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REPLIES TO THE QUESTIONNAIRE CONCERNING THE DEVELOPMENT OF REGULATION No. 51

Transmitted by the secretariat

Note: The text reproduced below was compiled by the secretariat and it contains the replies of the experts from the Czech republic, Hungary, Italy, Japan, Netherlands, Poland and the European Tyre and Rim Technical Organization (ETRTO) to the questions which had been formulated by GRB at its thirty-fourth session. The replies (reproduced as received) to the questionnaire should assist GRB in defining the conditions and requirements for the development of Regulation No. 51 (TRANS/WP.29/GRB/32, para. 21 and annex 2).

Note: This document is distributed to the Experts on Noise only.

QUESTIONS CONCERNING THE DEVELOPMENT
OF A TEST METHOD FOR UPDATING REGULATION No. 51
AND THE REPLIES PROVIDED BY VARIOUS EXPERTS

Question 1: **WHICH NOISE SOURCE SHOULD BE ADDRESSED?**
– MAINLY PROPULSION NOISE?
– PROPULSION AND TYRE ROLLING SOUND EMISSION?
- MAINLY TYRE ROLLING SOUND EMISSION?

Replies:

Czech Rep.: Propulsion and tyre rolling sound emission.

Hungary: (see annex 1).

Italy: The new method must depict the urban condition use. In such situation the generated noise is the result of a combination of power-train noise, intake/exhaust and tyre/road noise, which are related to the vehicle design conditions and by the road surfaces.
Whereas a specific road surface, these conditions change by vehicle to vehicle and will change in future according to the technical progress.
It must be taken into consideration the noise as a whole and as perceived in the urban environment.

Japan: Determination of the test method is important for reducing noise in urban driving. And for this reason, actual driving conditions in the urban area must be reproduced in the test method. Consequently, the vehicle as a whole should be considered without distinction between propulsion noise (e.g., engine noise, exhaust noise, intake noise or other power train noise) and tyre noise.

Netherlands: Our standpoint is that the noise production of the total vehicle should be subjected to the noise test. One cannot make an *a priori* choice between individual contributions. In general in case of modern gasoline powered passenger cars tyre/road noise contributes dominantly during cruise by at moderate and high speeds, however in case of low speed and/or acceleration the drive line is the most relevant source.
The starting point of the discussion should be the definition of environmental issues to be addressed by the regulation.
We distinguish two issues:

- the equivalent noise load on the urban population, expressed in its LAeq level,
- the specific annoyance of single events in living areas, city centers, intersections, etc. expressed as a series of LAmax values (which at his turn can lead to a significant Laeq level).

With respect to the stated question we advocate a test that addresses both tyre/road noise and propulsion noise, but in a separate way.

With respect to this question we acknowledge two important aspects:
1. the unfeasibility to make a clear distinction between types of vehicles;
2. the objective to approach the environmental properties over the entire vehicle life.

Ad 1: It is our opinion that the modern composition of the vehicle fleet in the market exhibits a very wide distribution of vehicle types in which all types of hybrids between vans, off-road vehicles, trucks and passenger car types exists. Since a clear distinction between types does not exist anymore we feel that a uniform test method should be constructed in which the properties of the vehicle and its noise quality implicitly

is addressed. For instance the load bearing capacity of the vehicle should be accounted for by loading the vehicle under the test condition, irrespective of its type (generally a small passenger car would not be loaded and a lorry will carry a substantial amount of weight during the test). This approach also leads to a more continuous change between passenger cars, vans and heavy vehicles.
This, together with the test situation to be chosen according to the single event and the LAeq conditions will result in a balanced focus on drive line noise and rolling noise.

Ad 2: It is acknowledged by all participants in the discussion that the tyre is an integral part of the vehicle, both from a manufacturers point of view as from a legislative point of view. The important role of the choice of tyre on the test result and therefor on the permission to use this vehicle on public roads, however has consequences for the choice of tyres at the moment of renewal.

An analogous situation is found in case of exhaust silencing systems. Since their technical properties are very decisive for the noise production of the vehicle, replacement systems are type approved, not only as a system on itself, but in combination with the vehicle. The background of this is to ensure that the noise quality of the vehicle will not degrade by a replacement part.

If the same line of thinking is applied to replacement tyres, it will lead to the obligation to mount replacement tyres with the same acoustical property as the ones applied during type approval.

Neglecting this important relation will lead to the application of artificial low noise tyres during type approval, while the tyres mounted during 90% of the vehicles life time are of a total different noise quality and therefor do lead to severe degradation of the total vehicles noise characteristics.

(a similar approach is found with exhaust emission, in which motor management not only must ensure low emission during the test phase but also must ensure proper functioning during its life time).

Poland: Propulsion and tyre rolling sound emission.

United Kingdom: Both the propulsion and tyre rolling sound emission should be considered in order that the vehicle manufacturer takes responsibility for minimising the noise propagated from the tyres specified for the vehicle. Technologies and measures reducing tyre-noise propagation can then be encouraged. Limiting of idling noise could also be given further consideration as a means of a) encouraging improved noise reduction technology and b) providing a base for in-use control.

ETRTO: Propulsion noise is the noise source to be considered within this Regulation as tyre/road rolling noise is addressed by another Regulation.

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Question 2: **IS IT MEANINGFUL TO INCLUDE A CONSTANT SPEED TEST IF THE RESULT IS DOMINATED BY TYRE ROLLING SOUND EMISSION?**

Replies:

Czech Rep.: Yes.

Hungary: (see annex 1).

Italy: During the vehicle urban use, usually occur conditions of partial acceleration.
The test procedure must depict this condition. The external test noise procedure must be simple and repeatable. Therefore it is considered more appropriate to reproduce the conditions of partial acceleration through two tests:
a) Constant speed
b) wide open throttle; as proposed by the ISO procedure (see point 1).

Japan: It is important to determine the test method so that it will be effective for reducing noise in urban driving. Accordingly, constant speed, which makes up the bulk of urban driving, must be considered.

Netherlands: Yes.
A constant speed test in a high gear is a good test to evaluate the status of tyre/road noise contribution. It will probably mean that there is another test needed for evaluating propulsion noise. We emphasize the approach formulated in 1. that the regulation must give assurance that the observed noise characteristics during the test are not jeopardized at the moment of tyre renewal.

NB. The fact that the speed is constant is not the reason that tyre/road noise is dominant. The ratio of the gearbox (and therefore the ratio between vehicle speed and engine speed) is the determinative factor rather than the rate of acceleration.

Poland: Yes.

United Kingdom: Only if separate limits are applied to the constant speed test (motorway driving) and transient test (urban driving). Consideration could also be given to the use of various speeds as per the tyre-noise test. Needs further examination.

ETRTO: Tyre/road noise shall be considered through a separate Regulation and it is not proved thys at low speeds this is a dominating factor.

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Question 3: **IS IT MEANINGFUL TO INCLUDE TYRE ROLLING SOUND EMISSION IF THE MANUFACTURER CAN CHOOSE THE TEST TYRE?**

Replies:

Czech Rep.: Yes.

Hungary: (see annex 1).

Italy: The tyre/road noise is part of whole noise produced by the vehicle. In the same time the test must be standardised as well as the road surface (the surface has been chosen according to the ISO STD 10844) even for tyres is advisable forecast selection criteria in order to avoid to test all the tyres that could be fitted on the vehicle.

Japan: This is not a problem because tyres are selected by automakers from among those established for the particular vehicle; special tyres are not selected.

Netherlands: Not if this would mean a totally free choice. If the juridical consequences (see answer 1) are taken, this is however very meaningful. Than the test tyre should comply with normal sales/production/use, which was agreed upon in GRB 34. It will be essential to report the noise-index of the tyre in the type approval report of the vehicle.

Poland: Yes, but the car manufacturer must ensure that the test tyre is the most frequently used one

United Kingdom: Yes, (see question 2) but further restrictions on test tyre could be applied, such as the use of widest tyre specified for the vehicle with the highest recorded rolling sound meeting the tyre-noise requirements. This needs further examination to consider the use of the quietest tyre vs. the noisiest tyre masking the propulsion noise.

ETRTO: Tyre/road noise shall be considered through a separate Regulation and moreover, the concern to address environmental noise disturbance shall deter to any suitable tyres available in the market for replacement. Therefore, tyres shall be excluded from the vehicle type approval.

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Question 4: **WHAT TYPE OF ROAD SHOULD BE ADDRESSED?**
– RESIDENTIAL STREETS?
– URBAN MAIN STREETS?

Replies:

Czech Rep.: Urban main streets.

Hungary: (see annex 1).

Italy: On the base of cost/benefits criteria it is necessary to choose roads which are more representative.
According to the FIGE TÜV statistics produced in 1997, these are the "urban main streets". These involve the 73 per cent of the population and the 67 per cent of the whole length of the road network with a speed limit of 50 km/h.

Japan: Noise must be reduced on both residential and urban main streets. In most cases, however, if measures are taken to reduce noise on urban main streets, noise will also be reduced on residential streets.

Netherlands: The goal of the type approval is to reduce the number of people annoyed in the most efficient way. Due to less traffic and lower speed, the L_{eq} in residential streets is lower than in main streets. Yet the number of people living in residential area's as well as the dose-effect relation of single events in residential area's is higher than in main streets. Therefore the total number of people annoyed is in the same order of magnitude for both type of roads.

Therefore the test should include both situations. We advocate a separate limit value for each test condition.

Poland: (no reply provided)

United Kingdom: Both. The considerations of the EU noise working groups including WG8 (Road Traffic Noise) could have a valuable input on this. There are to key issues:

- traffic noise in residential areas
- traffic noise from motorways

ETRTO: (no reply provided)

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Question 5: **WHAT VEHICLE SPEED RANGE SHOULD BE USED?**

Replies:

Czech Rep.: 30-70 km/h

Hungary: (see annex 1).

Italy: The speed range shall be around 50km/h, as it comes out from FIGE TÜV statistics reported in the above point.

Japan: Under urban driving conditions (stop → acceleration → constant speed running (at speeds up to 60 km/h) → deceleration → stop), the range should be set between 30 and 60 km/h, when driving is most frequent.

Netherlands: In case of two separate tests for single event (propulsion noise) and L_{aeq} (tyre/road noise), the latter should be tested at a high speed (50 km/h) in a high gear and the first should be tested at a low speed (25 km/h) and a low gear.
This test has our preference.

However in case of a single mode test there should be a good balance between propulsion noise and tyre/road noise. Propulsion noise is mainly dependent on engine speed and tyre/road noise is mainly dependent on vehicle speed. Therefore vehicle speed and engine speed should both be balanced and based on the urban statistics

- Either the 90 percentiles (V_{90} and N_{90}) are chosen. This probably comes close to the German proposal: (50 km/h in 3rd gear)
- Or the 50 percentiles (V_{50} and N_{50}) are chosen. This probably comes close the ACEA proposal, but based on 35 km/h instead of 50 km/h. The current ACEA proposal is based on the V_{90} and the N_{50}, which gives a balance focused too much on tyre/road noise.

Poland: As in Regulation No. 51.

United Kingdom: 0-120 km/h to satisfy the concerns raised in question 4. The key issues being:

- stationary vehicles (idling noise)
- heavy duty vehicles, high performance cars and motor cycles accelerating from standstill, 0 – 50 km/h in urban areas.
- acceleration of vehicles at WOT in urban areas from 15 – 80 km/h.
- vehicles passing by at constant speeds, of 50 km/h (urban) and 90 – 120 km/h motorway

To address all these concerns 4 tests may be required:

- A stationary idle test.
- 0 – 50 km/h acceleration test with laden vehicles, possibly fitted with tyres to provide maximum adhesion.
- A WOT acceleration test from a fixed speed.

Constant speed drive-by tests where the vehicle is fitted with the tyres specified for that vehicle.

ETRTO: (no reply provided)

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Question 6: **HOW SHOULD THE TARGET ACCELERATION BE DEFINED?**

Replies:

Czech Rep.: We have no information.

Hungary: (see annex 1).

Italy: Must be defined with reference to the power/mass rate of the vehicle considering a "Medium driving behaviour" as proposed in the ISO procedure.
It is needed to avoid the representation of anomalous behaviour that lead to a procedure representing a meaningless statistical condition, similar to the present ISO 362.

Japan: Given that the purpose is to reduce noise generated in urban areas, it is reasonable to use the accelerations of ordinary drivers, not of the small number of speed-craze drivers, since the latter appear infrequently in urban areas. Since surveys in Japan and Europe have indicated that there is a correlation between power-mass ratio and urban driving acceleration, the acceleration conditions of this correlation formula are favourable.

Netherlands: For the noise emission of most vehicles it is more important to have the right vehicle speed and engine RPM than to have the right acceleration.

Defining target acceleration rather than a driving mode (e.g. 2nd gear, or WOT, or both) looks like a good tool to avoid some complications with future gearboxes as well as some possibilities of cycle bypassing. Target acceleration should (in rank order of importance):
- not result in a higher speed and RPM at LA_{max} for faster cars (*);
- be high enough to make sure that the power train is developing the desired power;
- comply with the urban statistics (including hectic driving) on acceleration and RPM in order to avoid sub optimization and or cycle bypassing;
- be low enough to avoid tyres being optimized for unrealistic torque influences.

*) Since the noise emission is mainly dependent on vehicle speed and engine speed, a higher speed/RPM will result in a higher noise level. Therefore all vehicles have to be tested at the same speed. One of the problems with the current ISO 362 procedure is this unequal speed: The entrance speed is prescribed (normally 50 km/h), but the speed at LA_{max} depends on the acceleration (including delays etc.) and varies somewhere between 53 km/h and 70 km/h. This difference in speed, causes differences in LA_{max} of 4 dB(A), which are not found in normal traffic.

Poland: Mainly full throttle acceleration

United Kingdom: Varies according to vehicle type such as high performance cars vs. heavy-duty truck, engine rated speed (rated engine speed is high for low powered vehicles and low for high powered vehicles) and power to weight ratio.

Consideration also needs to be given to the issue of the 'single event' such as aggressive acceleration.

ETRTO: (no reply provided)

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Question 7: **WHAT LIMIT OF ACCELERATION WOULD AVOID AN EXCESSIVE TORQUE GENERATED NOISE OF TYRES?**

Replies:

Czech Rep.: We have no information.

Hungary: (see annex 1).

Italy: It is the maximum acceleration, over that an irregular tyre behaviour is introduced. This is not found in the urban traffic. Such value must be determined by the ISO group WG 42.
(The value of 1.8 m/sec^2 proposed so far for M1 could be acceptable).

Japan: If acceleration and load are matched with urban driving conditions, tyres will not emit excessive torque-generated noise. Moreover, the test conditions that yield excessive torque-generated tyre noise cannot be seen as representing urban driving conditions.

Netherlands: The reported limits of 1.8, 2.0 and 2.09 m/s^2 are well in line with the maximum acceleration found in normal urban traffic by us and therefore are totally acceptable

Poland: We do not see any sense for limiting the acceleration.

United Kingdom: Not certain, but probably depends upon speed and power to weight ratio. Namely, max. acceleration being used from 0–50 km/h for low power to weight vehicles and less for high power to weight vehicles. Should not be so low as to negate the purpose of the acceleration test. The further question of the use quiet tyres (slicks) vs those tyres, which will actually be used on the vehicle in service needs setting out.

ETRTO: This depends on the loading condition of the vehicle. The higher the load, the lower is the influence of torque on tyres, inflated at adequate inflation pressure.

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Question 8: **IF A PARTIAL LOAD TEST IS USED FOR THE VEHICLE, IS THERE A NEED FOR AN ADDITIONAL TEST FOR THE ACOUSTIC PERFORMANCE OF SILENCERS?**

Replies:

Czech Rep.: Yes.

Hungary: (see annex 1).

Italy: A test with partial load, as proposed by the Dutch delegation, suppose the installation in the vehicle of a device to limit the opening of the throttle. This complicate the carrying out of the type approval test and even more the conformity tests.
Therefore, it is advisable that the test will be realised with the WOT (and

constant speed) as proposed by the German and ISO delegations.
In this second case the acoustic performance of silencers is implied.
Japan: Additional testing to evaluate silencers is unnecessary. Test conditions are established from engine rpm, vehicle speed and acceleration, factors that have been determined from urban driving conditions. Noise values under these conditions represent the noise generated by the vehicle in urban driving (noise of the vehicle as a whole including exhaust system noise).

Netherlands: Probably not
- The test should be conform urban statistics in order to avoid sub optimization. This applies for speed (tyres) RPM (engine) and load (exhaust).
- If full load does not appear in normal urban traffic for high-powered vehicles, it should not be introduced in the test. If full load does appear in normal traffic for low-powered vehicles, it should be part of the test for these vehicles only.
- The rise in noise with load is often very non-linear: the largest increase in noise production is already observed at moderate load.
- The partial load condition in the NL-proposal will result in a WOT for low powered vehicles and only partial load for high-powered cars (> 70 kW/t). This will permit considerable freedom in exhaust design in case of extremely powerful cars, which will lead to significant contribution of exhaust noise in during abuse. However, these cars have similar allowances in the existing system as well and due to their small numbers, are not very relevant for the environmental noise problem.

Poland: Yes.

United Kingdom: Possibly. A further drive by test or even bench test would add to the cost of the test, ideally a single test procedure although perhaps with several test speeds is all that is required. The use of a limit value on the idle test may be a way of containing this?

ETRTO: (no reply provided)

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Question 9: **IS A FIXED VEHICLE SPEED SUITABLE FOR THE ACCELERATION TEST SINCE THE GEARSHIFT BEHAVIOUR IS ENGINE SPEED RELATED RATHER THAN VEHICLE SPEED RELATED?**

Replies:

Czech Rep.: No, the problem is engine speed related.

Hungary: (see annex 1).

Italy: The “gearshift behaviour” is connected whether to the vehicle speed or to that of the engine and it is originated by the combination of both, as well as other parameters.
In any case the new test method should be addressed toward the future and not linked only to the present technological situation.
In this way, we are in favour to the introduction only of parameters linked to the kinematic behaviour of the vehicles such as road accelerations/speed.

This is at the aim of avoiding subsequent adaptations derived by the technical progress.

Japan: In actual urban driving, throttle opening and gear selection are performed to match the target vehicle speed (speed limit or traffic flow speed), so there is no problem with specifications focusing on vehicle speed.

Netherlands: Not really.
This seems to be an unsolvable problem since vehicle speed and engine speed are rigidly related via a gearbox with fixed ratio's, which is different for about every vehicle. Therefore we prefer two clearly distinguishable modes: one which is representative for the single event situation (and the engine speed can be chosen accordingly) and one which is representative for LA_{eq} (and the vehicle speed can be chosen accordingly e.g. 50 km/h).

Poland: Yes.

United Kingdom: Yes, but need to define what the objectives of a fixed entry speed and final exit speed are:

- a fixed exit speed forces a low powered vehicle to produce more noise, and the target speed may be difficult to reach. Possibly more typical of urban use.
- a fixed entry speed forces higher powered vehicles to produce more noise on exit. Possibly more representative of interurban use.
- a fixed mid point spend ,may offer the best balance
- the use of both, possibly with various speeds, but this makes the test more complex and expensive.

Comparative data needs to be collated to establish which will the fulfil the objective of identifying a noisy vehicle under the conditions identified to answer of Question 1.

ETRTO: (no reply provided)

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Question 10: **WHAT IS THE FINAL TARGET FOR REGULATING VEHICLE NOISE?**
- WHEN IS THE VEHICLE SUFFICIENTLY SILENT?
- WHAT ARE THE SAFETY RELATED LIMITS?

Replies:

Czech Rep.:
- it depends on the test method;
- 2-3 dB higher than limits for "safety" tyres.

Hungary: An acceptable answer is the following:
"As a real target it could be the significant reduction of the environmental impact of noise caused by (urban) traffic."
(for the conclusions see annex 1)

Italy: The final goal is to achieve a traffic noise reduction. One of the actors of the traffic noise reduction will be the vehicle, but not only.
Finally the choice on which intervene should be carried out taking into account cost/benefits.

Japan: The objective is to achieve environmental standards, which are standards that should be maintained for reducing road traffic noise, protecting human health in all areas and preserving environments for daily life. In reducing road traffic noise, in addition to measures for the

vehicle, comprehensive measures are required, including road measures, noise barriers and traffic flow controls. These measures must be examined from the standpoint of costs and benefits, and steps must be taken to reduce noise from the vehicle as much as possible.

Netherlands: A decent, but safely audible level under all circumstances. As a rule of thumb, this may be translated into a desired noise level (on 7,5 m) not lower than 45 and not higher than 65 dB(A) under all normal urban circumstances.

NB. A small part of the passenger cars already fulfills this demand. In order to reach this goal for all vehicles, it would mean the implementation of this available technology for all vehicles. Already silent vehicles should not be reduced any further. But their status should be established and maintained.

Poland: The vehicle should be as silent as it is possible from technical point of view
The question of safety-related limits should be addressed to specialists in the field of audible perception of humans.

United Kingdom:
- By way of example a vehicle should be sufficiently silent that when sitting outside a street café you are able to carry out an uninterrupted conversation.

- By way of comparison, - a perceived sufficiently silent vehicle would be a gas powered heavy duty vehicle compared with an equivalent diesel powered heavy duty vehicle

- By way of example a safety related limit would be that vehicles are sufficiently noisy at urban speeds to warn pedestrians and cyclist of its presence. This may mean setting a minimum noise requirement as well as a maximum.

- By way of comparison, the safety risks of approaching noiseless fuel cell or electric powered vehicle are higher compared with a small petrol car.

ETRTO: (no reply provided)

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Question 11: **ARE ADDITIONAL SPECIFICATIONS NECESSARY TO AVOID TEST CYCLE BY-PASSING?**

Replies:

Czech Rep.: Yes.

Hungary: (see annex 1).

Italy: The spirit of the test should be that to depict as much as possible the noise conditions of urban traffic noise and as a consequence the levels measured during the test should be those recorded in the urban traffic. Anyway, the possibility of a "cycle bypassing" must be considered. Possible prescription to be introduced on this topic shall be carefully assessed in order to avoid the introduction of unrealisable prescriptions or excessively burdensome.

Japan: To avoid test cycle bypassing, additional specifications may be required, depending on the test method. How specifications will be

established and how they will be checked, however, are difficult problems. (In approval testing, a special test will have to be conducted in order to check whether the test cycle has been bypassed.)

Netherlands: Yes.
As long as low exterior noise levels are not a primary customer demand, manufacturers will always be looking for the easiest way to fulfill the legislative requirements. A “fair competition” as well as a real world noise reduction should be guaranteed with such a specification. General wordings of the text would broaden the scope, but also complicate the judgment of the approval authority.

Poland: Yes.

United Kingdom: The test needs to be representative of actual street use so that it is difficult to use cycle beating devices.

ETRTO: (no reply provided)

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Question 12: **HOW TO HANDLE THE ADOPTION OF NEW LIMITS WITH NEW TEST PROCEDURES?**

Replies:

Czech Rep.: New method => values which will be obtained by using the new method by 70 per cent of the best temporary cars, for all cars in 3 - 5 years

Hungary: This is the most important practical question after the question No. 10. It could be modified as follows:

"How to create a new system of the limits (including a more suitable system of the classification of vehicles based on P/M ratio) to provide a significant reduction of the environmental noise impact caused by the traffic flow?"
(for the conclusions see annex 1)

Italy: The adoption of new limits with the new procedure should be achieved in two steps:
a) In the first step, the limits should depict the present situation, allowing that a relevant percentage of present vehicles, satisfy such limits, it could be adopted a similar criterion to that adopted by the tyre Directive.
b) In the second step, it could be expected the adaptation of the limits in relation to results and indication of the EC Noise Policy Programme.

Japan: The purpose of changing test methods is to match them with urban driving conditions (since in tests conducted thus far, evaluations were made under conditions not matching those of urban driving.) For future regulations, new values should be established, based on current values and in light of environmental noise reduction targets.

Netherlands: This is a very crucial point. It is useless to discuss measurement methods when it is not combined with a re-evaluation of limit values. Any measurement method will be technology forcing as long as the limits are low enough. The best measuring method will not be effective unless the limits are right.

Therefore two steps should be taken at once: Adaptation to the new system and additional sharpening of the limit values in order to achieve a technology jump (i.e. implementation of better, yet available technology).

NB.
- E.g. when the ACEA method would be adopted, the new limit would probably be something like 67 dB(A) instead of the current 74 dB(A): -4 dB(A) to compensate for the change in measurement method and –3 dB(A) to enforce a technology jump.
- The main reason for the existing system not being effective is the too liberal limits during the past 25 years. We have seen too often in the past that a lowering of the limits was compensated by a change in measuring method. This should not happen once again!
- If these two steps are not taken at once, it will be far more effective for the environmental noise reduction to keep the existing measurement procedure and only lower the limits.
- It could be useful to discuss long term goals and a desired time scheme for adaptation of limit values.

Poland: We do not see necessity for introducing a new test procedure

United Kingdom: GRB should set down the test procedure and following this then consider the limit values.

ETRTO: (no reply provided)

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Question 13: **IS THERE AN ENVIRONMENTAL ADVANTAGE OF AVERAGING TEST VALUES?**

Replies:

Czech Rep.: No, it is only the question of reproducibility.

Hungary: (see annex 1).

Italy: The two conditions full load (WOT) and constant speed, have the role to reproduce an urban behaviour, which the vehicle use at "partial load".
None of the two ways is statistically meaningful if considered separately. It is of general interest to consider the vehicle in his statistic urban behaviour without attempts to separate the ways of use, artificially introduced to reproduce such behaviour.

Japan: Averaging of data on tests under different conditions of full acceleration and constant speed driving is necessary for simplification of measurement methodology, but it has no clear environmental advantage. Nevertheless, if the noise values obtained by this method correlate well with the noise values generated in urban areas, using this method to reduce noise levels will also make it possible to reduce environmental noise.

Netherlands: The environmental issues, presented in 1, necessitate the use of two separate test methods with two separate limit values.
Since the technical characteristics of both methods show less correlation averaging would lead to a degradation of the total effect (an extra reduction on the single event level by for instance a very silent drive-line, could lead to less stringent requirements for the LA_{eq} test result. This is from an environmental point of view not an advantage, on the contrary.

Poland: No.

United Kingdom: This aspect needs comparative work to establish the implications.

ETRTO: (no reply provided)

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Question 14: **WHEN THE TYRE ROLLING SOUND EMISSION INFLUENCE THE TEST, SHOULD THE LIMITS BE DEPENDENT ON THE WIDTH OF THE TYRES?**

Replies:

Czech Rep.: No.

Hungary: (see annex 1).

Italy: Consideration on vehicle safety suggests the introduction of noise limits, independent by the tyre width, in a first phase of application of the new method. This above, with the scope to assess the present situation, and eventually decide the adoption of limits, independent by the tyre width in subsequent adaptation phases.

Japan: In the new acceleration noise test method, the contribution of tyre noise is greater than in the conventional test method. This results from an improvement in the reproducibility of noise during urban driving. If vehicle noise can be reduced under the new acceleration test method, it will lead to a reduction of traffic noise in urban areas. Since the entire vehicle, including tyres, is covered in tests of vehicle noise, there is no need to set limit values by tyre width.

Netherlands: Yes.
There is a small group of products (wide tyres, sports cars, 4-WD etc) which is noisier than most of the others. It is far more effective to have technology forcing limits for the mass production vehicles and accept a slightly higher value for the extremities, rather than setting the limits on the level of the extremities and having no effect for mass production vehicles.

Poland: No.

United Kingdom: No. Although wider tyres are inherently noisier there population has become increasingly significant, counter argument to this is that there is a perceived safety benefit with the use of wider tyres. If the tyre function is to be given consideration in the test, the importance should that the widest and noisiest tyre is selected, to encourage noise reduction technologies.

ETRTO: Tyre/road noise shall be considered through a separate Regulation and be independent of any vehicle influence as on the replacement market there will be no way to relate a given tyre type to a given vehicle type.

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Question 15: **WHAT SHOULD BE TEST CONDITIONS AND ACCURACY?**

Replies:

Czech Rep.:

air temperature	0 to 35°C (± 1°C)
track temperature	-5 to +40°C (± 1°C)
engine speed	(2 per cent)
vehicle speed	(± 1 km/h)
humidity	(5 to 10 per cent)

Hungary: (see annex 1).

Italy: Test conditions and accuracy must be related to the best existing technological levels.
It is deemed that the proper service to point out the test conditions and accuracy would be ISO WG 42, where vehicle and instrument manufacturers, Universities, research institutes and tests executors are represented.

Japan: Measurements must be accurate. In the test method, aside from accuracy, reproducibility, precision, simplicity and convenience must also be considered.

Netherlands: 2 dB(A) top-top variation is probably the best which can be reached for a world wide site to site variation. Currently there are a lot of factors causing a significant deviation on the measured result. Examples of reported effects:

- 2 dB(A) altitude effect (0-1000 m)
- 1 dB(A) barometric pressure effect (970-1035 mbar)
- 2 dB(A) temperature effect (0-40 °C)
- 2 dB(A) wind effect (0-5 m/s)
- 2 dB(A) track influence
- 1 dB(A) hill effect (0,5 per cent hill)
- 1 dB(A) measuring equipment

Combining some effects, the total site to site variations might be up to 5 dB(A). Since it is to be expected that many measured values will be close to the limits, such a variation is unacceptable. It will probably mean that a tighter description, and or correction procedures for the test track and the meteorological conditions should be made.

Poland: As in existing Regulation No. 51

United Kingdom: The options and implications need studying.

ETRTO: (no reply provided)

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Annex 1

**HUNGARIAN POSITION ON
QUESTIONS TO BE ANSWERED WHEN CONSIDERING A TEST METHOD FOR UPDATING REGULATION No. 51**

All the questions are fundamental. Analysing them, we have formulated a new approach of the problem of improvement of the Regulation No. 51.

Let's start with the most important question No. 10:

What is the final target for regulating vehicle noise?

An acceptable answer is the following:

"As a real target it could be the significant reduction of the environmental impact of noise caused by (urban)traffic."

Another very important question is No. 12:

How to handle the adoption of new limits with new test procedures?

Really, how? We have some new, complicated test procedures as a proposal, without a word about the problem of limits.

If the final target for regulating vehicle noise is really the reduction of the environmental impact of noise caused by (urban) traffic, then the reduction of the present limit values (keeping the present test procedure) is enough to hit the target. So, here is a modification of question No. 12:

How to create a new system of the limits (including a more suitable system of the classification of vehicles based on P/M ratio) to provide a significant reduction of the environmental noise impact caused by the traffic flow?

This is the most important practical question after the question No. 10, mentioned above.

Our position is based on this approach and it is summarized in what follows:

1. It would be better to keep the present test procedure. A new system of limits is needed to provide a significant reduction of the environmental noise impact caused by the traffic flow. The benefits are:
   - simple, well known, inexpensive test procedure
   - it is possible to provide the reduction of the environmental noise impact using a suitable system of the limit values
   - the results of the present and the future type approval tests will be comparable
   - it is important, that the results of the investigations carried out by the researchers of FIGE, Japan, the Netherlands, etc. are usable to create the new system of limit values. The work will not be useless.

2. The limits in Regulation No. 51 should be concerning to the total emitted noise of the vehicle (i.e. including the rolling noise).

The justification below summarizes shortly why the reduction of the present limit values (keeping the present test procedure) is enough to provide a significant reduction of the environmental noise impact caused by the traffic flow.

JUSTIFICATION

It is generally admitted, that the regulations have acoustic energy descriptors usually explicit as L_{eq} to characterize the environmental impact of the noise caused by the traffic flow.

To give proper answers to the questions it is necessary to have a model for L_{eq} which shows the influence of the type approval limit value.

THE MODEL

Wide ranges of vehicles take part in a real traffic flow. The equivalent noise level is given by their average noise emission. To build a simple noise model let's deduce the case of real traffic to the case of just one type of vehicle going on the road.

To make things easier we think of a fictive type of vehicle. We substitute this vehicle for real vehicles in the in the traffic flow in such a way, that the equivalent noise level (L_{eq}) of the fictive traffic should be equivalent to the L_{eq} of the real one.

We define our fictive vehicle as statistically equivalent to the real cars. It seems to be practical to categorize the statistically equivalent vehicle in the same way as we do with real vehicles, making difference according to the P/M ratio of the vehicles (i.e. class of cars, light and heavy vehicles).

Here is the noise model that consists of just one type of vehicle (i.e. the statistically equivalent vehicle):

$$L_{eq} = L_{max} + 10\ \log((Q*\pi*d_0)/(T*v)) + 10\ \log(d_0/d)^{(1+a)} + 10\log(b/180) + K$$

where:

"L_{eq}" is the equivalent sound pressure level for one class of vehicles (i.e. for the ith class)
"L_{max}" is the class SPL_{max} (maximal value of the pass-by noise level at the reference distance d_0)
"Q" is the number of the vehicles of the i-th class passing during the relevant hour
"d" is the perpendicular distance from the centre-line of the traffic lane to the receiver
"a" is a site parameter between 0 and 1
"v" is the mean speed of the i-th class
"T" is the duration, usually 1 hour
"b" is the angle of the observer's view of a section of the roadway
"K" is the excess attenuation due to barriers, buildings etc.

(The proof of this formula is not complicated, I can put it at yours disposal.)

According to this model the L_{eq} (i.e. the basic descriptor of the environmental noise impact) directly depends on the L_{max} and the traffic density

[density (veh/km) = traffic flow (Q, veh/h) / speed (v, km/h)].

CONCLUSIONS

The value of L_{max} primarily depends on the velocity, but the load of the engine also has an important influence. Let's see how.

The practicable (possible) values of the maximum pass-by noise level are located between the upper and lower limit curve on the plane $L_{emitted}$ versus the vehicle speed (v).

The upper limit curve is given as a resultant of the rolling noise vs. vehicle speed [RN(v)] and the highest engine noise at maximum vehicle acceleration vs. vehicle speed [HEN(v)] through the following formula:

$$10 \log [10^{0.1RN(v)} + 10^{0.1HEN(v)}]$$

Similarly, the lowest limit curve is given as a resultant of the rolling noise [RN(v)] and the lowest engine noise at zero vehicle acceleration [LEN(v)] through the following formula (the rolling noise is dominant):

$$10 \log [10^{0.1RN(v)} + 10^{0.1LEN(v)}]$$

The range between the limit curves is quite wide (approx. 7-12 dB) for the i-th class at normal urban cruising speed. This means, that the highest engine noise level is above the resultant of the rolling noise level and the lowest engine noise level (at zero acceleration) by this 7-12 dB.
The momentary value of the noise-level emitted by a vehicle under urban driving circumstances depends on the partial-load of the engine at a given, constant cruising speed. This value will be found between the limit curves, which belong to the class of the given vehicle. In case of heavy vehicles (the power to mass ratio is low) the noise level will be quite near the upper limit curve, and as the P/M ratio is increasing (light vehicles, passenger cars) the noise level will be nearer and nearer the lower limit curves. So, the characteristic value of the noise emitted by a vehicle under urban driving condition depends on the P/M ratio. For this reason it is suitable to make further classification for the vehicles within the main categories on the basis of the P/M ratio, and to determine the limit value as a function of the P/M ratio.

The upper limit curve also depends on the type approval limit value through the following manner: an ISO 362-like test procedure is a "worst-case method". It calls for test to be conducted with no load at full acceleration from 50 km/h in 2nd and 3rd gears for cars and at full acceleration at ¾ S (three-quarters of the max. engine speed) in N/2 gear and above (N = total number of gears) for heavy vehicles. Thus the reduction of the type approval limit value yields a downward tendency of the practicable value of L_{max} (i.e. the upper limit curve).

Two ways are available to reduce the emitted noise of a vehicle under urban driving conditions: the reduction of the rolling noise and the reduction of the engine noise (the noise of the manifold system has no dominant importance any more).

Let's consider that the Regulation No. 51 orders a new, stricter limit value for a vehicle category. What will happen if the rolling noise is profoundly below the engine noise? The manufacturer will reduce the engine noise, because the engine makes a significant contribution to the emitted noise. The reduction of the engine noise yields an increasing contribution to the total (emitted) noise by the rolling noise. However, when the engine noise decreases because of the more strict limit value, the range between the upper and lower limit curves more and more will be reduced, the emitted noise more

and more will depend on the (worst case-like) limit value. Remember that the rolling noise has not changed. The conclusion is obvious: **a significant reduction of the (worst case-like) limit value is able to produce a significant reduction of the environmental noise impact caused by the traffic flow**.

Regarding the present situation, it can be to make the most of not utilized possibilities to reduce the emitted noise by way of reducing the engine noise. In the next stage of improving of the Regulation No. 51, when the rolling noise will be the only dominant noise source of a vehicle under urban driving conditions (nowadays not yet), a harmonization will be needed between the new, tyre-road noise Regulation and the Regulation No. 51.

Based on this Justification it is plausible that a suitable reduction of the type approval limit value is able to produce a relevant reduction of the noise impact caused by the traffic flow, just like the new proposed test procedures are able to do it, but without their problems.

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