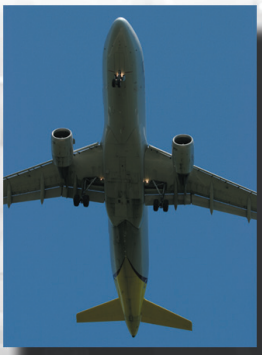

Striving against Traffic Noise

How Powered Two-Wheelers can contribute

acem

STRIVING AGAINST TRAFFIC NOISE

striving against traffic noise

INTRODUCTION

Nowadays traffic noise is often identified as one of the main sources of noise pollution. In fact a lot of technical improvements have been made over recent years, but these innovations have also been successively overtaken by the permanent growth of public traffic. This can be simply explained by the increase in the number of all motor vehicles and the extension of the road and rail network. Also the expansion of air transport, local and freight traffic contribute to the growing noise pollution. Today sustained economic development and traffic growth are intimately linked. Mobility is the key issue of our modern society and we have to face the fact that it causes a variety of noise sources.

Although powered two-wheelers (PTWs) are an economical means of transport their share in overall surface transport in Western Europe is only about 3%. However, noise made by PTWs excites interest and often emotional reactions and the noise discussion arouses conflicting positions amongst PTW users and non-users. Sound can rekindle pleasant memories of a past youth, represent a part of a current self-image, or simply be an everyday irritation or just a political headache.

This brochure deals with the field of noise exposure and all kind of means to reduce the noise from PTWs. It aims to fill the information gap and to dispel prejudice.

In fact PTWs in original condition and in everyday use are not loud although they do have a higher dynamic potential in terms of acoustics. So riders' behaviour has an important influence on noise pollution.

In the present parc of PTWs in Europe about 35 % of motorcycles and 65% of mopeds are equipped with illegal exhaust systems. The presence of so many illegal systems is responsible for high average noise pollution and for the noisy image of PTWs.

The usual way in which environmental policy addresses the noise reduction discussion is to decrease the limit values for new motor vehicles. In the case of PTWs this strategy will have a very limited effect in the real world. The greatest and swiftest improvement in the environment would come from a radical reduction in the high percentage of illegal exhaust systems currently in use.

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BASICS ABOUT NOISE

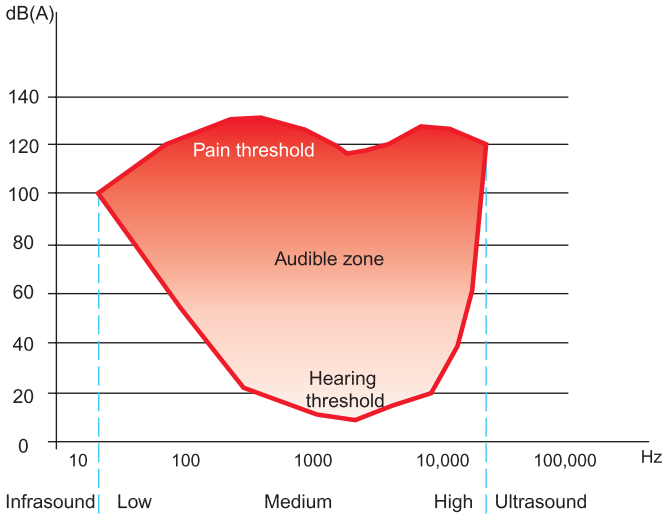
basics about noise

FROM SOUND TO NOISE

Physically speaking, noise is a composite set of sounds. In our everyday lives, it is an unwelcome sound or set of sounds that causes discomfort. Although the perception of sound varies according to multiple factors, its volume is the single factor that most often trips hearing from the bearable to the unbearable.

Discomfort also stems from the sound's duration. A short sound does not have the same impact on an individual as a succession of sounds or a prolonged single sound. Auditory and nervous fatigue is greater in cases of prolonged exposure, as in the case of a construction worker who has to put up with the ceaseless noise of a pneumatic drill, or a motorist subjected to the noise in the passenger compartment throughout a long journey.

The change from pleasure to discomfort also stems from repetition. An insignificant or even a pleasant sound can become excruciating if it is repeated often enough. Then again, the perception of noise can depend on individual tolerance levels. The sound impulses we generate ourselves seem less of a nuisance than those generated by others. We are also more indulgent when it comes to a "friendly" sound or noise – to music, for example, if you happen to be a musician yourself.



Lastly, the physical or psychological state of the hearer influences their perception of noise. A previously unnoticed sound can, in certain circumstances, become a source of severe irritation. A bird's warbling, which is quite romantic in a charming rural setting, can be unbearable if it causes you to wake up unexpectedly early.

HOW IS NOISE MEASURED?

A sound is nothing other than a fast change in pressure, which moves through the air as a sound wave and causes the human ear drum to vibrate. We perceive these vibrations as sound. Our perception depends on the strength of the sound wave and the speed of the vibration, i.e. its frequency:
– The higher the pressure, the louder the sound.
– The higher the frequency, the higher the sound.

Pressure is measured in bar. As, however, the sound pressure relevant for humans ranges from 0.0002 microbar (hearing threshold) to 200 microbar (pain threshold) and due to the fact that these kinds of numbers are extremely complicated to deal with, the sound pressure is converted into decibels (dB) and one talks about the sound pressure level:

- hearing threshold: about 0 dB(A)
- pain threshold: about 120 dB(A)

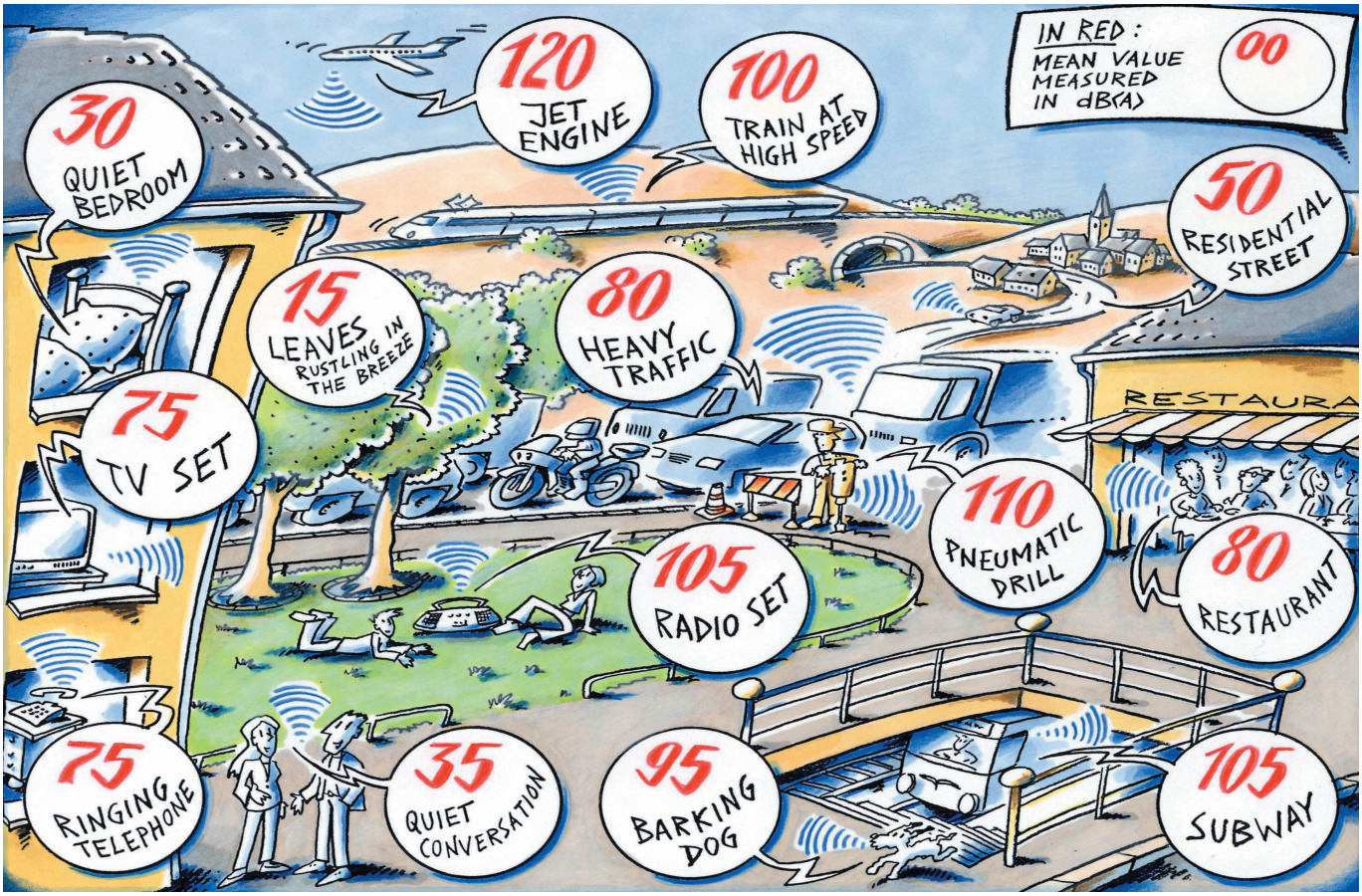
In order to understand the auxiliary quantity decibel, it must be clear that it is a logarithmic measurement. ***This means that the sound pressure does not increase in a linear fashion with the decibel value, but that, for example, an increase of 10 dB(A) in the sound pressure level is equal to a 200 % increase in the sound pressure - humans perceive this increase as a sound twice as loud as before.***

At the same sound pressure, humans perceive low and high-pitched sounds less loudly than medium-pitched sounds. In order to reproduce human hearing as accurately as possible, the sound pressure values measured are therefore corrected using the so-called A-filter, depending on the frequency. The sound pressure level is then expressed in dB(A).

COMPARISON OF NOISE SOURCES

comparison of noise sources

NOISE AND ITS KEY FIGURES



From leaves rustling in the breeze to the shriek of a jet engine, and from all those everyday noises such as conversation and phone ringing to neighbourhood noises like barking dogs or transport noise, here is an inventory of many of the sounds and noises in our everyday environment.

In this respect, road traffic noise plays more of a minor role with regard to the measurable sound pressure level. Instead, it is the duration of the noise which tends to be the cause of annoyance.

What we hear everyday:

Jet engine	120 dB(A)
Pneumatic drill	110 dB(A)
Train at high speed	100 dB(A)
Subway	105 dB(A)
Radio set	105 dB(A)
Barking Dog	95 dB(A)
Restaurant	80 dB(A)
Heavy traffic	80 dB(A)
Ringing telephone	75 dB(A)
TV set	75 dB(A)
Residential street	50 dB(A)
Quiet conversation	35 dB(A)
Quiet bedroom	30 dB(A)
Leaves rustling in the breeze	15 dB(A)

PTWs COMPARED TO OTHER VEHICLES

ptws compared to other vehicles

Different vehicles contribute to road traffic noise to differing degrees. According to the subjective impression of large sections of the population, the PTWs belong to the louder vehicles.

A comparison of the noise values of various vehicles determined for their type approval test is not enough to verify this subjective impression or to provide another explanation for it. Firstly, a whole series of readings for various speeds is necessary to even come close to reproducing actual conditions. Secondly, the measuring methods for the type test of PTWs, cars and trucks vary and as a result, the values determined cannot be compared. Thirdly, the type approval test for of all types of motor vehicles assumes a kind of worst case scenario, in which the values of the vehicle being evaluated are measured at full throttle.

In reality, however, road users only utilise a fraction of the performance potential of their vehicles. Instead of driving at high engine revolutions in each gear they change gears quickly and generally drive in the highest possible gear. The reason for this is usually the obligation to drive in keeping with the prevailing traffic conditions, as well as an attempt to save fuel. Ultimately, however, this behaviour also has a positive effect on the noise development. A renowned research and development institute in Germany has therefore created measurement series under realistic conditions for all types of vehicles, which allow a comparison of the noise development of various motor vehicles.

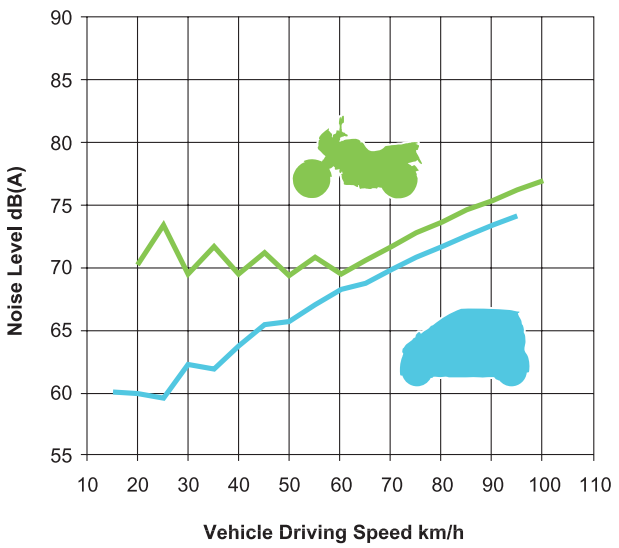
PTWs COMPARED TO CARS

The readings taken from various series car and PTW types lead to the discovery that both types of vehicle lie far below the statutory limit values under the given circumstances and do not represent significant sources of noise in traffic.

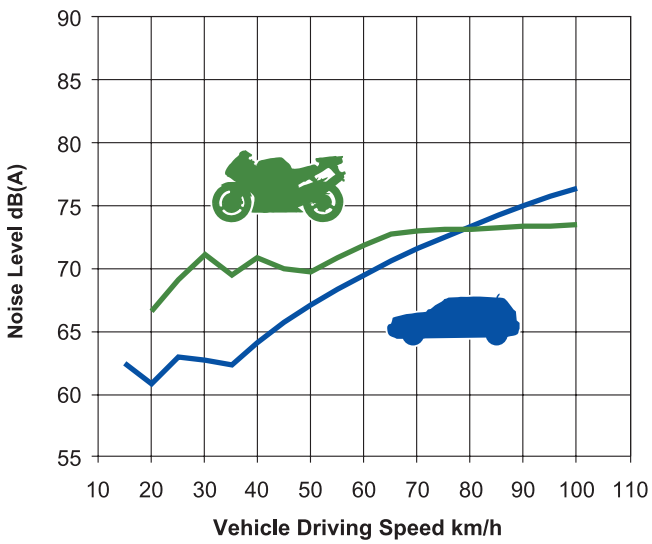
The main noise from cars is from the tyres, and this increases almost linearly with the speed, while the engine and transmission are less noticeable due to their effective containment. In the case of PTWs, however, the noise is predominantly from the engine and drive train, while the noise from the tyres plays a less significant role.

This is why PTWs are marginally louder than cars at speeds below 60 km/h, while at speeds from 80 km/h, they can even be quieter than cars.

Comparison City Car - Commuter Motorcycle



Comparison Passenger Car - Sports Motorcycle



PTWs COMPARED TO TRUCKS

In the case of trucks, there are very large differences in the readings. These are mostly dependent on the size, weight, construction and tyres of the vehicles. Light commercial vehicles, for example, are extremely similar to passenger cars in terms of noise development, although on a somewhat higher level, as they are slightly louder than PTWs from a speed of only 60 km/h.

Heavy trucks are, in general, audibly and measurably louder than PTWs and come considerably closer to the statutory limit value under the circumstances described than any other motor vehicles.

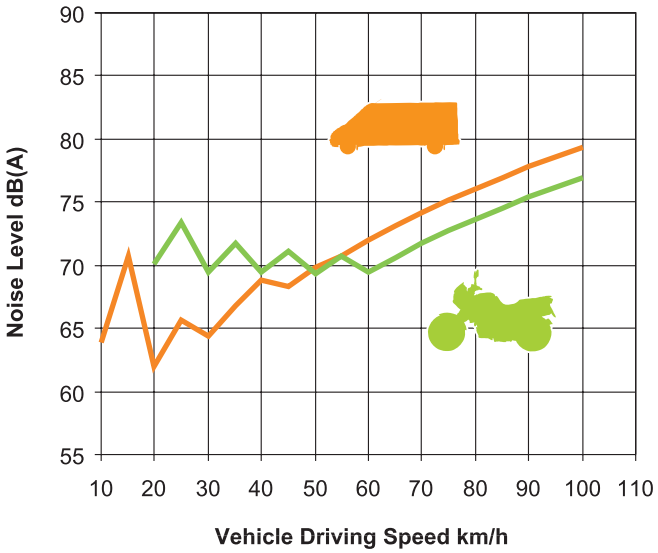
The right-hand diagram below displays the observed values for the loudest truck tested, which is 32 times as loud as the sports motorcycle used as a comparison at a speed of 80 km/h.

When trucks are equipped with special traction tyres, such as is the case with construction site vehicles, even higher noise values are reached.

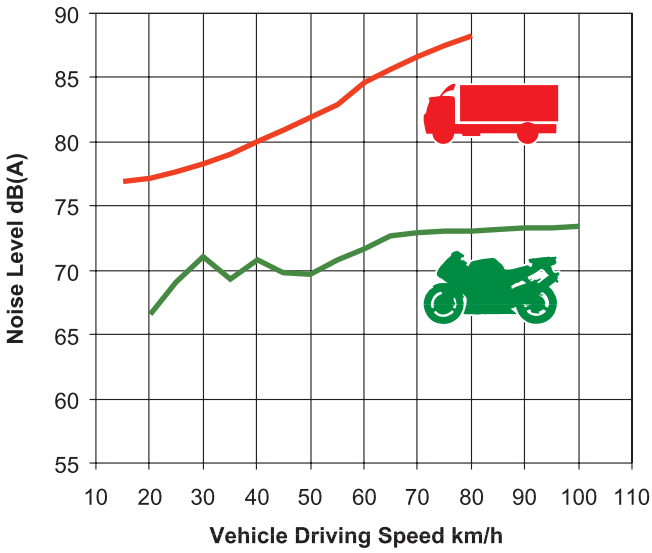
The striking difference between PTWs and trucks rarely becomes obvious in reality because both types of vehicle are seldom seen and heard in the same environment at the same time.

The fact is, however, that heavy trucks are clearly the loudest motor vehicles on our roads, while standard PTWs are on a similar level to cars and light commercial vehicles.

Comparison Light Truck - Commuter Motorcycle



Comparison Heavy Truck - Sports Motorcycle



CONCLUSION

A standard PTW cannot be rated to be noisy under normal traffic conditions. The noise produced by PTWs is very similar to that produced by passenger cars and much lower than that produced by heavy trucks.

THE SHARE OF PTWs IN TRAFFIC

the share of ptws in traffic

The comparisons made so far always apply to the measurement of individual vehicles. For an assessment of the extent to which PTWs contribute to the overall noise exposure, the percentage of PTWs in the overall motor pool is equally as important as their average use.

Of the approximately 230 million motor vehicles in use in Europe, only 25 million, i.e. a little over 10 %, are PTWs. Moreover the majority of these PTWs are not in daily use. This portrays a comparison between the average annual mileage of cars and motorcycles: with 5,000 kilometres, motorcycles cover only 20 % of the average annual distance covered by cars.

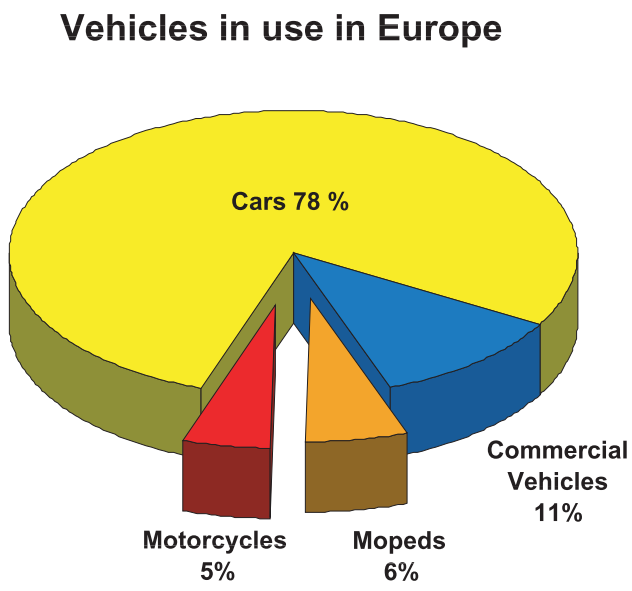
This means that PTWs neither contribute much to the total number of motorised vehicles nor to the overall noise level. Furthermore, a large majority of PTWs are used on city roads, which helps to improve urban traffic flows and the accessibility of city centres, as PTWs are flexible and require little running and parking space.

Vehicles in use in Europe

PTWs	
- Mopeds in use	13,600,000
- Motorcycles in use	11,500,000
Total	25,100,000
Cars / Commercial Vehicles	
- Cars in use	180,300,000
- Commercial vehicles in use (Light commercial vehicles, Trucks, Buses)	25,500,000
Total	205,800,000

Average mileage in Europe

Cars	25,000	km/year
Motorcycles	5,000	km/year



CONCLUSION

PTWs do not contribute much either to the total number of motorised vehicles or - as far as it concerns standard PTWs - to the overall traffic noise exposure.

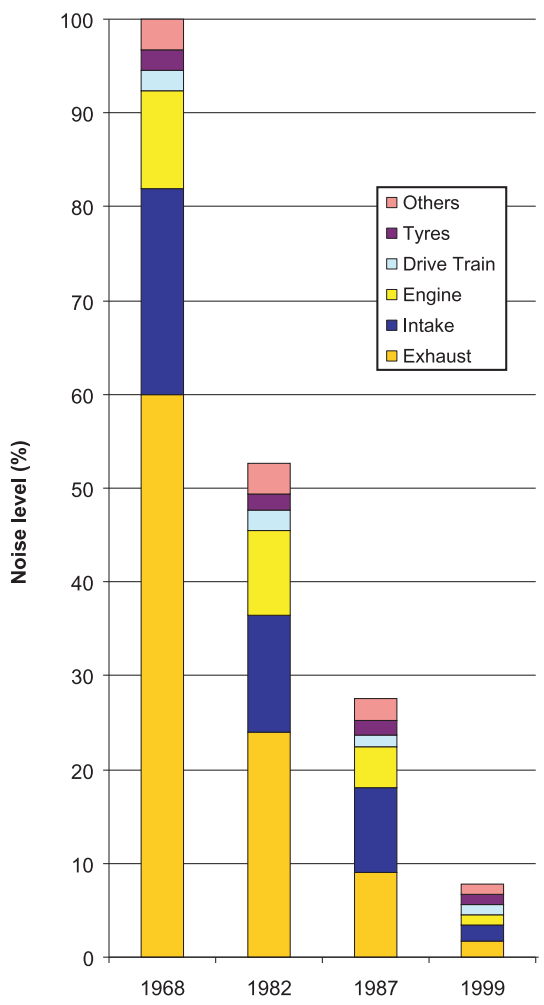
PTW NOISE REDUCTION

ptw noise reduction

NOISE REDUCTION IN THE PAST

The PTW industry has been working hard over the last thirty years to reduce the noise emissions of its products and significant progress has been achieved in this area.

History of PTWs noise level



The technologies applied are basically the same as for other motor vehicles. However, measures for PTWs are more difficult to realise for several reasons. The two most significant reasons are as follows:
- The engine cannot be contained as it is in a car.
- The potential for intake and exhaust noise reduction has already been fully exploited.

POTENTIAL FOR REDUCTION

The technical options for making new PTWs quieter are very limited, as known noise reduction technologies are already applied to meet existing limits.

Additional noise reduction by means of further technical improvement would require wide-ranging reduction measures at very high costs, while the overall effect can be estimated at a reduction of up to only 2 dB(A).

Moreover any further reduction would compromise the other requirements of a PTW. A PTW must meet not only noise requirements but also those involving safety, exhaust emissions, cost, productivity, durability, and rideability, amongst others.

Finally making standard PTWs even quieter would not lead to a drop in the noise level produced by PTWs, as even more PTW riders than today would be motivated to use illegal exhaust systems - see pages 10 and 11.

What is more, achieving a reduction in this manner would take many years – if not decades – as it takes a very long time for the new, quieter vehicles to become noticeable in the overall vehicle pool.

CONCLUSION

The technical options for making new PTWs even quieter are very limited.
Technical improvements will not significantly affect the noise level produced by PTWs.

THE REAL PROBLEM: ILLEGAL EXHAUST SYSTEMS

the real problem: illegal exhaust systems

ILLEGAL VS. PRODUCTION PTWs

If standard PTWs contribute so little to the noise level of road traffic, the question remains as to why the popular impression is that PTWs are loud. The answer is as follows: many PTW owners make their vehicles noisier with modifications, mainly to the exhaust system. These riders either manipulate the standard exhaust system of their PTW themselves or they equip their PTW with illegal after-market replacement exhaust systems.

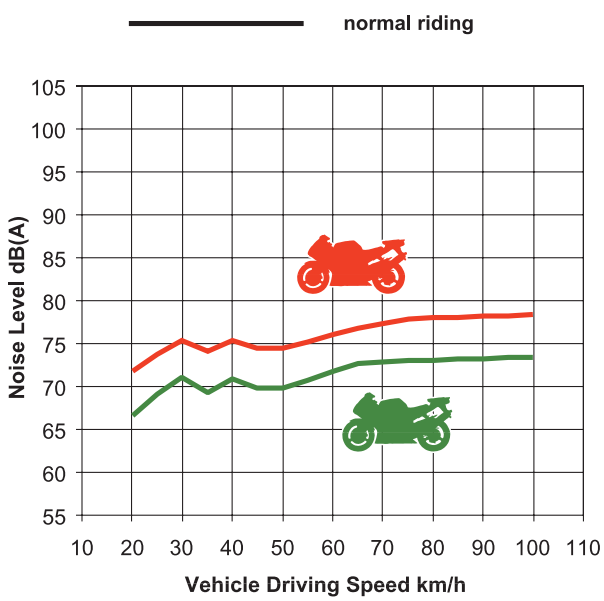
As shown in the diagram on the left below, tests with such illegal exhaust systems generally show at least a 5 dB(A) increase in the noise level compared to standard equipment when carried out with a normal riding style under the aforementioned conditions.

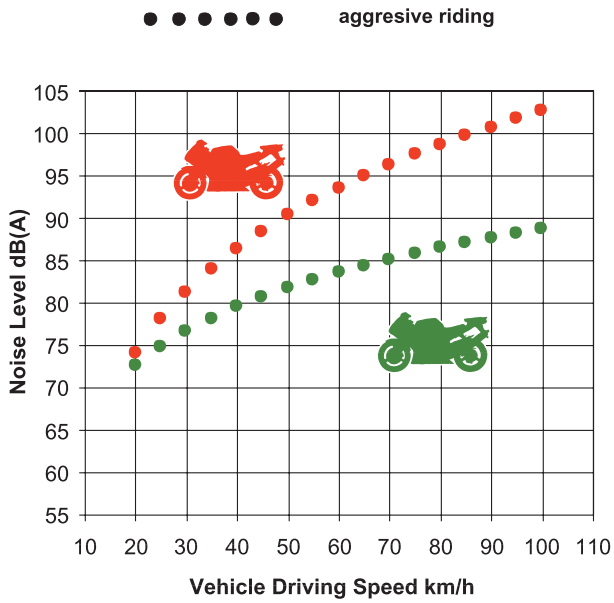
Some riders of PTWs with illegal exhaust systems, however, tend to have an aggressive riding style linked to increased noise level. They like to ride at high engine speeds and accelerate as far as possible in each gear instead of changing gears quickly. This behaviour people always keep in mind when they talk about the role of motorcycles in traffic noise.

With such riding behaviour, the noise emissions of a sports motorcycle with standard equipment increase by up to 15 dB(A), and even rise by up to 25 dB(A) with an illegal exhaust system – which is perceived by the human ear as more than five times as loud.

The acoustic potential, which will be discussed in further detail later, is extremely large for PTWs fitted with illegal exhaust systems. ***An aggressively-ridden sports motorcycle with an illegal exhaust system is up to 30 dB(A) louder than - in other words eight times as loud as - a standard version ridden normally.***

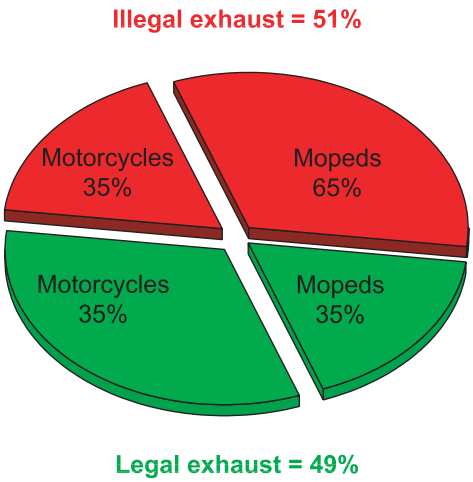
Comparison Legal Sports Motorcycle - Illegal Sports Motorcyle





STATISTICS ON ILLEGAL EXHAUSTS

Illegal replacement exhausts are very popular in Europe. There are an estimated 4 million motorcycles and almost 9 million mopeds with illegal systems. This means that around half of all PTWs in Europe have illegal equipment.



The motives for switching to an illegal exhaust system are diverse, but are mainly based on the rider's dissatisfaction with the original exhaust sound of their PTW. For the majority of PTW owners, the tonal quality is extremely important to the image of the product as a whole. The quality of the exhaust sound therefore has a high potential for alteration, which has nothing to do with a desire to break the law or necessarily achieve a more satisfactory performance.

In the past, the riders' dissatisfaction with the original exhaust sound of their PTWs increased each time the noise regulations for new PTWs were tightened. Under the given circumstances, ***a further restriction would not lead to a drop in the noise level produced by PTWs on public roads, but rather an increase, as even more PTW riders would be motivated to use illegal exhaust systems.***

Illegal exhaust systems are supported by the fact that very few legal obstacles are placed in the path of those who trade in these products and that the laws forbidding their use on public roads are not adequately enforced.

LEGISLATION AND ENFORCEMENT

If national authorities seriously wish to reduce noise they must achieve effective control of the sale of illegal systems, particularly of those which exploit the „for racing use only" loophole. However, direct owner modification and the continued use of illegal products can only be controlled at the roadside.

The following problems in particular have to be solved in order to curb the use of illegal exhaust systems:
- In some countries there is the need to revise legislation on roadside checks and subsequent vehicle rectification.
- The enforcement of noise legislation has a low priority in police work.
- There is a lack of trained manpower for effective testing at the roadside.

POTENTIAL FOR REDUCTION

Effective measures against illegal exhaust systems will have the greatest impact on the reduction of noise from PTWs. The overall effect can be estimated at 10 to 20 dB(A) on a short-term basis.

CONCLUSION

PTWs with illegal exhaust systems are numerous and much louder than standard PTWs. In some cases one illegal PTW is perceived as being louder than 1000 legal PTWs. Therefore the greatest improvement in drastically reducing the noise level produced by PTWs would come from reducing the number of illegal exhausts in use.

RIDERS CAN ALSO MAKE THE DIFFERENCE

riders can also make the difference

IMPORTANCE OF RIDER EDUCATION

The difference in noise output originating from riding styles, normal versus aggressive, is extremely large in the case of PTWs with illegal exhaust systems. This raises the question: Do standard PTWs have a higher noise potential than other motor vehicles?

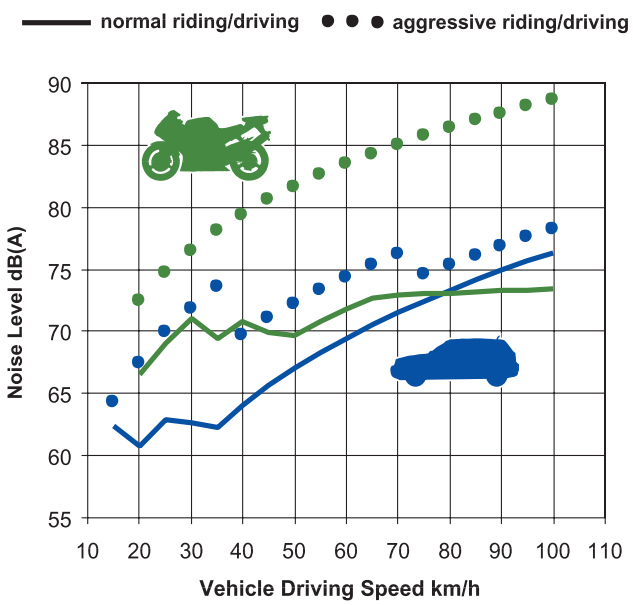
Comparative tests confirm that a sports motorcycle which is quiter than a car when accelerating normally can be up to 10 dB(A) louder than a car when accelerated at the limits of its performance. Nonetheless the motorcycle remains quieter than a heavy truck - regardless of driving style.

The diagram below right shows that the acoustic potential of a heavy truck is very small in comparison to that of a sports motorcycle. In other words, the driver of a heavy truck has little influence on the noise level of his vehicle with his style of driving – the truck is always loud. The rider of a sports motorcycle, however, has control over whether his bike is as quiet as a passenger car or almost as loud as a heavy truck. The education of riders therefore assumes particular significance in terms of aiming to reduce the noise level.

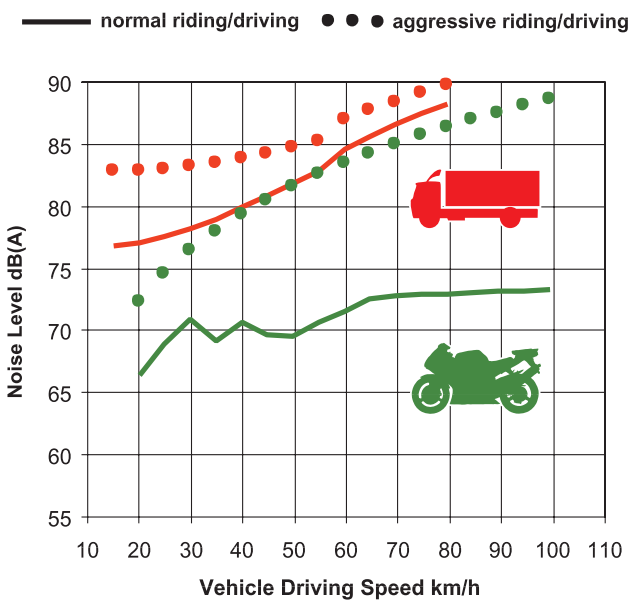
POTENTIAL FOR REDUCTION

Educating riders in matters of environmental protection creates reasonable potential for reducing the noise level. The overall effect can be estimated at 5 to 10 dB(A) on a long-term basis.

Comparison Passenger Car - Sports Motorcycle



Comparison Heavy Truck - Sports Motorcycle



CONCLUSION

There is a high dynamic potential of PTWs in terms of acoustics. If a PTW is accelerated very hard in a quiet environment it is perceived as loud. Education of riders discourages them from doing so.

SUMMARY

summary

WHAT CAN REALLY HELP TO FURTHER REDUCE THE TRAFFIC NOISE LEVEL PRODUCED BY PTWs ?

Standard PTWs cannot be rated as noisy. The noise produced by PTWs under normal traffic conditions is essentially identical to that produced by passenger cars and much lower than that produced by heavy trucks. The low percentage of PTWs in the overall vehicle pool, i.e. a little over 10%, also contributes to the fact that the traffic noise produced by PTWs is already very low today.

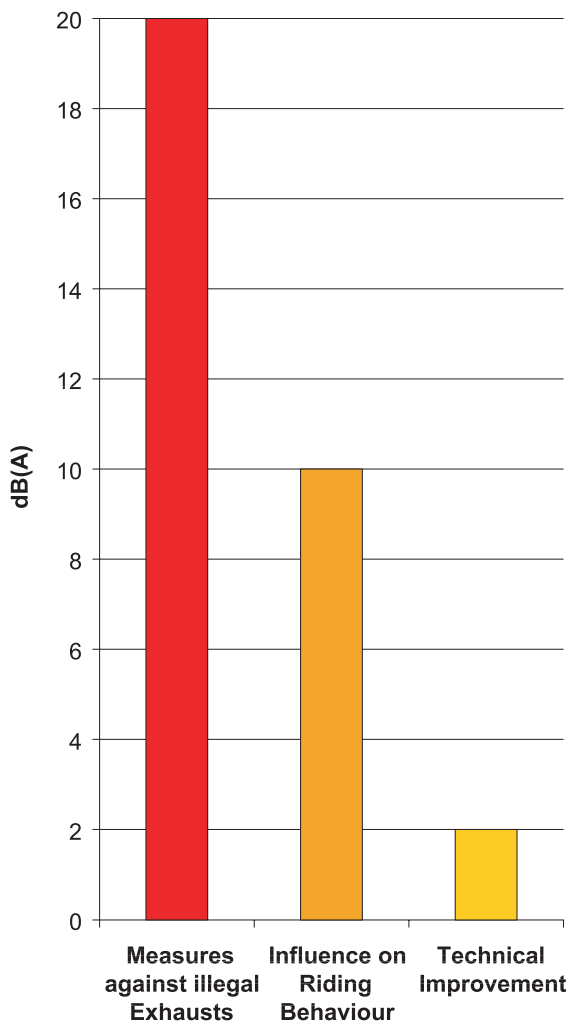
The technical options for further noise reduction are very limited, as all known noise reduction technologies have been successfully applied during recent years to meet existing limits. A huge amount of costs and manpower would only result in 2 dB(A) of noise reduction potential on a long-term basis. Moreover even more PTW riders would be motivated to use illegal exhaust systems. Therefore, a further decrease in the noise limits for new PTWs will have a very limited effect.

A PTW is only perceived as loud, due to its high acoustic potential, when it is accelerated very hard in a quiet environment. This is why noise disturbance from PTWs is generally associated with single events and peak noise levels. These are mainly dependent on riding behaviour, such as the use of high engine speeds, and very often arise from vehicles equipped with illegal exhaust systems.

Educating riders in matters of environmental protection therefore creates reasonable potential for reducing the noise load. The overall effect can be estimated at 5 to 10 dB(A) on a long-term basis.

The real challenge, however, is to find effective measures against illegal exhaust systems. The number of PTWs in use with illegal systems is very high, which essentially raises the average noise output. The reduction potential of 10 to 20 dB(A) is also very high, and reductions can be obtained on a short-term basis.

Effectiveness of measures for noise reduction



FINAL CONCLUSION

The best way by far of reducing noise from PTWs
is the effective law enforcement against illegal exhaust systems.

REFERENCES

references

LIST OF REFERENCES

ACEA: Tackling Noise –
How Motor Vehicles can contribute – 2002

ACEM Yearbooks 2001, 2002, 2003

ACEM Noise Project, Motorcycle Noise Evaluation –
Final Report, PORSCHE Engineering Services – 2002

European Commission:
Draft position paper on PTW noise – 21-6-2001

IMMA: Motorcycle Noise: The Curious Silence –
a report by the motorcycle industry – 1996

Steven/FIGE, Germany:
Noise investigations of motorized cycles – 1982

Stenschke, Umweltbundesamt, Berlin, Germany:
Possibilities for reducing noise emissions
from motorcycles – 1989

Nelson, FIOA: Controlling vehicle noise:
A general review – 1992

EC and UK 16th European Omnibus Survey:
Attitudes to noise – 1981

Sir A. Armitage: Report of the enquiry into lorries,
people and environment – 1980

Wilson report on noise (CMNO 2056) – July 1983

Miller, the Manchester Area Pollution Advisory Council:
Environmental noise survey – 1992

Vanke: Lara symposium – April 1993

Romaine, Derby City Council, Housing and
Environmental Services:
Motorcycle Noise – August 1987

Dunmore: National Society for Clean Air:
Annex C to noise committee agenda – August 1987

ABOUT ACEM

about acem

WHO WE ARE

ACEM, the professional association of the motorcycle industry in Europe, represents twelve manufacturers, ten national associations and three guest members at European level out of nine European countries, representing a turn-over of 10 bn EURO and assuring jobs for approximately 178,000 people.

The product range goes from small 50 cc town vehicles, up to big motorcycles with 1000 cc further on to cruiser with 1500 cc and even more. Our products are divided into different segments like mopeds, scooters, super-sport, touring, commuter, custom, traditional and off-road bikes. This large range of products explains why we refer to them simply as Powered Two Wheeler (PTWs).

WHAT WE DO

ACEM has engaged itself in activities, which include, but are not limited to, the following action:

- Develop and support the common interests of manufacturers at European level within the European Community and other countries
- Monitor, study and analyse issues of common interest including but not limited to environmental, economic, safety, technical transport, legal and fiscal matters
- Inform the members about all trends and development of common interest
- Develop, co-ordinate and implement joint positions
- Support the European Community institutions in dealing with matters of common interest
- Inform the public about positions on matters of common interest
- Maintain contacts and present homogeneous positions in dealing with other Europe and International Associations and Institutions

acem

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