MotoMyth – TRUE or FALSE
Does noise actually save lives?

Noise and comfort are not good friends, nor have they ever been. You always need a good reason to sacrifice one for the other. In the case of motorcyclists, safety is the reason why comfort is sacrificed in favor of noise. Some motorcyclists strongly believe that "loud pipes save lives". As a result, they choose to make noise, in the hope that this will make driving on two wheels safer. But is this actually true?

motoDNA association decided to run a test to bring to light the scientific part of this motoMyth.

The test was attended by:

- Department of Road Vehicles within the Faculty of Transport of the Polytechnic University of Bucharest;
- Noise specialists from Enviro Consult - the representation in Romania of Bruel & Kjaer, world leader in noise and vibration measuring equipment;
- motoDNA members, students and special guests.

Important disclaimer: This study does not aim to verify absolute noise levels. We aim to check relative sizes, respectively to compare the sound level emitted by the motorcycle measured next to the motorcycle and inside a car next to the motorcycle. As a result, the determinations were not performed based on the technical standards for measuring the noise made by a motorcycle, but we observed it, in the same conditions in all tests performed, in order to be able to compare the results. What mattered in the end was the relevance of the measurements for the real traffic situations, in which we are involved every day.

What is the foundation of this motoMyth?

Noise saves lives. How could noise save lives?

Directly, obviously it doesn't do that, but, indirectly, it can reduce the risk of an accident, and this is supposed to happen when the drivers in the car hear you and take care of you when they make necessary maneuvers in traffic.

Is there a side effect of noise?

Yes, for the rider there is a continuous sound at a high level, which in the short term gives headaches / dizziness with each motorcycle ride longer than 4 hours, and in time can cause irreversible problems of the hearing system.

Another effect? The one produced on the friends of the noisy motorcyclist / the inhabitants of the area where the motorcycle is running. Depending on the noise level, a state of discomfort is created which, if prolonged in duration, can lead to stress and hence to many other problems.

In this study we aim to analyze the first part of the problem: can a high noise level lead to greater traffic safety by alerting drivers in cars? The first logical step of this approach is to check if the driver can hear the sound emitted by the motorcycle and under what conditions does he hear it.

Sound related technical elements

The sound level is measured in dB (A), on a scale that mimics the perception of sound by the human ear.

Sounds can be low, medium, or high pitch, also called low, medium, or high frequencies. The frequency of a sound is measured in Hz. A sound in nature will always contain several frequencies, but with a different level from one frequency to another, depending on the tone of the sound.

Thus, at a high pitched sound, we will measure a high level in the high frequency area and a much lower level in the low frequency area. Such a frequency distribution of a sound defines its frequency spectrum.

For example, we have a drum and a violin that emit 90dB (A) sound at the same time. The drum has a low key. So, in its sound spectrum, we will have the maximum level of 90dB at a low frequency (let`s say 250Hz) while at a higher frequency (let`s say 600Hz) we will have a level of only 40dB. At the same time, the high-pitched violin will have a maximum level of 90 dB at 600hz, but will only have 25dB at a low frequency of 250Hz.

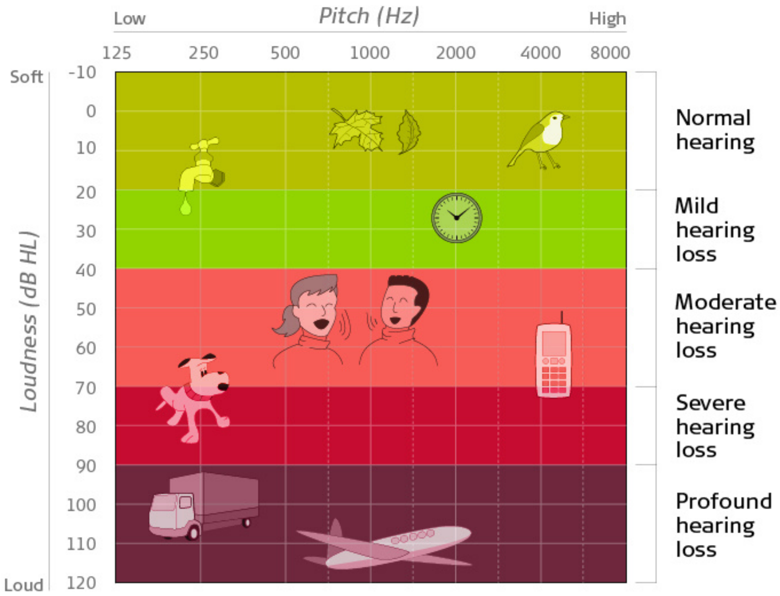
The human ear can distinguish several sounds at the same time only if they are on different frequencies. In the case of those that are on the same frequency, we hear only the loudest noises, i.e. those that have a higher level.

If we return to the previous example, the human ear will overlap the two sounds, the drum and the violin, but at the frequency of 250Hz the sound of the drum is heard because it has 90dB compared to the 25dB of the violin. At the same time, at the 600Hz frequency, only the sound of the violin will be heard.

The human ear is important in this experiment, because it is a study of perceptions and not of absolute measurements. The ear distinguishes sounds from 15dB (A). Sounds over 110dB (A) are considered annoying and those over 140 can cause trauma.

Another important feature of the human ear, respectively the brain, is that a low frequency sound source up to 400hz is very difficult to locate in the surrounding space, while a high frequency sound source over 1,000Hz is much easier to locate.

For example, we take 2 extreme cases. The low frequency sound produced by a subwoofer is not located by the human ear and that is why the subwoofer is single and can be placed anywhere in the room. On the other hand, the high frequency sound produced by the siren of an ambulance is immediately located in space and allows us to react when we are in traffic.



The sounds we are used to are in the area of 30-50dB (A). To give you a clearer idea, at a rock concert the sound level is at 120-130dB (A), in a bar / disco it is at 100-110dB (A) and a gunfire is at 140-150dB (A) .

From a medical point of view, sound traumas fall into two broad categories:

a) Acute sound trauma - short-term exposure to very loud noises, a few milliseconds to noises of 150dB (A), or several tens of minutes, even hours, to noises in the range of 120-150dB (A);

b) Chronic sound traumas - generated by long-term exposures to noises of intensity of 80 - 85dB (A). This includes those who work in environments characterized by loud noises - for example, those who, every day, break asphalt or stone with the picamer.

How were the tests performed

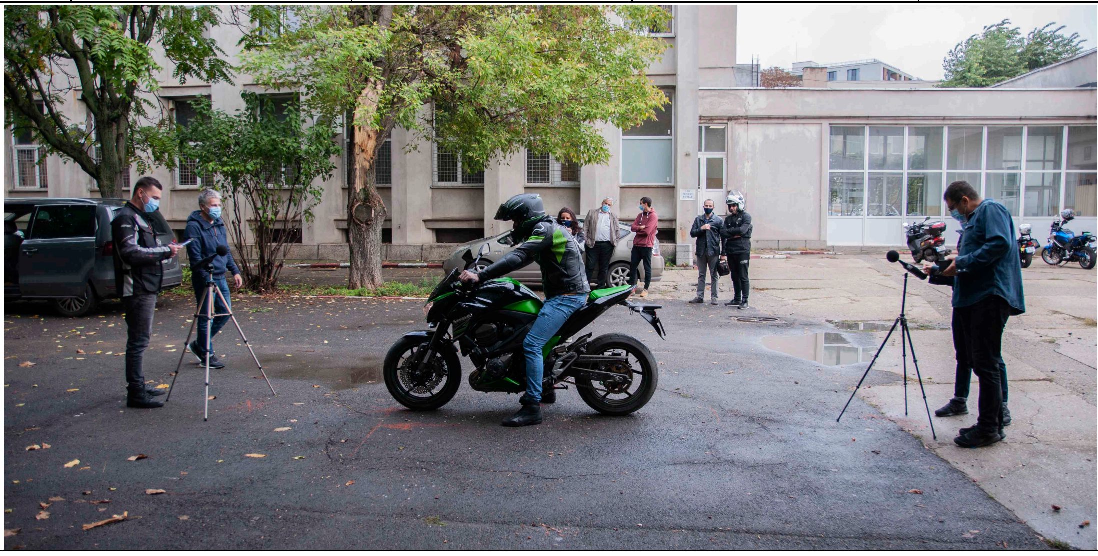
You will reread the previous chapter a few times to really understand it, but the presentation of the test will make you understand what all this information is used for.

The study involved taking measurements according to schemes discussed and agreed with the participants in this test.

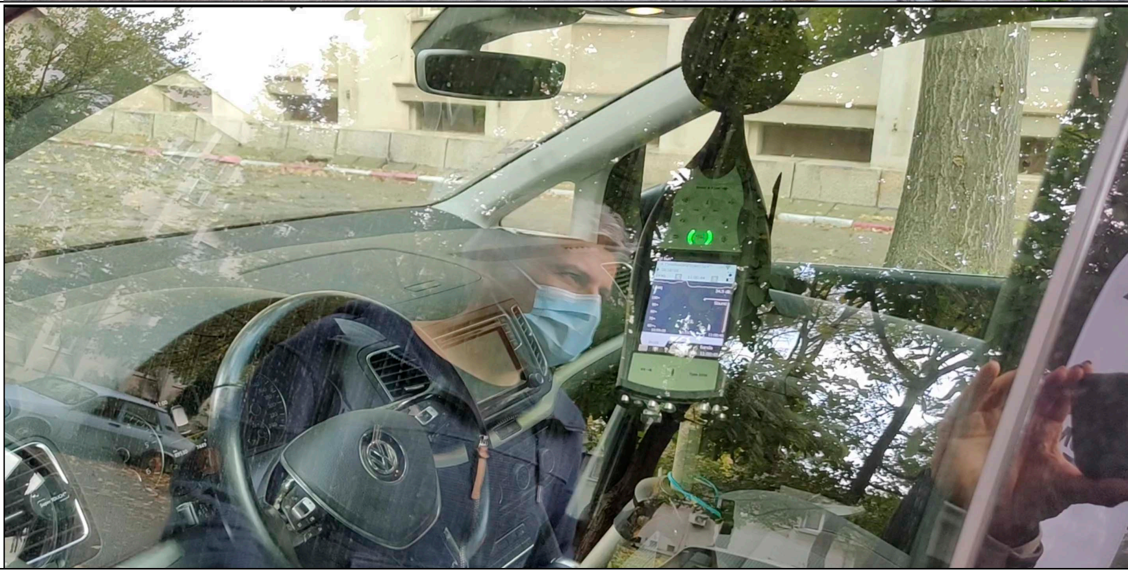
For measurements we used:

1. A 2015 Volkswagen Sharan
2. 5 motorcycles and a scooter - Kawasaki, Honda, BMW, Yamaha, Suzuki, Kymco
3. 2 professional measuring devices, metrologized by Bruel & Kjaer provided by Enviro Consult - the brand's representative in Romania
4. Bruel & Kjaer sound level meters Type 2250 class 1 accuracy, series 3011148 and 3024353

The measurements were performed in 8 scenarios, as shown in the table below:

<table>
<tr><th>Test Nr.</th><th>Test name</th><th>Microphone 1 position</th><th>Microphone 2 position</th><th>Measurements details</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Motorcycle sound front vs. back</td><td rowspan="2">At a height of 1.2 m and 1.5 m in front of the motorcycle</td><td rowspan="2">At a height of 1.2 m and 1 m in back of the motorcycle</td><td>The engine was run at an average speed of 2,500-3,000 rpm</td></tr>
<tr><td>High speed engine - 6,000-7,000 rpm</td></tr>
<tr><td colspan="5"></td></tr>
</table>

Test Nr.	Test name	Microphone 1 position	Microphone 2 position	Measurements details
2.	Mototrcycle – car distance 15m	Inside the car, next to the driver`s ear	At a height of 1.2 m and 1 m in back of the motorcycle	Motorcycle engine running at a high speed of 6,000-7 / 000 rpm Car with engine stopped and no music, with windows and doors closed.



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Test Nr.	Test name	Microphone 1 position	Microphone 2 position	Measurements details
3.	Motorcycle – car distance 10 m	Inside the car, next to the driver`s ear	At a height of 1.2 m and 1 m in back of the motorcycle	Motorcycle engine running at a high speed of 6,000-7 / 000 rpm Car with engine stopped and no music, with windows and doors closed.

<table>
<tr><td>Test Nr.</td><td>Test name</td><td>Microphone 1 position</td><td>Microphone 2 position</td><td>Measurements details</td></tr>
<tr><td>4.</td><td>Motorcycle on the left side of the car, near the back wheel</td><td>Inside the car, next to the driver`s ear</td><td>At a height of 1.2 m and 1 m in back of the motorcycle</td><td>Motorcycle engine running at a high speed of 6,000-7 / 000 rpm
Car with engine stopped and no music, with windows and doors closed.</td></tr>
<tr><td colspan="5">
</td></tr>
<tr><td>5.</td><td>Motorcycle at 4 m in front of the car</td><td>Inside the car, next to the driver`s ear</td><td>At a height of 1.2 m and 1 m in back of the motorcycle</td><td>Motorcycle engine running at a high speed of 6,000-7 / 000 rpm
Car with engine stopped and no music, with windows and doors closed.</td></tr>
</table>

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6.	Noise level in the car, only with engine	Inside the car, next to the driver`s ear	-----	The car took a 4-minute drive with the engine in gears 2 and 3 at a certain speed

7.	Noise level in the car with the engine running and music at a low level - allows easy conversations between passengers	Inside the car, next to the driver`s ear	-----	The car took a 4-minute drive with the engine in gears 2 and 3 at a certain speed

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8.	Noise level in the car with the engine running and music at a medium level - discussions are difficult due to noise	Inside the car, next to the driver`s ear	-----	The car took a 4-minute drive with the engine in gears 2 and 3 at a certain speed

The results obtained from these measurements are to be compared as follows:

a. The measurements made in test 1 compare how the noise produced by a motorcycle propagates in front of or behind the motorcycle, respectively, at a height of 1,2 m and at a distance of 1 m from the motorcycle.

This test is relevant to measure how much of the noise produced in the exhaust pipe is transmitted to the front of the motorcycle, where it is really important in traffic. At the same time, we measured the way in which, over the sound of the drums, the noise made by the engine overlaps.

Also, the sound level recorded by the microphone 2, the one behind the motorcycle, is the control sample to compare it with the sound level measured by the microphone 2 in tests 2-5.

b. The measurements from tests 6-8 are the control standards for car noise in 3 modes of useage: car in traffic without music, car in traffic with low volume music and car in traffic with music at medium volume. We simulated driving in the city at speeds of up to 50 km / h, in which case the aerodynamic noise is negligible. When traveling outside the city, this aspect becomes important and must be taken into account as additional noise.

c. Measurements 2-5 aim to establish the level of sound transmitted inside the car when the motorcycle is at a high speed and it is positioned at different distances from the car. To ensure that the motorcycle was at high revs, we used the tell-tale test mentioned in "a." above. This sound level measured in the car is to be compared with the control level recorded in the car in tests 6-8.

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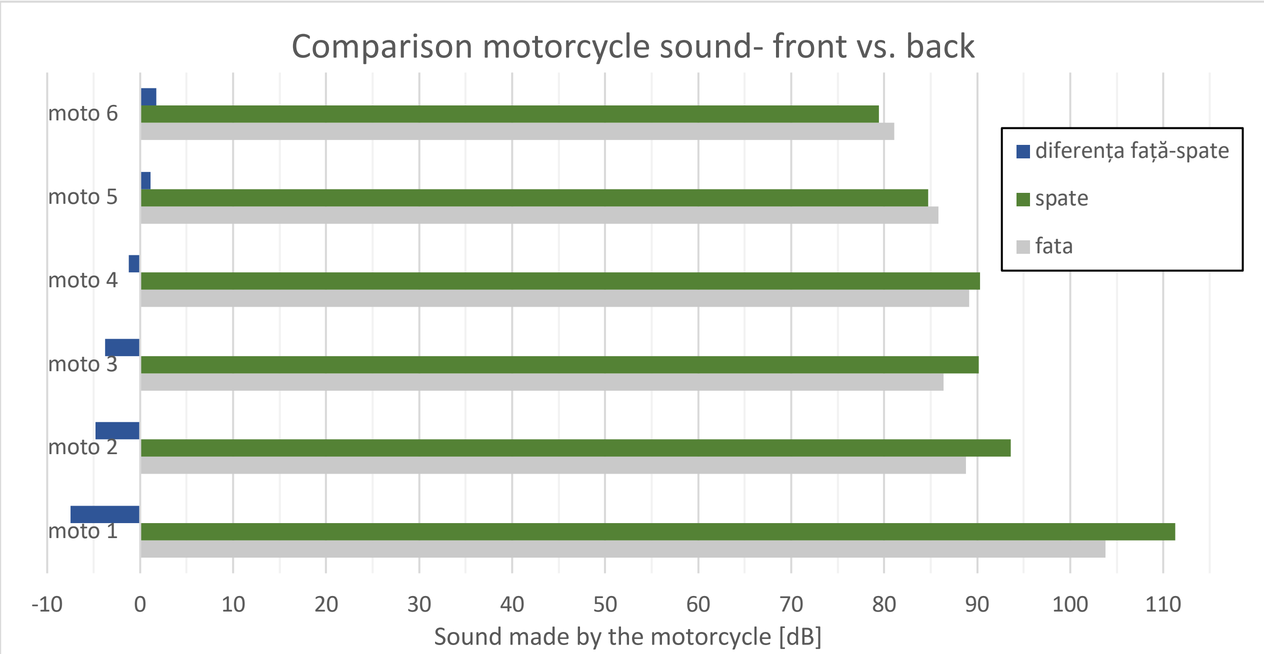
Mesurements, results and interpretations.

A. Testing the variation of noise emitted by a motorcycle

We all know that motorcycle exhaust pipes are pointing backwards, and the car that poses a potential risk to the safety of the motorcycle is the one in front. Starting from this fact, we wanted to measure how much of the sound emitted by the motorcycle is transmitted to the car in front of the motorcycle. To perform the measurement, we used test 1 described above.
The results of this test were as follows:



How we interpret these results:

1.1 The noisiest motorcycle in the test produced 111dB (A) (in the back) and the quietest 80dB (A) (in the back)

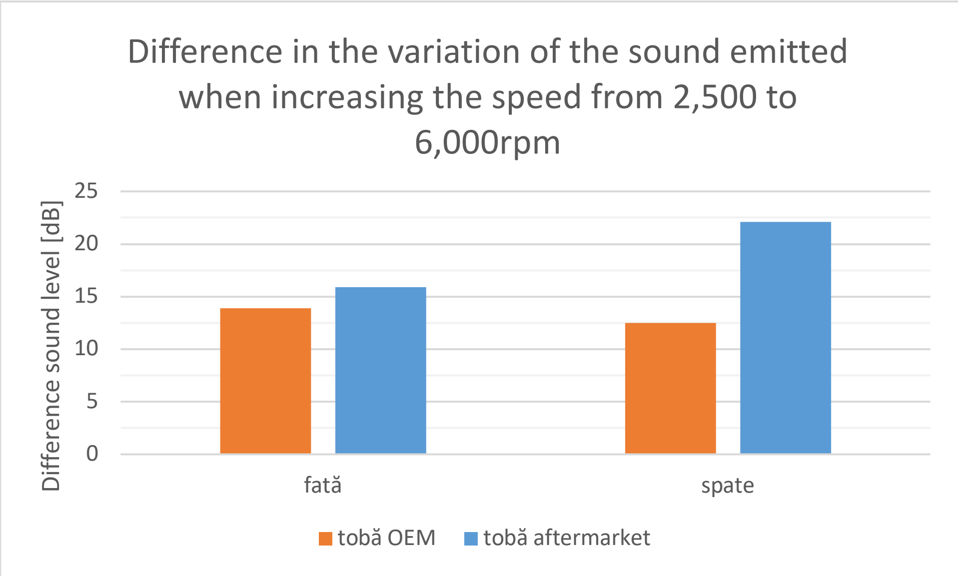
1.2 the level of sound measured in front of the motorcycle is lower than that measured behind it, in most cases, which confirms the idea that much of the sound is transmitted to the back and only part of it to the front. Thus, the "loss" of noise, as the difference between front and back, is about 5dB (A) See moto1-moto4 graphs

1.3 In the case of silent drums, we found that the sound level measured in front of the motorcycle is higher than that measured in the back, and this is due to the noise made by the engine, which in this case seems to be higher than that of the drums exhaust. See moto5 and moto6 graphics.

1.4 It should be noted that, as the motorcycle is noisier, the difference in sound between what is produced by the drum and what is transmitted in front of the motorcycle also increases. Thus, in the case of a motorcycle with a normal noise level, the difference is about 4dB (A), and in the case of a noisy motorcycle, 7.5dB (A) is lost.

Important! The sound transmitted to the front of the motorcycle is lower than that transmitted to the back, and the difference depends on the type of drum used on the motorcycle. The loss is higher in the case of noisy drums and it is, on average, about 5dB (A).

The above measurements were performed at high engine speed. We continued to measure the variation of the sound level transmitted in front vs. in the back, when the engine speed increases from 2,500 rpm to 6,000 rpm. For more information, we made the measurements with two types of drums - one OEM and one Aftermaket.



From here we notice that:

• The noise generated by the motorcycle increases with speed, as expected;

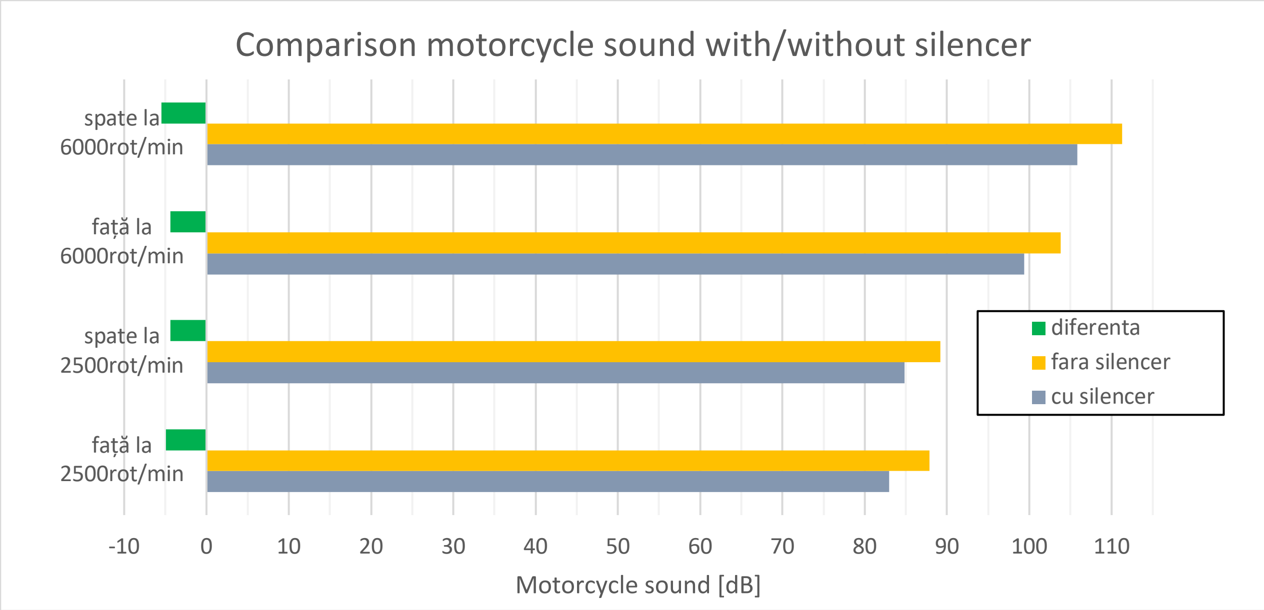
• As the speed increases, in the case of the OEM drum, the sound transmitted to the back increases by 12dB (A) while the sound transmitted to the front increases by 14dB (A). This shows that OEM drums limit the increase of noise at high speeds.

• As the speed increases, in the case of the aftermarket drum, the sound transmitted to the back increases by 22dB (A), while the sound transmitted to the front increases by only 15dB (A). This shows that, at high speeds, the aftermarket drums produce more noise, but it has the same effect as an OEM drum, if we talk about the noise transmitted in front.

Important! A noisy drum leads to an increase of the noise produced behind the motorcycle, but slightly changes the noise transmitted to the car in front, which means that using a noisy drum will give the rider the impression of a much louder noise compared to what the car in front hears.

We must mention that the aftermarket drums have as an option a silencer that the user can mount to reduce the noise level. During the tests performed, we measured in both situations: with the silencers mounted / disassembled.

If we test the impact of the silencer on the noise produced by the motorcycle the results are the following:



How do we interpret this graph:
2.1 Removing the silencer from a drum makes the noise emitted by the motorcycle increase by approximately 5dB (A), regardless of the speed;
2.2 The increase in noise is slightly higher at high speeds, but only for the sound transmitted to the back.

Important! Removing the silencer results in an overall increase in motorcycle noise of 5dB (A)

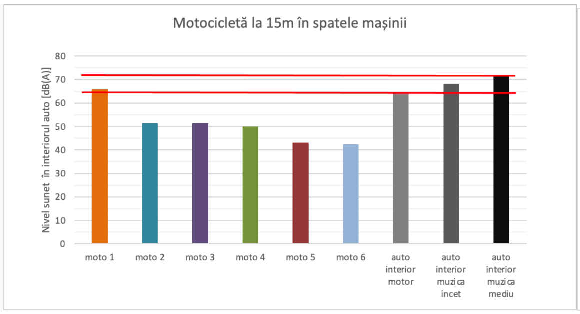
A. Measuring the sound produced inside a car when approaching a motorcycle

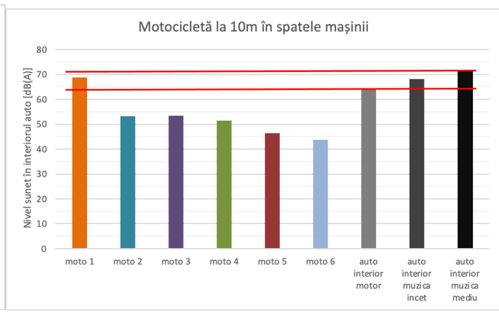
For this test we used the measurements recorded in tests 2-8 above. During the tests we simulated the overtaking of a car in traffic by a motorcycle. The sound in the car is measured in 3 operating modes, and the motorcycle is at a high speed, to produce a noise as loud as possible which simulates the engine speed while overtaking.
It should be noted that the vast majority of motorcycles considered noisy have a sound level of up to 105dB (A), provided that the legal maximums are at the limit of 95dB (A). The motorcycles measured in the test were used at a high speed and the noisiest produced a maximum of 111dB (A). This level is above the level usually encountered in traffic and does not allow the use of the motorcycle for a large period. (see description from "Sound related technical elements")

To simulate overtaking, we measured the noise produced by the motorcycle when it at 15m, 10m behind the car, on the side of the car and then in front of the car. Details are described in the chapter "How were the tests performed".

B1. The case of the motorcycle behind the car at 15m or 10m

The sound level recorded in the car compared to the sound level generated by the motorcycle. The measured values look like this:

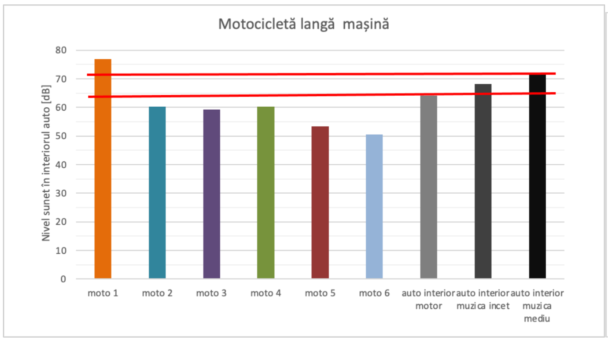


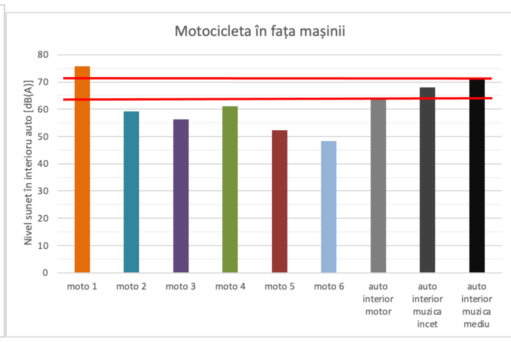


Important! When the motorcycle is 15 m behind the car, none of the motorcycles can be heard inside the car. Only moto 1 with the 111dB (A) measured in the back is at the limit at which it could be heard if there was no music in the car and the passengers did not speak.

At 10 m behind the car, the motorcycle makes a 3dB (A) sound inside the car over the background noise of a moving car, if the music is turned off and the passengers do not speak. If the music is turned on, at low level, then the impact of the motorcycle is almost 0, and if the music is turned on at a medium level, then the motorcycle produces a sound 4dB (A) below the noise level in the car. It is considered that an average level of music ensures a good hearing inside, but without the music being considered loud and without disturbing discussions between the passengers.

B2. The case where the motorcycle is next to the car and then in front of it





Important! In these two cases - the motorcycle next to the car and the motorcycle in front of the car - the motorcycle can be heard in the car at a level that attracts the driver's attention, even when the music is at a medium level.
In these two cases, the maximum noise produced by motorcycles is 5 dB (A) above the background noise level in the car with the music at a medium level. This value can be easily heard by the human ear.

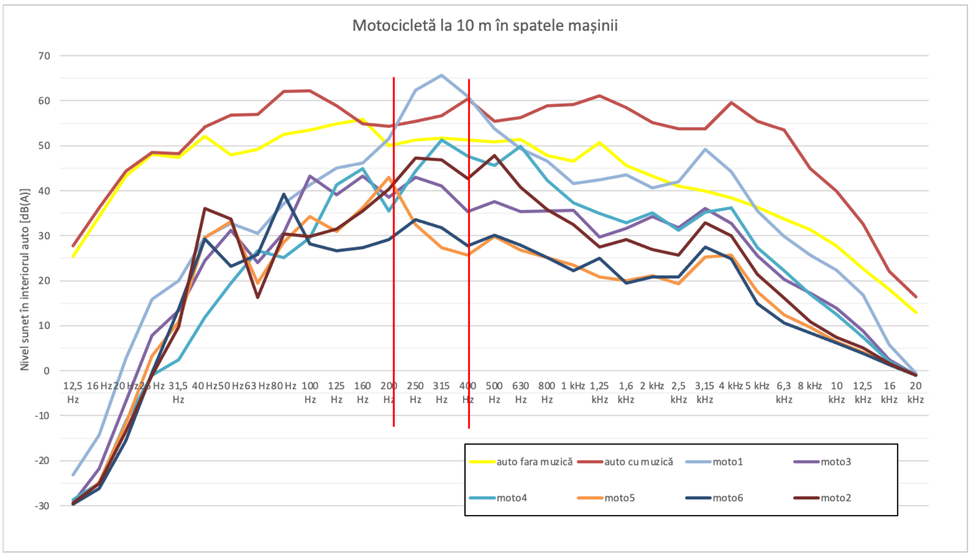
B3. How does a motorcycle sound in the car?

We have seen from the measurements so far that a motorcycle cannot be heard in the car if it is at a distance of more than 15 m, no matter how modified the motorcycle is and no matter the background noise in the car.

If the motorcycle is 10 m behind the car and has an extremely noisy drum, it may be heard inside.

How is it heard and how much is it heard?

To get an answer, we need to check the frequency spectrum of those noises.
The graph shows the frequency spectrum of the noise produced by each motorcycle, but also of the background noise in the car.



It is important to analyze the curve marked in red and the one in blue, related to the background noise with medium volume music and the noise produced by moto1.
Analysis - on each frequency segment, the human ear perceives the strongest. Thus, the human ear will hear moto1 where the noise produced by it is louder, respectively when the blue graph is above the red graph, which represents the background noise in the car.
I marked this interval with two red vertical lines. The frequency range thus identified is between 200Hz and 400Hz, and the level difference is a maximum of 9dB (A).

Important! the 9dB (A) level is high enough to be perceived by the human ear, but the 200-400Hz frequency range of sound is a low frequency that is difficult for the human ear to locate, which means that the driver cannot tell where the motorcycle is, even if it can hear the noise it makes.
For the demonstration, we tried to reproduce these sounds in a short test presentation film that can be watched at this link .....

B4. What is the required noise level of a motorcycle to be heard inside the car at distances of more than 15 m

We have identified so far that only part of the noise produced by the motorcycle reaches inside the car. Compared to the measured figures, we estimated that 55% of the sound produced by the motorcycle reaches inside a car located 15m away.

The background noise inside a car traveling at speeds below 60km / h, with music at an average level is 71dB (A).
To ensure that the sound of the motorcycle is heard in the car, it should be at least 3dB (A) above the background noise inside the car. Thus, the motorcycle should produce a sound of 74dB (A) inside the car.
Important! In view of the above, it appears that, in order to be heard in a car 15m away, the motorcycle should produce a sound level at the exhaust pipe of 135dB (A).
This sound level is painful to the human ear and cannot be tolerated for more than a few seconds.

CONCLUSIONS

Is this myth true or false?

We summarize the issues identified in the above analyzes:
• The sound transmitted to the front of the motorcycle is lower than that transmitted to the back The attenuation is higher for noisy drums, and on average it is about 5dB (A).
• A noisy drum increases the noise behind the motorcycle, but slightly changes the noise transmitted to the car in front.
• A motorcycle cannot be heard in the car (in motion) if it is at a distance of more than 15 m, no matter how modified the drum is and no matter the background noise in the passenger compartment;
• At a distance of 10 m from the car, a motorcycle (with a noise level produced above the legal limits) can be heard, but the sound is in a low frequency area where the sound is difficult to identify by the human ear and is difficult to position in space;
• When the motorcycle is near the car or in front of the car, the noises produced will be heard in the car at a level that attracts the driver's attention, even when the music is at a medium level. At this distance, however, no maneuver by the driver could be prevented that would endanger the motorcyclist.
• To be heard in a car 15 m away, a motorcycle should produce a sound level at the exhaust pipe of more than 135dB (A), a condition that is impossible in reality.

In conclusion, *Loud pipes save life* ... is a false statement! The sound produced by a motorcycle is not heard by the drivers of the cars in front or is heard too late to be able to influence the drivers` decision.
What do we have left? Let's be seen, not heard, and this can be done by following all the rules imposed by preventive driving. Bonus, we will have much less headaches and we will not bother the other traffic participants ... useless, as the measurements show.