor vehicles provide a useful starting point.

Table III. Emission limits for tyre noise (dB) and points scores for a noise label for vehicles in categories M2-N3.

Tyre type	**Limits Reg.**	**0 pts**	**1 p**	**2 p**	**3 p**	**4 p**	**5 pts**
C2	72-73	72-73	71	70	69	68	<68
C3	73-75	73-75	72	71	70	69	<69

There is indeed enough data to support the creation of a noise label for the other vehicle categories. The need for the labels for these categories are even more obvious than for private cars for they emit more noise. A noise label already exists for certain specific types of vehicles, such as concrete mixers, refuse collection vehicles, street cleansing vehicles etc., for the (external) noise they produce

during the work cycle. The limits and rating system which apply are established by European Directive 2000/14/EC. There are also labels for the interior noise of machinery such as excavators. In the Netherlands, trucks, lorries and transport vehicles are covered by the (voluntary) 'QUIETtruck' certification system, also known as the Piek-Keur certificate, the use of which is promoted by means of financial incentives with the objective of reducing environmental noise during the loading and unloading of vehicles during evening and night-time hours. It may therefore be concluded that there is a (public) requirement for information concerning the noise emissions of vehicles.

For buses (category M3) and minibuses (M2), interior noise is clearly an important consideration. At the same time, buses are a significant source of environmental noise, particularly in the built-up area. In the Netherlands, and in many other countries, noise is an important criterion in the tendering and selection process for public transport concessions. A noise label for these two categories will enhance transparency to how noise levels are measured and reported.

Information about noise emissions is of equal importance in the case of commercial vehicles in categories N1, N2, and N3 (vans, light-duty trucks, and heavy-duty trucks). As stated above, some countries have already implemented requirements governing noise production during the loading and unloading of vehicles. Some cities and regions have designated 'environmental zones' in which (stringent) restrictions apply. Vehicles which exceed a certain noise emission level may be excluded from these zones altogether. A noise label will help to identify such vehicles and avoid disputes. Only vehicles with a certain label rating could be allowed to enter the zone.

A final consideration is that most vehicles in the 'other categories' are driven by professionals who spend their entire working day at the wheel. A low (or lower) level of interior noise will enhance health, safety, and job satisfaction.

4. Points for discussion

A noise label fits perfectly within society's desire to have cleaner, quieter and more economical vehicles on the roads. Alongside the 'energy label' which indicates a car's fuel consumption and CO_2 emissions, the noise label will inform the consumer about the benefits of purchasing a quieter vehicle, enticing him or her to do so. No less important is the effect that the label will have on manufacturers. If the noise emissions of a vehicle and its comfort in terms of acoustic quality are given a prominent place in promotional materials and at the point of sale, this can only encourage producers to develop quieter vehicles. After all, no manufacturer wishes to acquire a reputation for producing noisy cars.

The Regulation on the sound level of motor vehicles establishes six main vehicle categories, three for 'the carriage of passengers' (M1-M3) and three for 'the carriage of goods' (N1-N3). The model for noise labelling in this paper is based on there being a total of six labels, one for each main vehicle category. Of course, it would be possible to create separate labels for each sub-category and for each type of tyre. However, the resultant plethora of individual labels will do little to promote transparency or simplicity. Also, a high-performance sports car may then have a 'quieter' label than a family car, because each is only compared against other vehicles in its own sub-category. This is a significant shortcoming of the existing energy label for cars.

The scoring system of the model for a noise label in this paper has been designed in such a way that very few current vehicles would qualify for the highest (i.e. quietest) rating. This is deliberate: it ensures that there is room for improvement. Should noise emissions show a significant decrease in future, it will be easy to adjust the scoring system. It is better to make the label itself dynamic than to add various 'super' ratings such as AA, AAA, A+,

A++ etc., as has been done in the case of the energy label for domestic appliances.

The perception of interior noise is very much dependent on the nature and acoustic quality of that noise, its spectrum, frequency, pitch etc. Nevertheless, the labelling system presented in this paper is based on the noise level (in the sense of volume or intensity) because this is easier to measure and an ISO standard already exists. It also satisfies the KISS principle: 'Keep It Stupid Simple'.

A noise label for vehicles will support consumers' purchasing decisions, allowing them to opt for a quiet (or quieter) vehicle. It will also create opportunities for governments to implement (fiscal) incentives to promote sustainability in the field of transport, perhaps linking the label rating to the rate of road tax payable or the notional value of a company car for the purposes of income tax. At the local level, it will be possible to restrict or grant certain facilities to vehicles with a minimum label rating: access to an environmental zone, reserved parking places, dedicated lanes, or exemptions to the standard loading and unloading periods, for example.

A notable development in recent years has been the desire for quieter zones in the urban area. To ensure that such zones are effective and can be enforced, all vehicles – not only new ones – should have a noise label. The model described in this paper can be readily applied to vehicles which are already on the roads, perhaps as part of the annual inspection. Moreover, the standard inspection should be expanded to include the re-assessment of noise emissions. It is possible that new tyres or a new exhaust have been fitted since the noise label was issued, whereupon the rating may no longer be accurate.

The application of the labelling system to existing vehicles, together with the necessary regulation and enforcement measures, will be a useful supplement to the statutory limits which apply to new vehicles and new tyres.

The noise label presented in this paper integrates both interior noise and the exterior, environmental noise produced by the tyres and the powertrain (engine and exhaust system). It is, however, based on the assumption that consumers will attach importance to interior noise. A label that is concerned solely with environmental aspects probably will take no account of interior noise whatsoever. The Global New Car Assessment Programme (GNCAP) and the Global Fuel Economy Initiative (GFEI) recently announced the intention of developing a system to assess and quantify the environmental performance of cars: GreenNCAP. It seems appropriate for the GreenNCAP assessment to include both components of exterior noise: powertrain noise and tyre noise. The approach presented in this paper may prove a useful model.

Last but not least, consideration must be given to whether vehicle noise labels should be introduced first or whether it would make more sense to move towards an integrated environmental label straightaway. After all, a noise label for vehicles will be an adjunct to the existing energy label and the label for tyres. Integration does not necessarily mean an improvement. An integrated label may be so general that it provides little or no useful information at all. Or it might be difficult and cumbersome to find out the information behind such a general integrated label. The development of an effective noise label for vehicles could be overshadowed and subsumed by the introduction of an integrated label. For this reason, it seems advisable to gain some experience with a vehicle noise label as such, and only later pursue integration if necessary and appropriate. That said, it may be preferable to present the environmental information of the three labels (energy, noise, and tyres) as a combined 'Environmental Information Package'.

References

This paper is an extended summary. The full paper can be accessed through: http://www.unece.org/trans/main/wp29/wp29wgs/wp29grb/grbinf61.html, informal document GRB-61-01.