Draft Report of

3rd Meeting of the Informal Working Group

on

Quiet Road Transport Vehicles for a Global Technical Regulation

April 16th to 18th,

held at the ACEA offices, Brussels, Belgium

1. Introduction of participants and organizations

National bodies:

Canada (Transport Canada), Spain (LCOE), EU Commission, Korea (Korea Transportation Safety Authority), US (NHTSA, Chairman), Germany (BMVBS), Japan (NTSEL & JASIC), France (UTAC), China (CATARC).

Associations:

NFB (US National Federation of the Blind), OICA (SMMT, JAMA, Renault, MAN, Porsche AG, Daimler AG, Scania, Volvo Trucks; Volvo Car Corp., Ford), ISO, CLEPA (Denso, Brigade Electronics), IMMA,

Researchers:

IDIADA

2. Opening remarks by Philippe Jean, EU Commission

Head of Unit Sustainable Mobility and Automotive Industry

Mr. Jean points out the importance of the subject of QRTV becoming more prominent in daily traffic in future and with it the need to develop adequate legislation. A GTR with worldwide accepted technical prescriptions and requirements for AVAS is prerequisite for a sophisticated device, keeping costs for the manufacturers to a minimum level at the same time. Mr. Jean thanked NHTSA for taking the role of chair of this WG. Also he expressed the Commission’s determination to support the development of a practical solution for a common standard.

3. Adoption of the agenda

OICA stressed the importance to determine the road to finalize the work of the group in line with timeline a fixed in the ToR and proposes to fix timing for the future proceedings in the working group.

The agenda was adapted accordingly

4. Adoption of the minutes of 2nd meeting

The minutes were reviewed and adopted without changes

5. Consideration and review of the key technical elements for the draft GTR

5.1. Review of latest ISO work (measurement conditions and metrics)

Follow up of tasks assign during last meeting. In cooperation with OICA and SAE, ISO evaluates the findings from the first QRTV meeting. During the last meeting, issues had been identified in terms of Measurement and correction for 1/3 octave data, Measurement uncertainty and the use of minimum sound levels in 1/3 octaves for detection and recognition. In addition to the handling of the known issues, also some new information is given on additional vehicles that are tested according to the requirements from the NPRM. Testing has been performed using the named requirements in order to show interior versus exterior and Indoor versus Outdoor noise data, results from jury testing, the application of the Loudness model and pitch shifting issues.

A comparison between overall sound level measurements revealed that while indoor measurements has advantages at stationary or low speed testing due to the lack of background noise, measurement at higher speed (20km/h and 30 km/h) is unsatisfactory due to the noise coming from tires interacting with the dynamometer rolls. For outdoor measurement, the findings are the other way round. Stationary/low speed is difficult to evaluate due to relatively high background noise, noise at higher speeds however can easily be measured.

1/3 octave bands can merely be measured outdoor as they are not stable but would need longer measurement periods. Indoor measurements at stationary and 10 km/h can be carried out with good result for precision and repeatability. At higher speeds, again there are issues arising from tire noise resulting in data that can so far not Cleary be identified.

The measurement of interior noise reveals a significant difference in noise levels between AVAS on and off up to >25dB.

The results from jury testing show good correlation between Lcrs OA sound level and the detection distance in the way that detection constantly increases with increasing vehicle speed.

Comparison between indoor and outdoor at 10km/h proves the same detectability of overall sound as well as for all 1/3 octave bands.

According to Professor Colin Novak, University of Windsor, Project Leader for ISO TC43/WG9 “Loudness”, the ‘Moore partial loudness model’ used by VOLPE is older version and needs to be updated. However the impact of that update is not clear and needs further evaluation. The impact in the 300-800 Hz band can be up to a 10 dB difference
The model was intended for single frequency band analysis. Impact of multiple frequency bands needs further analysis.

The analysis of a simulated test with a small frequency band shifting with vehicles speed showed that this shift can be detected from comparing the overall noise levels at different speeds. This was to prove that frequency shifting can be objectively evaluated.
When comparing indoor with outdoor measurements results from a vehicle test however the concern with negative impact especially at higher speeds becomes obvious, outdoor even more than indoor. Clear recommendation therefore is to carry out simulated testing, either on the vehicle or at pure component level.

Forecast/Recommendations

Latest findings support a viable technical approach for measurement and analysis. SAE and ISO documents will be updated in short term to reflect editorial, clarification, and corrections noted in ISO/CD ballot comments (3-4 months for republished SAE J2889-1).
Inclusion of updated 1/3 octave measurement procedure and developed commencing motion procedure will take further time (9-12 Months for implementation into SAE and ISO).
Alternative pitch shift measurements need conceptual development and validation

Choice of bands and levels might need to be reevaluated to better match required detectability without negative interior noise impact to customers. The conflict between the requested detectability of an approaching vehicle for road users and the potential annoyance of vehicle passengers can probably be solved by more accurately selecting frequency bands with the associated levels.
A test alternative for full vehicle outdoor measurements may need to be developed for more robust results. Pitch shifting reviewed to allow “Gear Shift” effect for improved detectability.
A clear guidance from the IWG on direction can reduce development time within ISO/SAE

Questions/remarks

OICA criticizes the low level of flexibility that the NPRM incorporates. An OEM needs the possibility to design a sound so to not only fulfill the required safety aspects but also customer expectations. Experience from interior sound design shows that while an average sedan driver would expect a high level of silence, sports car drivers would probably accept turbo whistling.

The basic concept of 1/3 octave bands needs to be overthought because it necessarily leads to sounds intruding into the vehicle and at the same time not being acceptable to the customer. Other than sounds coming from the engine or even music, pure 1/3 octave risk to be rejected.

It is a political decision to allow pitch shifting to simulate gear changes or to purely simulate a vehicle speed increase.

Chair: do we already know what customers are ready to accept?

Canada: Marketing groups of OEMs best know about customer expectation and assumed acceptability
OICA: As this is a new subject where we have very few experience, we can only guess based on experience we made with sounds from ICE. However it is obvious that sound is a very important attribute of a vehicle. We therefore strongly support the idea of having as much flexibility as possible, allowing us to reprogram a sound on vehicles in the fleet, once it turned out that a specific sound is rejected by the customer.

Presentation of OICA database

The OICA database contains 97 vehicles in the meanwhile and will increase in future. It consists of a standardized data input sheet for all relevant data in terms of technical data of the respective vehicles as well as for sound emissions including ECE R51 pass-by noise. For QRTV several conditions are recorded:

- Stationary with the intention to drive forward
- Stationary with the intention to drive reward
- 10km/h
- 20km/h
- 30 km/h
- 4 runs
- Stationary
    - Minimum
    - Maximum
    - Average over 10 seconds
    - 5 microphone positions
    - semi-circle around front and rear end of vehicle : left /right/center front /45 degrees
- Pass by
    - Maximum at entry into test track
    - Maximum at height of micro

Maximum SPL and frequency analysis is measured.

Also listening files are recorded; however we have not yet determined a common format. Therefore this data is not widely distributed. Also interior sounds are recorded to get a picture of the effect of exterior sounds on the passenger compartment.

A sample is played of a vehicle that is equipped with a sounder that meets the proposed NHTSA requirements. The vehicle is prepared with the same insulation measures as applied to vehicles of the same types but with different powertrains. The sound sample shows that the interior noise increases by 3 dB(A). It is difficult to further improve the insulation measures. A sound coming from outside must not necessarily be completely suppressed, but it must be acceptable to the customer.
A pleasant sound composed of harmonics is potentially better accepted. One can imagine the requirements for 8 frequency bands as a minimum requirement with the possibility for the OEM to add further sound components. The 8 prescribed frequency bands must however have a lower minimum level. This would allow the creation of a sound well recognizable from exterior, but at a low interior SPL with an acceptable quality for the passengers.

Suggestions for AVAS sound requirement (Japan)

Japan presented results from various examinations on the requirements for the sound quality of AVAS. The examination result in the following suggestions:

- Sound must be emitted from at least 2 1/3 octave bands
- The audible distance should be proportional to the overall sound level

Both suggested requirements have been verified with various forms of testing including lab and jury testing.

The mentioned overall level shall be determined as a function of the vehicle stopping distance. However the required SPL to fulfill that target is not yet decided at the moment and needs further investigation.
1 kHz to 5 kHz is detectable for people with normal hearing; elderly people have difficulties with the higher frequencies.
OICA: on the first glance it appears as if it positive under environmental aspects to use as few energy as possible when producing a sound that is detectable because this reduces the overall SPL. But this has nothing to do with annoyance. Even a low SPL signal can be an issue for public. We must be careful not being too scientific when determining suitable frequencies, leaving aside the subjective aspect of public perception.
CLEPA: the frequency band from 1 kHz-5 kHz as identified by JAPAN is not only best for detectability but also for locatibility.

ISO: how precise do you need to define the content within one individual 1/3 octave band?
J: This question needs to be discussed in ISO.
OICA: In fact, looking at page 6 of the presentation, the shown curve may be interpreted to contain more than only 2 prominent frequencies, but 5 or even 6, depending on how narrow the definition of one frequency is taken. A clear definition is needed. This does also contain the opportunity to leave room for flexibility to the OEM as long as he designs sound outside of the defined requirements.

Discussion on certification systems

Self-certification scheme in Canada – Canada's Motor Vehicle Safety Regulations

Any vehicle regulated under the Motor Vehicle Safety Act, which is imported or offered for sale in(to) Canada has to be self-certified by the OEM at the time the main assembly of the vehicle is completed. It is the responsibility of the OEM to ensure compliance of its products with existing legislation. Documentation showing proof of compliance must be produced and retained for at least five years from date of manufacturing or importation and supplied to Transport Canada upon request. The test methodologies used by the OEM to certify their products should be in accordance with the test requirements detailed in the Motor Vehicle Safety Regulations.

Self-Certification scheme in the United States

The OEM is obliged to meet certain requirements, testing is not mandatory. It is not a violation of US law if no in-house reports are available. However usually he would do the testing do to be confident that requirements are met. NHTSA will do performance testing with vehicle samples that are acquired anonymously. If in this test requirements are not met, NHTSA will request certification data from the OEM. If data made available by the OEM does not prove compliance, this may ultimately lead to recall civil penalties.
This is for safety certification. Environmental aspects may be treated differently. EPA in some cases, e.g. Exhaust Emissions, issues certificates, yet they are not based on EPA testing but on information delivered by the OEM. Compliance with requirements is typically verified with field surveillance testing that is carried by EPA in its own labs. Just as with Safety requirements, the OEM will be requested to deliver evidence in the case of non-compliance. For Exterior Noise, no certificates will be issued; it is assumed that vehicles are in compliance by virtue of bringing the product to the market.

Compared with the type approval process applied in some countries, for self-certification compliance a product must fulfill requirements at all possible conditions covered in the standard. In contrast for type approval one specific condition of the range of possible conditions is tested and leads to approval. Example: In a given temperature range from 20-

30°C, the OEM must take care that his product is in fulfillment of all possible combinations of conditions while for TA, if it is proven that for one condition the product is compliant, there is no necessity to prove other conditions.

A presentation of TA system and principles will be given at a later stage.

Enforcement Program in the US NHTSA (NHTSA, Chairman)

The chairman gave a presentation about the rulemaking and enforcement process in view of FMVSSs

NHTSA has authority over two large areas – a behavioral part and vehicle safety part. Senior associate administer of the Vehicle safety part is Dan Smith. He is in charge of four offices:

- rulemaking office,
- research office,
- data office,
- Enforcement office.

Each office is headed by an associate administer. This presentation focuses on the proceeding of the enforcement office headed by Nancy Lewis. There are three sub offices:

- office of defects and investigation covering any safety related problem in the field (responsible for most of the vehicle recalls)
- Office for vehicle safety and compliance **OVSC** (market surveillance to check conformity with FMVSSs). Also covers CAFÉ Fuel Economy Enforcement program
- Office for odometer fraud department relying on data delivered by EPA.

All FMVSS have to meet basic criteria to be established. These basic standards are

- there must be the proof that there is a safety need,
- it must be practicable, i.e. it must be technically feasible,
- it must be objective and measureable, meaning that there must rules for proceeding allowing several bodies independently to carry out a verification test and come to the same result.
- Standards are typically performance based, and
- it must be appropriate for each vehicle type.

Methods of enforcement:

- Recalls
  Any product brought to the market must comply with all FMVSS standards. An OEM must on own initiative do a recall (notify the owner and provide remedy for the entire

population of the concerned vehicles if it learns about safety defects or non-compliance or if NHTSA decide to do so. This duty is not limited to non-compliance with FMVSS standards but is also applicable in the case where an OEM detects a safety defect of any other nature.

- Civil penalties
  $6.000 per violation limited to $25.000.000 for related series of violations.
- Criminal penalties

Defects and investigation office screens many sources of information of possibly defects to identify likely candidate for investigation, such as customer complaints, monitoring of OEM bulletins and advisory for the dealership, early warning reports – self reporting of the manufacturers about possible concerns, formal petitions to the administrator.

Presentation on US Rulemaking process (T. Healey/NHTSA)

In the US both formal and informal rulemaking processes exist. In publishing safety standards, NHTSA usually applies informal rulemaking. Formal is traditionally reserved for licensing. Informal rulemaking usually consist on the publication of an NPRM and the subsequent receipt of comments. The decision for the final rule has to be based on the administrative records, i.e. all documents that are used for the final rule must be publicly available so that everybody can follow the process. The reason is fairness for all stakeholders. Not placing everything in a docket may result in the rejection of law.
A record of the ongoing of the QRTV meetings will also be published. All questions put and comments made will be recorded and made available for public follow up.

Deep dive explanation of the NPRM (T. Healey/NHTSA)

The US NPRM was presented by the US since no other info was added. The subsequent discussion incl. all comments will be available from the NHTSA website soon.

Presentation 'Vulnerable road users awareness using wireless Communication' (OICA/Ford)

This presentation gave a status report about the current status of wireless technology in the field of V2X (=V2V – vehicle to vehicle & V2I-vehicle to infrastructure). It is may also be known as C2X = Car to x. Its deployment is expected for CY2015. It is an essential part of the IT'S (Intelligent Transport System), which is anticipated to significantly reduce the number of road accidents.

This driver assistance technology uses Radio frequency devices, intended to extend the possibility of communication between vehicles and other road user over a distance of up to 200m and at low cost. It goes beyond the classic communication that it based on visual or audible contacts between the road users, either via eyes, ears or cameras. Objects covered by buildings, trees or other vehicles are detectable on a bi-directional communication, allowing the proactive participation in traffic under safety aspects. Also it allows safer, more efficient and more comfortable driving.

There are a number of activities ongoing on a worldwide basis where both governmental bodies and Industry work together on the further development of this technology. The associated technologies are integrated into vehicle systems to a constantly increasing degree.

The idea behind RFID tags is to inform the vehicle driver about the proximity of a vulnerable road user. In a second step a notification to the pedestrian shall be raised. Today it is not clear which kind of Human Machine Interface shall be used – a Smartphone is one opportunity. Up to now there are no dedicated solutions for blind road users. It is a general challenge for the V2X technology if users at both ends are equipped with the specific devices. The European Commission is specifically interested in how it is thought to avoid the risk of overloading road users with additional information coming from V2X technology. It also expects a much bigger advantage for the driver as for the vulnerable road user. NFB sees the concern that probably blind people wouldn't want to carry an additional device, so that it is questionable if such a system could work reliably. In terms of using the mobile phone as carrier of a RFID it was stated that today's Android technology is not suitable to be used by blind people.

6. Practical demonstration of AVAS meeting NPRM requirements (CLEPA/Brigade)

In the proximity of the meeting location, a vehicle based demonstration of a sound emitting device was in order to evaluate recognisability as well as impacts on interior noise. A Hybrid vehicle equipped with two speakers, one at each front and end of the vehicle, and two different sounds were shown.

Prior to the demonstration it was explained that the sounder fitted to the vehicles would not meet the proposed requirements from NHTSA. The signal fulfills all the basic requirements in terms of detectability and locatibility and at the same does not penetrate into the vehicle. The sound of the AVAS fitted to the demo vehicle did not have the full spectrum as initially specified. However, it contains ten 1/3 octaves with distinct signal/noise ratio between 1 – 8 kHz. This along with the modulation is the reason why it is detectable despite its low SPL.

The chair asked to explain how the sound that was heard during the demonstration compared to the proposed requirement in the NPRM. CLEPA stated that is meets the intend of having content between <1kz to >5 kHz and at least 8 1/3 octave bands with a distinct signal/noise ratio so to give sufficient info for detectability and locatibility. With 4 of these bands fulfilling the requirements as described, it meets about 50% of the NPRM. The overall SPL is about 52dB. The second sound had much more tonal content with a very dominant signal at 1 of the 1/3 octave bands which lead to a penetration into the cabin. The overall SPL was about the same. ISO requested CLEPA do deliver to the group a more detailed analysis of the presented sounds. NFB supports ISO's observation that the sounds as presented fulfilled the intention in terms of detectability. OICA questioned if the SPL during forward driving was the same as during reverse. The reason behind this question is the fact that on trucks other than on passenger cars, a speaker would have to be mounted very near to the windscreen and can't be so that there is a much higher risk of driver annoyance. CLEPA confirmed that the SPL measured at the speakers is identical, but due to the lower masking effect of the rear speaker, the intrusion of signal coming from the rear speaker into the cabin was much higher. On request from NHTSA, CLEPA stated that there is noise known reason for the hardware as used on the vehicle cannot meet the specification as proposed by NHTSA. However this remains to be practically proven. Japan mentioned that the first sound was not in line with the requirements from the Japanese guideline as a continuous sound is required, whereas the demonstrated sound contained modulation. ISO claimed that the term of 'continuous' may need a concrete definition as some may see the modulation from the first as continuous while other what interpret continuous much stricter. NHTSA mentioned that modulation may be desirable as it may lead to improved detectability.

Presentation 'Drive patterns of EVs' (Korea Transportation Safety Authority)

Korea carried out intensive research on road operation, monitoring and safety assessment of EV and typical drive pattern throughout the last 3 years. The appropriate SPL for AVAS can be determined by comparing human detection of ICEVs. In order to clarify the term 'Practical use' as included in the GRB proposed guideline for AVAS sound, one must differ between the driving states deceleration, cruise and acceleration. On an ICEV, the SPL increases with acceleration. However so far testing for the development of the test method has only been done in cruise and it needs to be clarified if this is sufficient. The results already presented during the last meeting in Berlin showed data for cruise as well as for acceleration which supported the thesis that sound emission during acceleration is higher than during cruise. Between 2010 and 2012, during 1194 days in several cities, 'Research of road operation monitoring on the EV' was carried out. During these days, typical drive patterns were recorded and it turned out, that cruise condition is very rare. In summary the analysis of typical patterns revealed that

- Instantaneous acceleration or deceleration occurs continuously in actual road driving.
- It is hard to see cruise drive patterns especially in low speed.
- Also, it is not easy to maintain constant speed in low speed.

This leads to the conclusion that

- Many transient drive patterns are typical for real traffic situation.
- Actually, it is hard to maintain constant speed within a low velocity.
- We have to determine the reference driving condition either minimum level compared to ICEV or the real traffic sound level of ICEV.
- The generated sound during cruise is close to minimum.
- Therefore, the SPL should increase if we consider acceleration

ISO confirmed that the test procedure is designed to measure the minimum sound emission. During the development of the method is turned out, that it is difficult to reached repeatable constant acceleration at low speed and out of practical reasons it was decided test in cruise condition. Also ISO can support the finding that during acceleration, the emission is increased compared to the cruise emission at the same speed. The reason in the tyre torque effect. An AVAS only emitting the minimum of typical cruise condition at the respective vehicle speeds would simulate the pure vehicle or powertrain noise. An EV fitted with such an AVAS and under acceleration would however emit a higher noise as the noise coming from tyres would be produced and must be added to the AVAS emission. Therefore it is sufficient for the AVAS to produce cruise sound emission only. It must however be admitted that, an increase in engine speed and the associated increase of noise may occur prior to an increase of vehicle speed.

Presentation Work program of the IWG in view of the timeline as given in the ToR (OICA)

OICA presented an outline that takes into consideration the timeframe as contained in the ToR of the working group. This proposed timeline is intended to clearly determine the necessary next steps of the IWG so to deliver to GRB and WP29 an anticipated draft GTR by September 2014 and November 2014 respectively. Beside a timely schedule for next meetings, it also clearly describes the necessary work that needs to be accomplished during those meetings. Following this timeline would result in a publication of the GTR late 2015. The proposed timeline was accepted by all involved parties.

Presentation ‘Recent Findings from Research conducted by Mercedes Benz and the Technical University of Dresden (OICA)

The objective of the research carried out by MB and TUD is to determine the effect of different sound characteristics in a situation where a stopped vehicle near a pedestrian resumes motion. It intends to clarify the necessity for having sound at idle. So to ensure for a visually impaired pedestrian to quickly recognize vehicle has started its movement.

The following basic variances in sound of the quiet vehicle were compared:

- Vehicle with sound at idle
- Vehicle without sound at idle
- Vehicle without sound at idle but with commencing motion sound (CMS)

In all cases the sound of vehicles when driving complied with the NPRM

In a testing arrangement, the subject should signal the approach of a vehicle that was original stopped at a distance of 10m. The a.m. variances of vehicle sound where overlaid by different types of ambient noise. Test is carried in the TUB sound using recordings taken in the MB indoor test rack. 30 subject (25 sighted/5 visually impaired or blind) were exposed to. Test conditions differing not only in the a.m. variances but also in randomized starting time of the vehicle. It was their task to signal. The average results:

- Stationary sound 1.43s delay after start of vehicle
- No station sound: 1,12 s
- CMS +6 dB(A): 1,02
- CMS +12 dB(A): 0,84s

In summary it can be concluded that the capability of detecting a starting vehicle w/o sound at idle is bigger (1.12 s) compared to a vehicle with stationary sound (1.43 s) and the application of a CMS accelerates detection even further (0.84 s – 1.02 s). The different ambient didn’t not result a significant difference in detection time.

These test results suggest that the sound change (contrast) transitioning from no sound while stationary to alert sound active in motion has a measurable effect on detectability.

The results are in line with the joint demonstration conducted by Nissan, Toyota, Honda and Mitsubishi, showing that sound level of sound at idle as proposed by NHTSA can mask the sound of an approaching vehicle. A vehicle poses a danger to a visually impaired person only as it starts to move. Therefore, quick detection of a vehicle approaching is paramount to the detection of a stationary vehicle. For this situation the study shows that CMS is more effective than sound at idle. It is therefore proposed to allow CMS as an alternative to stationary sound.

NFB: What would be the result in the case of sound at idle and CMS?

OICA this risk to result in a vicious circle as it would always request in CMS to be louder than the sound at idle with all its negative impact on the environment.
NFB: The concern of no sound at idle is that a blind would not know of the presence of a vehicle at all and can therefore not take any appropriate action. A vehicle would only be recognisable when in motion, but not earlier. Also, hearing a vehicle would not only give information about the vehicle itself but also about the presence of a street and can therefore increase the orientation.
OICA: from a safety aspect, it may be important to have as much information available as possible. We must prioritize, which information is of higher value: a vehicle in standstill which in this condition does not pose a risk or a moving vehicle.
NFB: blind unions and associated institutions have all expressed their preference for sound at idle over CMS.
EU: Isn't there a risk of masking of vehicles behind vehicles with sound at idle?
NFB: the risk is minor as once you hear one vehicle, you are aware, that a second one might be masked so that you can take appropriate action.
OICA: In terms of improved orientation, there are other items that better serve, such as house wall and curb stones
NFB: in a residential area this may be true, but in normal urban traffic with multilane roads, any acoustical info is very helpful. Start/Stop systems of ICEV risk posing a similar concern.
OICA: For an engineer it is important to collect data that can be analysed. It was not the intention of this presentation to argue against navigation aids, but some of the mentioned arguments are difficult to measurement and with it difficult to evaluate. The presentation intended to show that there is a risk of masking other potential risk. So we must balance our knowledge between safety aspects, but also we must consider the environmental aspect in parallel.
EU: we support the OICA position and are interested in learning about the NFB's attitude towards the potential lowering of environmental noise from EVs.
NFB agrees overall sound level going down is beneficial. The final solution will have to be determined based on a concerted compromise between safety and environmental aspects.
The Chairman concluded that there is a general conflict in approaching the subject of the necessity of a sound at idle. While a sound at idle may be used for general navigation purposes as it includes the information about the location of a nearby road, it is not supportive for the cognition of a vehicle that changes its condition from standstill to move.

<u>Interaction between QRTV and maximum noise requirements acc. to ECE 51 (GRB chair)</u>

During the last WP29 meeting the potential overlaps between both ECE 51 and QRTV were discussed. Requirements for overall SPL as defined in the NPRM may result require more SPL than parts of ECE51 would allow. There is no conflict in terms of speed range as the Annex 3 test is carried at a level above speeds applied in QRTV. However the potential future limits of 68dB(A) risk to be near to the overall SPL from QRTV. The GRB chair questioned if it was possible to determine QRTV requirements without considering the environmental aspect. The annoyance resulting from vehicle noise at any speed is important, independent from the application of legal limits. The Chairman reminded the group of the environmental assessment that is part of the NPRM. It reveals that the overall impact on the environment is insignificant, namely in the magnitude of 0,9 dB(A) However, there is no cost-benefit analysis available. ISO clarified that the ASEP speed range is in the region of conflict. The basic idea of ASEP is to prove that the TA value from Annex 3 is representative for the vehicle's sound emission at all velocities. France looked back to the demonstration that was given to the group which revealed that a vehicle is recognizable even with an overall SPL of 50DB(A) in a normal ambient condition.

Presentation Electric Vehicle Alert for Detection and Emergency Response (eVADER)

This EU funded project intends to increase the pedestrian safety in view of risks arising from quiet vehicles on one side and keep the noise levels of those vehicles at the lowest possible level on the other side. Basically the idea is to actively detect pedestrian and evaluate the potential risk for collision. A sound shall be emitted in the direction of the pedestrian only. The emitted sound must clearly be different from background noise so to better be detectable. The detection of pedestrians is effected with the use of a specific camera that constantly screens the area in front of the vehicle. The sound to be emitted is produced using up to 6 speakers or inertia mass shakers that bring the front bumper of the vehicle in motion. The intended interference of various noise sources of the bumper results in a sound that 'sends' the majority of its energy into the direction of the detected pedestrian only. In order to allow the system to evaluate the risk for collision, data from typical traffic accidents with pedestrian have been analysed. Also typical background noises from urban traffic were elaborated. Sounds have been identified and developed, using sophisticated understand of the psychoacoustic mechanism in the ear, that have the same recognisability as a Diesel engine but at a level of 6 dB below. For the brain it is much easier to detect a single frequency rather than a broadband signal. However in order to cover situations where a person is not detected by the camera, permanent low level omnidirectional signal needs to be emitted in addition. That signal will be adapted to the background noise and to the actual location of the vehicle. The characteristic of the location, determined from a GPS signal will also influence the signal. Within this year a practical demonstration of a vehicle will be available.

Inside of the vehicle, a directed signal will be emitted that informs the driver about the presence and the location of a pedestrian with collision risk. So far the system is developed to have frontal and lateral detection of pedestrians.

US: cost taken into account in the economic analysis is for speakers and added cost for energy.

COM: Beside these direct costs, also indirect costs must be looked at, such as cost for society, long terms effects, and health costs. The broader view on the financial impacts is the motivation for COM to launch the project.

eVADER: The costs for the system today are high as it deals with innovation. But it is expected to substantially lower by the factor of 10 within the 5 years.

OICA: Typical vehicle sound should be composed of single frequencies, not from broadband. AI requests to define a frequency range and an overall level. Inside of this range, the OEM is free to liberately determine frequency bands incl. pitch shifting and modulation.

Presentation Overview on 1998 Agreement - Criteria for technical regulations

The Chairman explained the background for the development of the GTR for QRTV with a special focus on the criteria as laid down in article 4 of the 1998 Agreement:

CRITERIA FOR TECHNICAL REGULATIONS

4.1. To be listed under Article 5 or established under Article 6, a technical regulation shall meet the following criteria:

4.1.1. Provide a clear description of the wheeled vehicles, equipment and/or parts which can be fitted and/or be used on wheeled vehicles and which are subject to the regulation.

4.1.2. Contain requirements that:

4.1.2.1. Provide for high levels of safety, environmental protection, energy efficiency or anti-theft performance; and

4.1.2.2. Wherever appropriate, are expressed in terms of performance instead of design characteristics.

4.1.3. Include:

4.1.3.1. The test method by which compliance with the regulation is to be demonstrated;

4.1.3.2. For regulations to be listed under Article 5, where appropriate, a clear description of approval or certification markings and/or labels requisite for type approval and conformity of production or for manufacturer self-certification requirements; and

4.1.3.3. If applicable, a recommended minimum period of lead time, based upon considerations of reasonableness and practicability that a Contracting Party should provide before requiring compliance.

4.2. A global technical regulation may specify alternative non-global levels of stringency or performance, and appropriate test procedures, where needed to facilitate the regulatory activities of certain countries, in particular developing countries.

The Chairman pointed out, that the final scope of the GTR to be developed still needs to be specified. Today we are looking at all types of EV/HEVs. That include passenger cars, buses, lorries, 2- and 3-wheelers etc. In the course of the development of the GTR it needs to be determined which of those types of vehicles will finally be included in the regulation. He also points at the main aspects that are laid down in 4.1.2.1.: Safety, environmental protection, energy efficiency or anti-theft performance. Antitheft performance however will probably not be part of the GTR's content. It is pointed out that in the GTR performance criteria described rather than design characteristics. Antitampering provisions are supposed to be covered under safety aspects so that the systems as built into the vehicle are supposed not to be easily manipulated by the consumer. In the US, only the product up to factory gate release is regulated by federal law. Consequences of manipulation by the consumer are regulated under the control of the individual States. The GTR has to include an explicit test procedure suitable to prove if a system to be certified fulfils the requested criteria. This test needs to be objectives and reproducible by independent parties. Recommendations for lead time for the national implementation of the Regulation shall be established. Stringency of requirements (test method and/or limit values) may differ if necessary for the implementation or the adoption to existing national legislation.

Presentation 'Proposal for QRTV GTR based on Japanese concept' (JASIC)

During the last meeting, Japan had presented basics for a concept of a GTR. This presentation contain concrete proposal. The operating conditions for sound generation method and attenuation are identical with the requirements that are specified in RE3. However, a contracting party shall have the possibility to allow the fitting of a pause switch.
The type of sound shall be the same as R.E.3, except that the article of "The following and similar types of sounds should be avoided" should be deleted, since it is confusing whether (iv) and (v) are prohibited or not.
The pitch shift shall be quantified. It is proposed to have frequency changes of at least 15% at speeds between 5km/h and 20 km/h. The overall volume level should be [xx] dB(A) or more at the vehicle speed of 10km/h and [xx] dB(A) at 20km/h. Each frequency range of [less than 800Hz] and [over 1.25kHz] in 1/3 octave band frequency should exist one or more bands of [xx]dB(A) or more at the vehicle speed of 10km/h and [xx]dB(A) at 20km/h.

France supports the general concept. A maximum overall needs to be defined. For the US it is at the current point in time difficult to decide about a general maximum level so that this may have to be assigned to the individual contracting parties. From the safety aspect a minimum level is required. COM requests to clear set minimum and maximum levels that are well balanced between safety and environmental aspects. The US there is no federal maximum noise level today (pass-by) and it appears difficult to determine such a value for QRTV. On national level, maximum sound emission should be regulated by adequate legislation, such as

ECE R51. France replied that ECE 51 does not cover the critical speed range in question. WP29 may have to request GRB to further develop R51 to an extended speed range.

Presentation Cost/Benefit analysis (US NHTSA)

US presented basics and findings on the evaluation on costs for AVAS and potential benefits. Benefits are only financial not taking into account environment. The calculation is done based on reported and unreported crashes (i.e. crashes that occurred but are not reported to the police). 2800 avoided injuries to pedestrians and cycles are expected through the lifetime of MY2016 vehicles due to the anticipate US legislation for QRTV. The estimated benefit of the rule is $178 Mio. Estimated cost for the speaker are about $30 and $5 extra cost for energy due to increase weight and electricity. In the meanwhile several comments were made in terms of the cost for speakers and NHTSA will have to reassess them. The total cost for 4-wheeked vehicles is $22Mio for 2016 MY. Cost is going to increase with the number of HEV/EVs. Cost for heavy duty trucks cost is higher due to the fact that 2 speaker are requested. Overall cost for medium and heavy duty trucks, buses and motorcycles is estimated to be $1.5Mio. Cost for design and testing is not included. This results in costs for a saved life between $830Mio and $990Mio. This is very cost efficient for NHTSA rulemaking.

Further details of the analysis can be found in the NPRM

An environmental assessment has been carried out and is available from the website. The analysis of typical US urban driving behavior reveals that the AVAS would be active less than 1% in total US vehicle fleet mileage, assuming a crossover speed of 20kph and 2.3% at 30kph.It concludes that with 50% of vehicle fleet being EV/HEV with AVAS, the overall noise level would increase by 0,9dB(A) compared to the same fleet w/o AVAS. This number does not take into account the increasing number of HEV/EV.

<u>Sketched framework for GTR on QRTV</u>

In order to start working out a proper text for the GTR, various aspects from the Japanese proposal as well as from the NPRM are put together into one document

1. Introduction / Background / Motivation

2. Scope

   This standard applies to--

(a) Electric vehicle passenger cars, multipurpose passenger vehicles, trucks, buses, motorcycles, and low-speed vehicles;

(b) Passenger cars, multi-purpose passenger vehicles, trucks, buses, and low-speed vehicles with more than one means of propulsion for which the vehicle's propulsion system can propel the vehicle in the normal travel mode in reverse and at least one forward drive gear without the internal combustion engine operating and;

(c) Motorcycles with more than one means of propulsion for which the vehicle's propulsion system can propel the vehicle in the normal travel mode in at least one forward drive gear without the internal combustion engine operating.

3. Definitions [to be determined at a later stage by ISO]

- Broadband sound & content
- Electric/Hybrid Electric vehicle (refer to GRPE subgroup on definitions of vehicle propulsion definitions
- Front plane
- Fundamental frequency
- Rear plane

4. Requirements

4.1. Modes and speeds for activation

4.1.1. The AVAS shall automatically generate a sound at least in the range of vehicle speed up to [20 km/h][30km/h] (not including stationary) and during reversing if applicable for that vehicle category, except prohibited by national/local law

For vehicles having a reversing sound warning device, it is not necessary for the AVAS to generate a sound during backup

4.1.2. Sound at stationary
The AVAS shall remain deactivated when the vehicle is not moving / at idle / stationary

4.1.3. Start-up sound
When measured according to the test conditions of S6 and the test procedure of S7.2, the vehicle must, within 500msec of activation of its starting system,

emit a sound having at least the A-weighted sound pressure level in each of the one-third octave bands according to Table 1.

4.1.4. ICE engine
In case the vehicle is equipped with an internal combustion engine that is in operation within the vehicle speed range defined above, the AVAS may not need to generate a sound. [*further discussion is needed to exactly define the conditions under which AVAS sound is not necessary*]

4.1.5. Pause switch / (Timely limited deactivation switch)
If the vehicle emits a synthetic sound to meet the requirements of this regulation, the driver may disable the activation at his discretion. If equipped with pause switch, an indicator shall indicate the deactivation.
The system shall automatically become reactive under the following conditions

4.1.6. The AVAS sound level may be attenuated during periods of vehicle operation.

4.2. Type of sound

4.2.1. The sound to be generated by the AVAS should be a continuous sound that provides information to the pedestrians and vulnerable road users of a vehicle in operation.
However, the following and similar types of sounds are not acceptable:
(i) Siren, horn, chime, bell and emergency vehicle sounds
(ii) Alarm sounds e.g. fire, theft, smoke alarms
(iii) Intermittent sound

Note: this paragraph should be deleted as it is not a performance based description.

4.2.2. At least 2 1/3 octave bands

4.2.3. Each frequency range of [less than 800Hz] and [over 1.25kHz] in 1/3 octave band frequency should exist one or more bands of [xx]dB(A) or more at the vehicle speed of 10km/h and [xx]dB(A) at 20km/h.

4.2.4. For vehicles capable of rearward self-propulsion, whenever the vehicle’s gear selection control is in the reverse position, the vehicle must emit a sound having at least the A-weighted sound pressure level in each of the one-third octave bands according to Table 2 as measured according to the test conditions of S6 and the test procedure of S7.3.

4.3. Pitch shifting

4.3.1. Pitch shift (frequency shift) should be quantified

4.3.2. Pitch shift should have frequency changes of [15%] or more in the range of vehicle speed from 5km/h to 20km/h.

5. Verifying procedures and requirements

5.1. The conditions for the testing incl. tolerances are laid in procedures SAE J2889-1 and ISO 16254

Tests may be carried out in an indoor test facility. In case of indoor testing, a correction of results as function of background is not necessary.

5.1.1. When tested under the conditions of S6 and the procedures of S7.4, the vehicle must emit a sound having at least the A-weighted sound pressure level in each of the one-third octave bands according to Table 3 at any speed greater than or equal to10 km/h, but less than 20 km/h.

Table 3. One-third Octave Band Min. SPL Requirements for 10 km/h Pass-by

One-third Octave Band Center Frequency, Hz	Min SPL, A-weighted dB
315	48
400	49
500	49
2000	48
2500	45
3150	43
4000	39
5000	37

5.1.2. When tested under the conditions of S6 and the procedures of S7.5, the vehicle must emit a sound having at least the A-weighted sound pressure level in each of the one-third octave bands according to Table 4 at any speed greater than or equal to 20 km/h but less than 30 km/h.

Table 4. One-third Octave Band
Min. SPL Requirements for 20 km/h Pass-by

One-third Octave Band Center Frequency, Hz	Min SPL, A-weighted dB
315	54
400	55
500	56
2000	54
2500	51
3150	49
4000	46
5000	43

5.1.3. When tested under the conditions of S6 and the procedures of S7.6, the vehicle must emit a sound having at least the A-weighted sound pressure level in each of the one-third octave bands according to Table 5 at 30 km/h.

Table 5. One-third Octave Band
Min. SPL Requirements for 30 km/h Pass-by

One-third Octave Band Center Frequency, Hz	Min SPL, A-weighted dB
315	59
400	59
500	60
2000	58
2500	56
3150	53
4000	50
5000	48

5.1.4. Sounds emitted by AVAS above the regulated speed range

Notwithstanding existing legislation for maximum pass-by noise, there are no requirements for the sound emitted above the regulated speed range.

5.2. Correction of test results

When testing is carried on an outdoor test track, the following correction shall be applied to the measured values:

Table 6. Corrections for Background Noise

1/3 Octave Band Noise Level $OBL_{bgn,fc}$	* Peak-to-Peak 1/3 Octave Band Background Noise Level $OBL_{bgn, fc, p-p}$	1/3 Octave Band Level of jth test result, ith frequency, minus 1/3 Octave Band Noise Level DL = $OBL_{test,j, fc}$ - OBL	Correction L_{corr}
≥ 25 dB(A)	**	> 10 dB	0 dB
	< 8 dB	> 8-10 dB	0.5 dB
		> 6-8 dB	1.0 dB
	< 6 dB	> 4.5-6 dB	1.5 dB
		> 3-4.5 dB	2.5 dB
		≤ 3 dB	Do not correct, but report $OBL_{testcorr, j} < OBL_{testj}$
< 25 dB(A)		≤10 dB	Do not correct, but report: $OBL_{testcorr, j} < OBL_{test j}$
	**	> 10 dB	0 dB

In the case of indoor testing, no correction is necessary.

5.3. Directivity

When measured according to the test conditions of S6 and test procedure of S7.2, the sound measured at the microphone on the line CC’ must have at least the A-weighted sound pressure level in each of the one-third octave bands according to Table 1.

It was decided to circulate the draft sketch within the group prior to the next meeting.

Next Meeting: July 16th to 18th, NHTSA, Washington