2011-03-11

To: European Commission Vice-President Antonio Tajani, DG Enterprise and Industry

Re.: Expert support for stricter vehicle noise emissions standards

Dear Vice-President Tajani,

As independent experts on noise, from the fields of health and vehicle technologies respectively, we write to support an ambitious Commission proposal for stringent standards to reduce road traffic noise throughout Europe.

After a long period of very little progress in reducing road traffic noise, during which the health burden has increased, we support the initiative to tighten the European standards for vehicle noise emissions. An effective regulation will reduce the severe health impacts and the associated costs of road noise, but only if appropriately stringent limit values are set.

Road traffic noise contributes substantially to the burden of disease in the EU. The World Health Organisation's Night Noise Guidelines (2009) confirm that nighttime noise levels above 55decibels (dB) are "increasingly dangerous for public health" and cause adverse health effects.[i] The noise maps for agglomerations and transport infrastructures made available by the Environmental Noise Directive provide data illustrating the extent of public exposure to noise. Exposure data is now available from the EEA's NOISE database, supported by the Expert Panel on Noise (EpoN), which has also published a Good Practice Guide summarizing the state-of-the-art knowledge on noise exposure and potential health effects.[ii] A comprehensive Danish study published this year has indicated the severity of the health burden of traffic noise.[iii] Furthermore, a report on the European Perspective on Environmental Burden of Disease covers the health effects of noise in detail.[iv]

With this – mostly new or updated – knowledge of EU-wide exposure to traffic noise, the health impacts and associated costs, better estimates of the benefits of noise reduction measures can be made than was possible 10 years ago.

In addition to benefits associated with health there are additional benefits associative with productivity and impacts on the ecosystem which although presently difficult to quantify are nevertheless recognized as important factors when assessing cost benefits from noise reduction.[v] [vi]

We are concerned that the report "Monitoring procedure in the vehicle noise regulation" (2010) commissioned by the European Automobile Manufacturers' Association (ACEA) does not reflect the relevant up-to-date information on the health benefits of traffic noise reduction.[vii] The purpose of the report is to carry out a cost-benefit analysis of standards to reduce noise produced by motor vehicles. This is in itself a commendable action, and has been carried out at a technically advanced level, as one may expect from an organisation with such a public interest and impact. However, the choices that have been made in the analysis lead to an underestimation of the benefits, and a systematic exaggeration of the costs. The ACEA report argues that measures to reduce car fleet noise emissions by just 3dB would barely be cost-effective. We strongly disagree with this conclusion.

We therefore write to you, Vice-President, to recognise the underestimation of benefits and the overestimation of costs presented in the ACEA report and to ensure that state-of-the-art knowledge on health benefits of noise reduction is properly taken into account and reflected by an ambitious proposal in the coming weeks.

Underestimation of benefits, especially health benefits

The protection of health and wellbeing is the primary motivation for improving vehicle noise standards. It is therefore regrettable that the report for ACEA does not take the severe health effects of traffic noise and the benefits of noise reduction properly into account.

The general approach taken in the report for ACEA for calculating the benefits of noise reduction is narrow, with every possibility taken to play down the value of the benefits. For example, a meagre 2.8 dB reduction in L_{den} (the noise exposure over a 24hour period) is found in the report for ACEA to raise an EU-wide benefit of €52billion, outstripped by costs of €112billion over 20 years. We take this opportunity to explain why this is not accurate:

(a) Health effects are not included in the benefit calculations. These are commonly evaluated in terms of Disability-Affected Life Years (DALYs) and taking effects of nighttime noise reduction into account. The inclusion of up-to-date knowledge on health effects would lead to a more accurate evaluation of benefits. State-of-the-art data included in a forthcoming WHO report on Environmental Burden of Disease clearly show the connection between road traffic noise and cardio-vascular diseases, for example.[viii]

(b) The evaluation only takes willingness-to-pay (WTP) studies into account. The figure used comes from an EU-WTP value based on 2001 prices (€25 per decibel per household per year) which is seen as very conservative as severe health effects are not included. The flat-rate per decibel fails to take into account that each decibel reduction in a noise hotspot has a much higher value. More recent hedonic pricing studies a bandwidth for a loss of property values between 0.2-1.5% per decibel for L_{den} over 50-55dB, with the best-estimate at 0.5%.[ix]

(c) Benefit estimates are very sensitive to the choice of threshold for onset of health effects. Standard practice and the EU-WTP-value uses a threshold value of $L_{den:}$ 50-55dB. However the report for ACEA has chosen a higher threshold of 55dB. While exposure data between 50-55dB is more difficult to obtain from EU-data, extrapolations from other data could be used.[x]

With reference to these points, the report for ACEA recognizes that an alternative method, as used by the UK government, is available for benefit calculation based on the relationship between noise and house prices:[xi] "*If one had applied the UK method for benefit calculation as described in the Transport Analysis Guidance (…), the* ***benefit would be roughly twice as high*** *as described here*." (p.20) However, this important admission is not adequately reflected in the report's conclusions.

(d) As the cost-benefit calculations span over a long time period, the WTP figure should at least be corrected for inflation. As the figure was established in 2001, it should already be corrected to be around €30/dB/household/year.

(e) Referring to the WHO Night Noise Guidelines and the EEA NOISE database a benefit estimation of nighttime noise reduction can be made (including part of WTP): assuming an effective linear noise reduction reaching 3dB by 2030, our calculation of benefits comes to €38-230billion over the period. (See appendix 1)

In conclusion: the benefits are underestimated by at least a factor of 2, and up to a factor of 4 when the latest health research, exposure data and valuation techniques are taken into account.

Overestimation of costs to manufacturers

Production costs and investment costs should be examined separately. The production costs found in the report for ACEA are similar to those quoted in a report for the European Commission by TNO[xii], and in accordance with previous reports, at around €20 per decibel per vehicle reduction for M1 vehicles.[xiii]

In contrast, estimates of investment (mainly R&D) costs vary widely. It can be concluded from the report for ACEA that a 3dB noise effective reduction of the limit values for M1 vehicles is estimated cost €26million for each vehicle type, whilst a 4dB reduction would cost €59million. (See appendix 2) There are several reasons why this estimate is not realistic:

a) Many of the noise reduction measures listed (Appendix D, table D5) have already been applied for several decades. Although it can be accepted that some of these common measures need some adaptation, attributing all or main part of the costs to future cars is a severe overestimate.
b) The attribution of R&D costs over a 20 year period appears unjustified. This accounts for at least 50% of the total costs. R&D costs will occur in the short-medium term only, once the stringency of the regulation and deadlines for implementation are apparent.
c) There is no technological barrier to quiet vehicles, witnessed by the fact that substantially quieter vehicles are already available throughout the price and product range (including sports and luxury models, family cars and budget models). No correlation is found between noise emissions and power, or between noise emissions and price. There are already many models on the market which are 3-4dB below the current noise limits, so it seems unfeasible that R&D costs would be so high. Please see appendix 3 (figure 2) which illustrates that half of M1 vehicles are 3dB or more quieter than the current equivalent limit values.
d) In a cost-benefit analysis, the costs to be used are the costs to society. The study "Review and analysis of the reduction potential and cost of technological and other measures to reduce CO2-emissions from passenger cars" (2006) has a thorough literature review and analysis regarding the factor by which to multiply increased production costs to estimate societal costs.[xiv] Whereas the study concludes a factor of 1.16 for additional costs is appropriate, in relation to CO2 abatement costs, the report for ACEA has used a facor 1.7 (page 25). There is no indication that a higher figure should be used in relation to noise abatement.

Importance of improved noise standards for heavy vehicles

For the health and wellbeing of the European citizen in the coming decades, significant noise reduction of heavy vehicles is absolutely essential. Development in traffic and vehicle compositions over the latest decade, as well as the anticipated time trend has made noise emission from heavy duty vehicles (HDV) increasingly important in relation to that of light vehicles. This is because HDV traffic has increased much faster than light vehicle traffic. Furthermore, although some HDV may shift to hybrid or electric, the trend will most likely be faster among the light vehicles. Importantly, the new tyre noise limits (Regulation 661/2009) are much less stringent for heavy vehicle tyres than for light vehicle tyres and will enter into force much later, in combination with the fact that approx. half of the heavy vehicle tyres (retreaded tyres) are not subject to any noise limits. Therefore, special attention must be paid to reducing HDV noise emissions. The ambition level for reducing HDV noise should be higher than for light vehicles, to achieve significant overall traffic noise reduction.

We believe that strict standards will achieve significant results. In 1989, Austria introduced a nighttime driving ban for heavy duty commercial transit traffic, unless the vehicles complied with a noise level 4 dB(A) lower than the EU limit of 84 dB coming into force about the same time. There were strong objections that the noise reduction would be almost impossible, or at least extremely expensive, to achieve. However, two truck manufacturers offered compliant vehicles almost immediately. By the early 1990s, many, if not most, of the heavy trucks travelling in central Europe met the 80 dB limit, well ahead of the 1996 deadline for the EU-wide limit value of 80dB.[xv]

Noise control technology has advanced substantially in the past 20 years. For example, in order to meet the noise limits which entered into force in 1996, encapsulation was commonly used, but technological progress quickly rendered this unnecessary. There is therefore important scope to redeploy encapsulation to significantly reduce noise emissions from HGVs in the short-medium term.

In addition to the maximum limits, it is important to promote the development of quiet city buses and quiet vehicles for urban services during the night. We therefore suggest that in addition to the maximum limits, requirements are introduced for "quiet heavy vehicles" to which customers (e. g. city administrations and public bus companies) could refer in procurement requirements. Hybrid and electric vehicles that meet such purposes are already becoming available. This could initiate a "buy quiet" development.

Issues for future consideration

Motorcycle noise is not to be included in the forthcoming proposal. However, we want to emphasize that noise from motorcycles is a growing environmental concern.[xvi] With the planned noise-reducing measures for cars, buses and trucks in Europe, motorcycle noise will be even more prominent. It is absolutely necessary to also tackle the noise emissions of these vehicles, and in particular to improve enforcement as a significant proportion of two wheelers are found to be louder than permitted due to tampering.

A minor problem in the past which could become more serious in the future, is related to low frequency noise (referred to here as 16-125 Hz). There is a tendency that noise emission from heavy power units shifts to lower frequencies. The noise limits as they are set in A-weighted sound levels expressed in decibels (commonly indicated as dB(A)), do not take the low frequency problems sufficiently into account. Barriers, windows, etc, attenuate the high frequencies much more effectively than the low frequencies. The low frequencies do not significantly influence the A-weighted levels in the certification measurements but may dominate the noise on the reception side; especially indoors. One simple way to correct this problem would be to set limit values with both A- and C-weighting. This would promote technical measures on the vehicles of importance for the environment but which are not motivated to comply with certification limits set in A-weighted dB only. The industry should be positive to this since these low frequencies may create drowsiness of drivers.[xvii]

Conclusions

We the undersigned are convinced, on the basis of scientific evidence, that the monetary benefits of quieter traffic by far outweigh the costs of quieter cars to society. This is already proven by market availability of cars that would satisfy even the most stringent future demands. If all vehicles would meet the level of today's best current technologies available, the environmental noise problem caused by road traffic would be greatly reduced. The technology for quieter vehicles is sufficiently well known to set substantially stricter noise limits.

Vehicle noise emissions limits have remained unchanged since 1992, with the result that the noise burden on Europeans has continued to increase. Vehicle manufacturers have regrettably not been encouraged by regulation to reduce noise, and we strongly support the Commission's initiative to finally take action with several steps of increasingly stringent limit values to be introduced over the coming years.

We the undersigned request the EU Commission, Council and Parliament to take the above into consideration when making proposals to revise the legislation on vehicle noise emissions.

The coordinators of this letter are open to answer any questions in this regard, including the appendices and would welcome an opportunity to provide further inputs in support of this proposal.

Sincerely,

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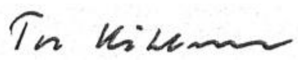
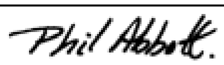
Prof. Tor Kihlman (coordinator)	Prof. em. Applied Acoustics, Chalmers University of Technology, Sweden; Chair, CAETS Noise Control Technology Committee; Board member, International Institute of Noise Control Engineering (I-INCE); Former member EU Working group Health and Socio-economic assessment	tor.kihlman@chalmers.se 
Philip Abbott	Technical Director Acoustics, AECOM	
Dr. Wolfgang Babisch	Temporary advisor to the WHO on health effects of noise; International Commission on the Biological Effects of Noise (ICBEN), Member of Team 3 (Non-auditory Health Effects)	
Prof. Em. Birgitta Berglund	Institute of Environmental Medicine, Karolinska Iinstitute, Department of Psychology, Stockholm University; Temporary advisor to WHO; Author, editor WHO Guidelines for Community Noise; EU Noise Steering Group, chair of Dose/Effect WG; CEC Steering Committee on Urban Air, Indoor Environment and Human Exposure; President, International Commission on Biological Effects of Noise	

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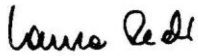
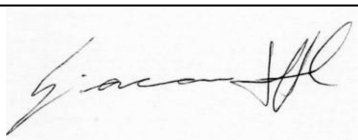
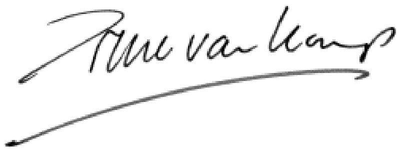
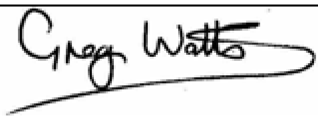
Michael Jäcker Cüppers	Consultant, formerly of German Federal Environment Agency
William W. Lang	Secretary, CAETS Noise Control Technology Committee; Vice-President I-INCE; Noise Control Foundation, USA
Prof Peter Lercher, M.D. M.P.H.	Interim Director, Division of Social Medicine, Medical University Innsbruck
Alain Muzet, MD	Former Research Director, CNRS, France; Former chairman, ICBEN; Former temporary advisor to WHO; Former member of the French Control Authority on Airport Noise Annoyance; Acting chair of the Working Group on Noise and Health Indicators, French Agency for Food, Environmental, Occupational Health and Safety
Prof. José Manuel Palma-Oliveira	Professor of Environmental Psychology, University of Lisbon; Expert, Health and Socio-economic WG on END; Representative on Portuguese noise steering group
Marco Paviotti	Former member, EC WG Assessment of Exposure to Noise (WG-AEN); Former member, EC Expert Panel on Noise (EpON); Member of the CNOSSOS-EU drafting team

Dr. Laura Reali	Primary Care Pediatrician, Pediatric Cultural Association Education and Research secretary; Member of “Pediatri per un mondo possibile”	
Dr. Eng. Ulf Sandberg	Senior Research Scientist, Swedish National Road and Transport Research Institute (VTI); 2002-2008 Adj Prof in Tyre/Road Noise at Chalmers University of Technology	
Dr. Dietrich Schwela	Senior Research Associate, Stockholm Environment Institute, University of York; Co-chair, ICBEN Team 9; Former staff member of WHO.	
Prof. Stephen Stansfeld	Professor of Psychiatry; Chair, ICBEN; Coordinator, European Network on Noise and Health (ENNAH); Temporary advisor to WHO	
Dr. Giacomo Toffol	Primary Care Pediatrician; National expert to “Pediatri per un mondo possibile” Pediatric Cultural Association	
Dr. Irene van Kamp	National Institute of Public Health and Environment, the Netherlands; Temporary advisor to WHO; ICBEN – International Commission on Biological Effects of Noise; Member of European Association for Public Health	
Prof. Greg Watts	Professor of Transportation Noise Bradford Centre for Sustainability Environments, School of Engineering, Design and Technology, University of Bradford	

<u>Appendix 1:</u> Benefit estimates of exposure to night time road traffic noise

Martin van den Berg

Introduction

The Good Practice Guide on health effects (EPoN) offers the necessary instruments to calculate Disability Adjusted Life Years. The first requirement is the dose-response relation for sleep disturbance (section 3.2.1) and the second the disability weight (0.07; table 4.3).

In order to calculate the number of DALY's for the EU population, the number of exposed inhabitants to a certain noise level is needed.

Exposure

The EU noise mapping exercise was intended to produce the required overview of exposure. The EEA made the reported levels available via the NOISE- database.

For road traffic noise 2 data sets are available:

- Road traffic noise exposure in agglomerations>250.000 inhabitants
- Exposure to road traffic noise to motorways with more than 6 million vehicles/year.

The total numbers (June 2010 dataset) are:

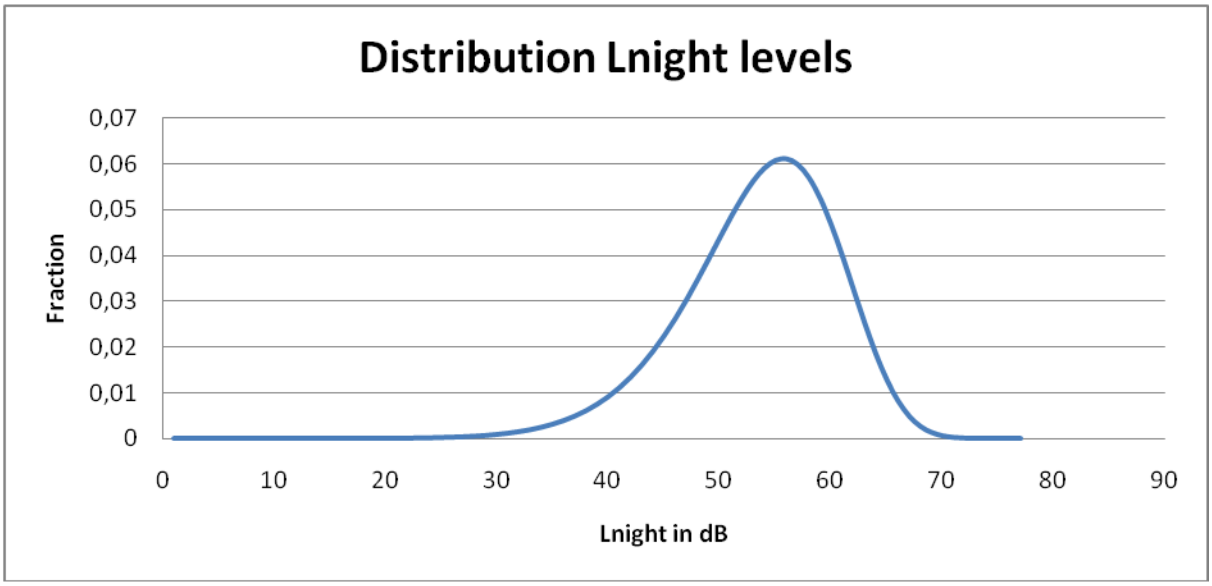
Table 1. Exposure data from NOISE-database

Lnight(dB)	Exposed inhabitants in agglomerations and along major roads
50-54	33.160.300
55-59	18.397.400
60-64	9.267.500
65-69	2.999.600
>70	1.965.500
Total	65.790.300

These are partial data, referring to only 17% of the population (in agglomerations) or a minor part of the road network (<5%) outside agglomerations. Extrapolating the data is not straightforward, as the collected data can be assumed to represent a higher than average noise polluted part. Comparing the partial data with data from countries where nationwide inventories are available (Austria, Netherlands) suggest that the burden is at least a factor 2 higher.

Furthermore, the night noise effects start to increase from a level of 40 dB, whereas the EU-mapping is limited to levels of over 50 dB. An estimate of the exposure at lower levels can be obtained by assuming a Weibull distribution, and calculating the missing data from the Weibull function.

Optimising the 2 parameters that fix the distribution to be 9.3 and 54.6, the following distribution results:



Applying this distribution to the EU-population of 501 million[1] (Eurostat, 2009),.

Lnight(dB)	Exposed inhabitants in agglomerations and along major roads	
40-44	44.687.162	9,4%
45-49	92.645.691	19,5%
50-54	142.062.891	29,9%
55-59	133.631.352	28,1%
60-64	56.235.502	11,8%
65-69	6.526.095	1,4%
>70	96.564	0,0%
	475.885.258	

This compared reasonably well with nationwide estimates and is the basis to calculate the benefits.

Daly

[1] Strictly spoken the age-group <16 should be excluded. Because children are marked as vulnerable group for night noise, they are included as well.

According to the Night noise guidelines NNG), the percentage Highly sleep disturbed can be assessed using the dose-effect relation established in the EU-position paper on night time noise:

%HSD=20,8-1,05*Lnight+0,01486*Lnight^2 for Lnight>40

Applying this to the weibull distribution, the number of Highly Sleep Disturbed is 38 million people.

The NNG defines a DALY weight of 0,07 for severe sleep disturbance due to noise.

Multiplying this factor by the number of people with high sleep disturbance results in a yearly loss of healthy life years.

According to the noise mapping data now established by EEA, this would result in 431.165 healthy life years lost. Using the extrapolated data (therefore including also exposed between 40 and 50 Lnight and all those not yet "mapped"), the resulting loss is 2.7 million.

Health Cost

The recommended Value of a healthy life year (VOLY) by NEEDS (New Energy Externalities Developments for Sustainability, 2007), using a contingency valuation study to assess the VOLY in 9 different European countries, is to use €40,000 per VOLY with a confidence intervals of €25,000 and €100,000.

Using this figure the cost of night time exposure – therefore the potential benefit- to night noise is a minimum of 17 G€/year, up to 108.7 G€/year if all exposed are considered.

Effect of source reduction

Lowering the source levels reduces this cost, but may also run into costs. Assuming that effective source levels are lowered by 3 dB in 20 years time, the benefits would be 33.6 G€ for the NOISE-assessment, up to 230 G€ for the extrapolated data.

Appendix 2: Separation of production costs and investment costs in the UTAC-TÜV Nord report for ACEA

A separation of the costs can be effected from the data in Figures D 8 and D 9 in the report. These two figures are reproduced below:

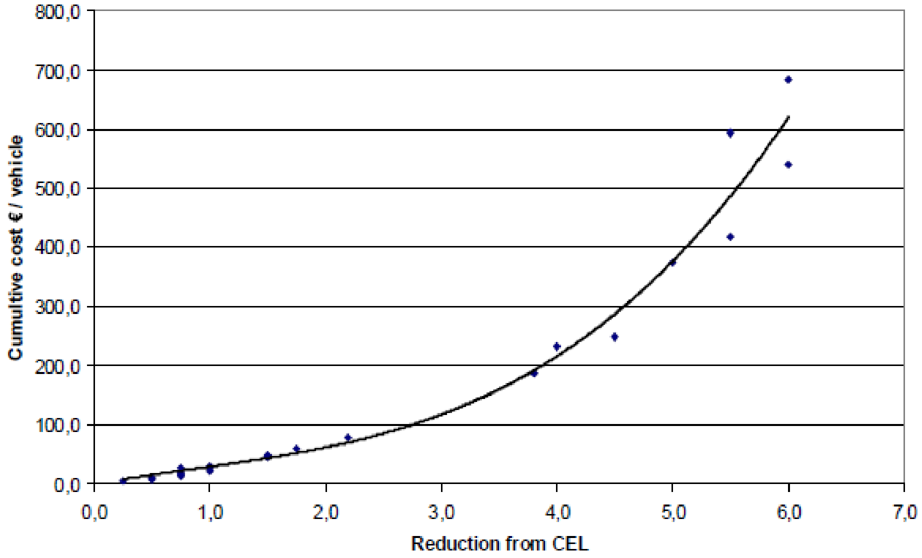


Figure D 8: Cumulative cost with reduction from CEL (M1 ,N1 and M2-A)

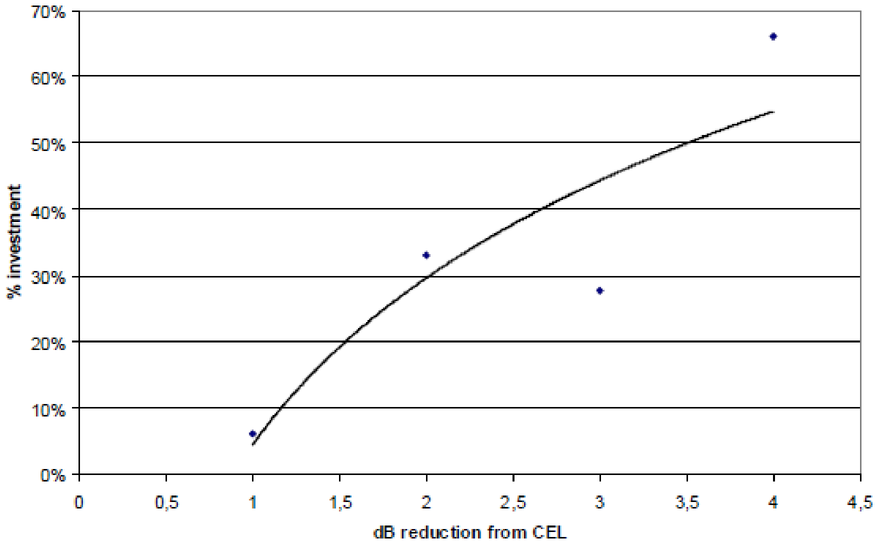


Figure D 9: Percentage of investment costs

By reading off values from these two figures, the following table is readily obtained:

	Noise reduction						
	1dB	2dB	3dB	4dB	5dB	6dB	
Total cost per vehicle € (from figure D8)	29,0	60,4	118,4	216,0	373,4	613,2	
% investment cost (from figure D9)	4,2	29,7	44,3	54,7	62,0	68,0	For 5 dB and 6 dB the % are estimated by rough extension of fig D9
Investment cost €	**1,2**	**17,9**	**52,5**	**118,2**	**231,5**	**417,0**	
Production cost €	**27,8**	**42,5**	**65,9**	**97,8**	**141,9**	**196,2**	
Production cost € per dB	**27,8**	**21,2**	**22,0**	**24,5**	**28,4**	**32,7**	

It is clear from this separation of costs that the contribution from the investment costs to the total cost per vehicle is very high.

It is of interest to calculate the total investment costs per vehicle type. The following information is given on page 100 of the ACEA report:

> Costs for investments are counted by car line and distributed on all vehicles produced: 100 000 vehicles sells / years over 5 years.

The investment costs per vehicle in the table above can accordingly be multiplied by 500 000 in order to obtain the investment costs per vehicle type:

	Noise reduction					
	1 dB	**2 dB**	**3 dB**	**4 dB**	**5 dB**	**6 dB**
Investment costs per vehicle type	**0.6 M€**	**9 M€**	**26 M€**	**59 M€**	**116 M€**	**208 M€**

From other information given in the report, it seems that these costs mainly relate to research and development costs. The estimates are very much higher than the estimates given in the TNO report.

<u>Appendix 3:</u> Analysis of type-approval and manufacturer data

1. Distribution of Type Approval Noise Limits in the EU

A large percentage of the vehicles manufactured today easily meet the type approval noise limits.

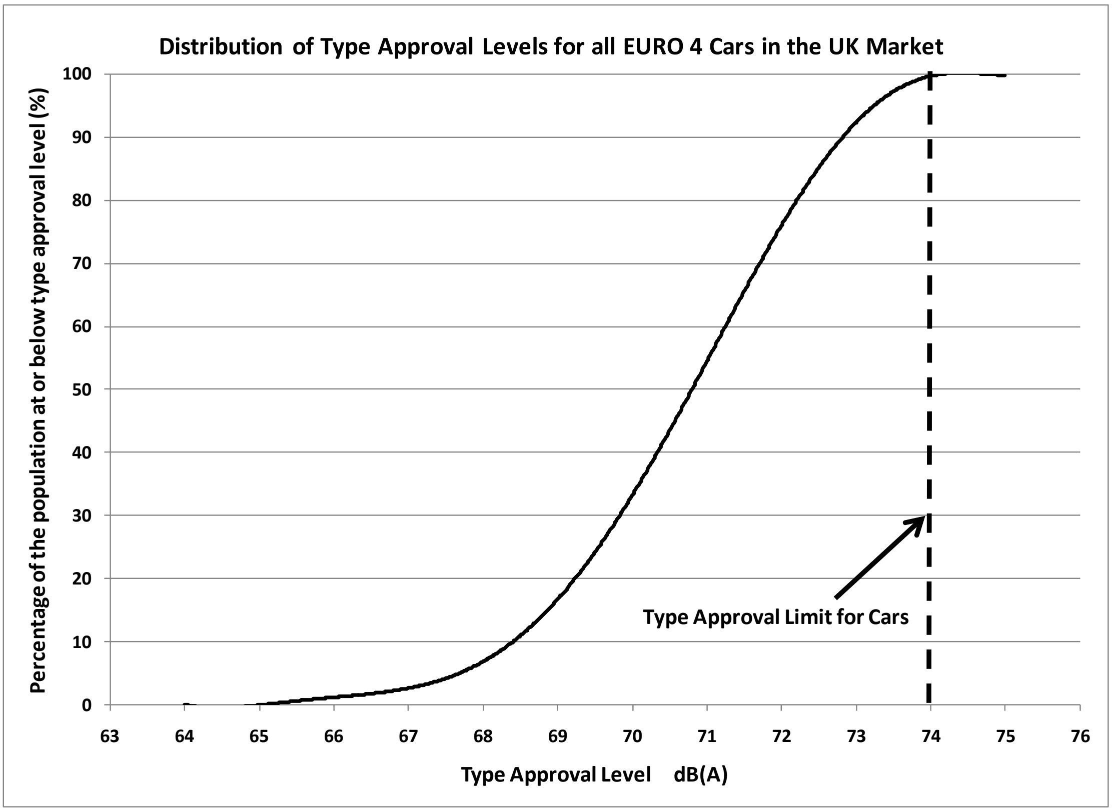


Figure 1: Distribution of Type Approval Levels for all EURO 4 Cars in the UK Market[1]

[1]Source: Vehicle Certification Agency: www.vcacarfueldata,org.uk/downloads/may/2010.asp

Figure 1 shows the distribution of type approval noise levels for all EURO 4 vehicles that were on the UK market in 2010. The range in type approval levels range from about 65 to 74 dB(A) with nearly 50% of the market having type approval noise limits at 3 dB(A) or more below the type approval noise limit.

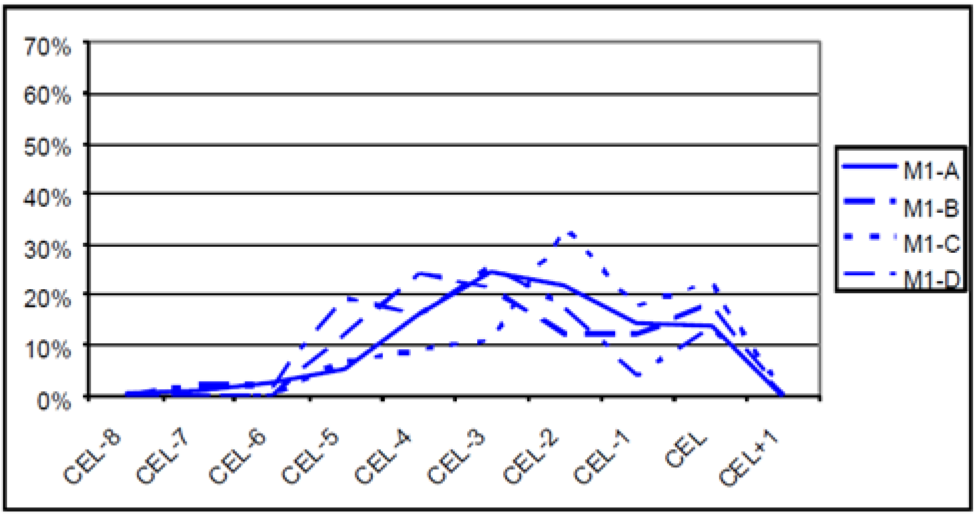


Figure 2. Noise distribution for M1 cars (in total 591) according to current equivalent limit CEL, diagram from UTAC-TÜV report for ACEA report, table E1 (page 112).

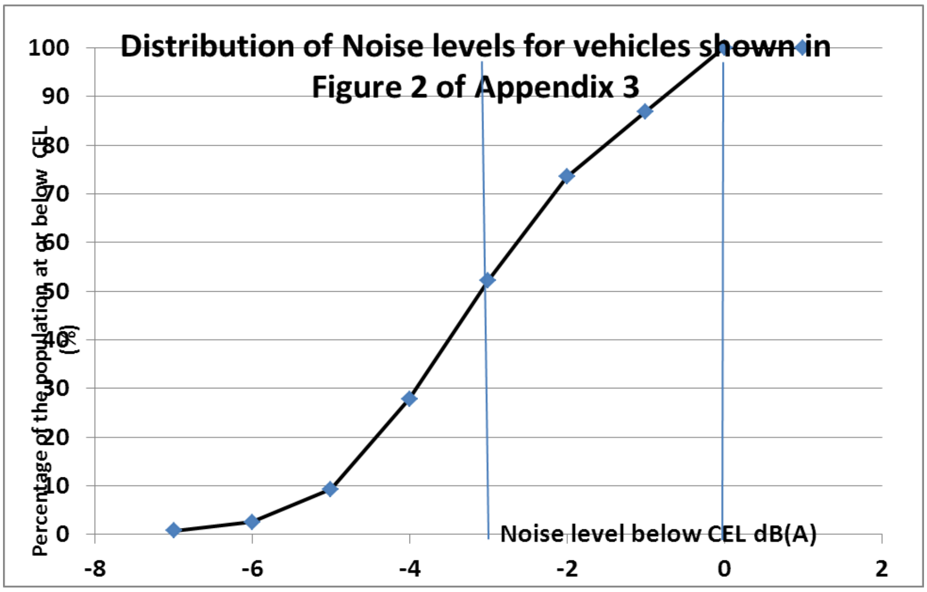


Figure 3 Comparison Figures 1 and 2 The data set from ACEA confirms the findings of Figure 1 that approx. 50% of the dataset is 3dB or more below CEL values.

2. Comparison of vehicle noise levels from different manufacturing regions

Table 1 Comparison of Noise Levels for Cars with Automatic Transmission[1]

Statistic	METHOD A			METHOD B		
	EU	JAPAN	USA	EU	JAPAN	USA
Sample	15	19	12	15	19	12
Mean	72.8 (+1.5)[2]	71.3	75.1 (+3.8)	70.5 (+0.7)	69.8	71.7 (+1.9)
St. Dev.	1.72	1.33	1.62	1.65	1.16	0.89

[1]Data Source: ACEA Database M1 Vehicles 2004.

[2] Values in brackets indicate the difference in mean noise levels compared with Japan.

Table 1 compares noise levels obtained from Method A and Method B for all cars in the ACEA Database with automatic transmissions. This was the only vehicle type found in the database which had sufficiently large samples from each area to carry out statistical analysis.

Comparing the noise levels from each manufactured region, the results show that for both Method A and B, the mean levels for Japan are lower than compared with the EU and USA.

Under Method A, cars with automatic transmissions from Japan are on average 1.5 and 3.8 dB(A) lower than their counterparts from the EU and USA, respectively.

Similarly, under Method B, cars with automatic transmissions from Japan are on average 0.7 and 1.9 dB(A) lower than their counterparts from the EU and USA, respectively.

To show whether these differences are likely to be real differences rather than occurring by chance a statistical analysis comparing the means (Student-t Test) provided the following results:

Method A: Cars with automatic transmission from Japan, noise significantly lower than similar vehicles from EU ($p > 0.01$) and USA ($p > 0.001$)

Method B: Cars with automatic transmission from Japan, noise significantly lower than similar vehicles from USA ($p > 0.001$) but were not found to be significantly lower than EU vehicles.

The values of p shown in the brackets indicate the probability of the result being correct for the whole population, eg when $p = 0.01$ there is a 99% probability that the result is correct and when $p = 0.001$ a 99.9% probability).

References

[i] WHO (2009) *Night noise guidelines*, Bonn.

[ii] EEA (2010) *Good practice guide on noise exposure and potential health effects*, Technical report No 11/2010, Copenhagen.

[iii] Sørensen, M., et al (2011) *Road traffic noise and stroke: a prospective cohort study*, European Heart Journal Advance Access, published January 25, 2011.

[iv] Hänninen and Knol (eds) (2011) *European Perspective on Environmental Burden of Disease*, National Institute for Health and Welfare, Helsinki.

[v] DEFRA (2008). *An Economic Valuation of Noise Pollution – developing a tool for policy appraisal.* First report of the Interdepatmnental Group on Costs and Benefits, Noise Subyect Group. http://www.defra.gov.uk/environment/quality/noise/igcb/documents/igcb-first-report.pdf

[vi] DEFRA (2010). *Noise & Health – Valuing the Human Health Impacts of Environmental Noise Exposure.* A Response by The Interdepartmental Group on Costs and Benefits Noise Subject Group (IGCB(N)). www.defra.gov.uk/environment/quality/noise/igcb/documents/igcn-noise-health-response100707.pdf

[vii] UTAC and TÜV Nord (2010) *Monitoring procedure in the vehicle noise regulation,* Final report, prepared for ACEA.

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