

**Report of ASEP Technical Task Force
to
ASEP Informal Group**

i. Executive Summary

1. Objective of Group

2. Process

3. Test Concept Development

4. Data Reporting

5. Outstanding Issues

6. Conclusions and Recommendations

NOTE: This report represents the work of the ASEP Technical Task Force (TF) as authorized by the ASEP Informal Group from February through August 2006. However, this document does not necessarily reflect the views of every participant on the TF. The document reflects the judgment of the TF chair in reporting the outcome of the TF discussions.

Executive Summary

The Additional Sound Emission Provisions (ASEP) Technical Task Force (TF) was given the task by the ASEP Informal Group (IG) to determine if a test procedure could be developed, in concept, which had the potential to be used to fulfill Annex 10 of the proposed ECE Regulation 51. Annex 10 is concerned with the noise emission of M1 and N1 vehicles at conditions different from the test defined in Annex 3. The TF evaluated proposals from France, Netherlands, and Germany as well as using the expert engineering judgment of the TF members in providing TF recommendations. The criteria for evaluation of test methods and data reporting are the same used for Annex 3: The test should fulfill fitness of purpose, be performance based, technology neutral, and globally applicable.

The TF concluded that the development of a test that can be used to determine if a vehicle fulfills Annex 10 is technically feasible. The TF has made significant progress to identify a proposed outline of such a test and to identify issues which must be addressed in the development of any test suitable for use in ECE Regulation 51. Consideration of emerging technologies; i.e., hybrids, adaptive automatic transmissions, etc., will cause an increase in the development time to insure such vehicles can be tested and the noise emission results are consistent with in-use noise emissions. The TF has also developed proposal for the evaluation of test results to assist governments, industry, and other users of the test results assess the specific test results in a performance based and technology neutral manner.

1. Objective of Group

The ASEP TF group was formed as a result of the ASEP IG action to establish a technical working group which would provide to the ASEP a technical assessment on the feasibility of a test method suitable for use in Annex 10. The TF group was charged to consider the three proposals for test methods submitted to the ASEP IG, From Germany, Netherlands, and France as a starting point for its discussions. The TF was given the following criteria to judge any test:

- a. **Performance based:** Operating requirements in terms of vehicle speed and acceleration.
- b. **Technology neutral:** The test is applicable for all present and future engine / transmission technologies.
- c. **Globally applicable:** The test is representative as a measurement tool for all vehicle types independent of market.
- d. **Repeatable and Reproducible:** The test provides consistent results over time and can be verified by independent parties.
- e. **Simple and Practical:** The workload and technical expertise required to perform the test should be consistent with checking the Annex 3 result.
- f. **Fitness for Purpose:** The test should be able to clearly distinguish between vehicles whose noise performance at operating conditions other than those specified by Annex 3 are as would be expected. "As would be expected" takes account of the physics of sound generation and propagation based on engine operation, vehicle performance, and tire/road interaction.

An important component of the TF's mandate was what is would not discuss. Any issue that was predominantly political was reserved to the IG. The TF group was to focus its attention on developing recommendations on test feasibility. Issues relating to limit values, timetables, enforcement, environmental relevance, costs, benefits, or other issues beyond a technical assessment of test feasibility would remain with the ASEP IG.

Finally, the TF group was given a timetable to report its conclusions to the ASEP IG by September 2006. As of September 2006, the mandate for the ASEP TF expires and no further work is planned.

2. Process

The ASEP TF scheduled four (4) meetings between February 2006 and August 2006. The meeting timing was designed to enable TF participants sufficient time to make engineering assessments of conceptual proposals, but was not sufficient time to carry out in-depth studies of any proposal. Due to the requirement to report results in August 2006, the TF group relied on expert engineering judgment supplanted with limited experimental results to arrive at the recommendations and conclusions presented in this report.

3. Test Concept Development

The ASEP TF began its feasibility assessment with three test proposal for Annex 10. The three proposals were submitted by Germany, Netherlands, and France. The TF group attempted to combine aspects of all three proposals to arrive at a unified proposal that would meet the technical criteria defined in the Objectives of the ASEP TF. The test measurement protocol identified by the TF to have merit for use in ASEP is as follows:

1. Select gear (if manual transmission) or D (is automatic transmission) and vehicle speed at AA' to achieve engine speed target at point BB' of:

$$n_{\max_BB} = \min(2.6 \cdot \text{PMR}^{-0.29}, 0.9) \cdot (s - n_{\text{idle}}) + n_{\text{idle}}$$

subject to vehicle speed at BB' being between 20 km/h and 70 km/h

2. If vehicle speed at BB' exceeds 70 km/h, select gear and vehicle speed at AA to achieve maximum possible engine speed at BB' with BB' vehicle speed of 70 km/h.
3. AND/OR If vehicle acceleration exceed 3.0 m/s² from AA' to BB' (or PP' to BB' for non-lockable CVT), select gear and vehicle speed at AA' to achieve acceleration less than 3.0 m/s² and maximum possible engine speed at BB'

The test is so designed to make vehicle engine speed the primary requirement for the test.

4. Data Reporting

During the discussion on the test method(s), the question of how to report the data was identified as an issue of equal importance to the measurement of results. Given any test, the issue of data reporting addresses the same issues as the test itself. Namely, given the possibilities to measure many operating parameters of a vehicle and the sound of the vehicle at multiple operating points, what level of sound should be reported vs. what vehicle parameter(s) to provide a result that is technically meaningful, technology neutral, and serves the fitness for purpose criteria.

Given there can be test conditions where different engine speeds, vehicle speeds and vehicle accelerations are obtained, the TF has developed two proposals to evaluate the test results. Both test results attempt to take any measurement result and provide a means to answer the question: Are these results expected from the Annex 3 results? The two proposals are:

1. The proposal from France to use a model of expected noise behavior. The model predicts expected noise emission levels based on the Annex 3 result, the vehicle speed during an ASEP test and the engine speed during an ASEP test.
 - a. $L_{\text{vehicle}} \text{ (dB)} = 10 \log(10^{-L_{\text{engine}}(n)/10} + 10^{-L_{\text{tire}}(v)/10}) + 2$
 - b. with $L_{\text{engine}}(n) = L_{\text{engine}}(N_{\text{Annex3}}) + b \cdot (N_{\text{ASEP}} - N_{\text{Annex3}})$

- c. with $L_{\text{tire}} = L_{\text{tire}}(v_{\text{Annex3}}) + a \cdot \log(v_{\text{ASEP}}/v_{\text{Annex3}})$
- 2. The proposal of Mr. Gerhard to plot the test results as dB vs. acceleration* velocity (m^2/s^3)

Both approaches to presenting and analyzing the data have strengths and weaknesses. Further evaluation of vehicle data is necessary to determine a preferred approach.

5. Outstanding Issues

While the feasibility assessment has determined it is possible to construct an Annex 10 test, there are a number of outstanding technical issues which must be resolved prior to recommending any test to GRB.

1. The work required to fully develop an Annex 10 test will be proportional to the range of vehicles it must apply. To meet the requirements of "Globally Applicable" and "Technology Neutral" any test will need extensive practical investigations to provide a reasonable assurance these criteria have been met. This workload could be reduced if the following question can be answered positively:
 - a. Can a vehicle(s), be identified as specifically providing concern regarding the representativity of Annex 3 results at other operating conditions?
2. All vehicle performance targets/boundaries (acceleration, engine speed, etc.) should be reviewed by the ASEP IG.
3. Both a test method and a data analysis method are necessary to provide technically meaningful results.
4. A method to determine the expected noise emission at any vehicle operating point based on the Annex 3 result will be a necessary part of a complete Annex 10.
 - a. French proposal to evaluate expected noise emission as a function of vehicle speed (velocity) and engine speed.
 - b. OICA proposal to evaluate expected noise emission as a function of vehicle velocity and vehicle acceleration.
 - c. Should tire/road noise be included?
 - d. Evaluate noise as function of engine speed only (Japan)
 - e. How many runs are necessary?
5. Annex 10 should require the same or less measurement work as Annex 3.
6. What is uncertainty of any measurement method / analysis method?
7. The test method should be suitable for use by facilities and equipment used in Annex 3 testing.

- a. UK proposal to use multiple microphones.
- b. Continuous measurement equipment?

6. Conclusions and Recommendations

The ASEP TF has concluded it is technically feasible to develop a test method suitable for Annex 10. Development of such a test method will require additional experimental investigations and specific political direction on the scope of the test method. The specific recommendations from the ASEP TF are:

1. A person/organization should be selected to lead further technical development of any ASEP test.
2. ASEP requirements are applicable for all vehicles.
3. Identification of "Vehicle(s) of Concern" by governments will greatly aid the development of the technical test procedure and provide useful data for any political discussion on regulatory action.
4. The test procedure should be drafted in ECE format to provide a basis for further discussion. Possibilities for test parameters can be left in brackets.
5. A vehicle testing and evaluation program should be conducted which will provide technically correct and politically acceptable results. These criteria seem to indicate some cooperative work between various organizations is necessary.
 - a. Vehicles should be selected that are expected to pose problems (CVT's, AT, etc) in addition to traditional MT vehicles. Want to understand both vehicle behavior and possible technical test issues.
6. ASEP TF recommends Annex 10 measurements use the same equipment and test facilities as required for Annex 3.
7. Any Annex 10 testing must be suitable for inclusion into ECE Regulation 59.
8. Recommended conditions for vehicle performance are:
 - a. Engine speed target [German proposal as a function of PMR]
 - b. Vehicle speeds [20 – 70 km/h]
 - c. Vehicle acceleration maximum [3 m/sec²]

Summary of reasons chosen for test boundary conditions

Vehicle Parameter	PRO	CON	Technical Comment
Vehicle Speed test range 20-70 km	Covers important urban operation	Vehicle speeds over 70 km/h not evaluated	Vehicle speed range where propulsion noise dominant in WOT.
	Practical on existing ISO 10844 test		Higher speeds are impractical due to

	tracks		test track dimensions and may be a safety issue for testing.
Vehicle acceleration limited to 3 m/sec²	50% higher than Annex 3.	Some vehicles have higher acceleration capability.	[FWD, 2WD] vehicles can experience wheel slip at higher accelerations.
	Acceleration of today's R51.02 for 3 rd gear tests. Minimum acceleration for R51.02 3 rd gear test is 1.88 m/s ² (5m vehicle). 3.0 m/sec is equal to a vehicle with a speed changes in today's test of ~17 km/h from AA to BB		Annex 10 test in 3 rd gear will be close to today's test.
Vehicle Engine Speed Target (BB) (Germany)	Value has some connection to environmental concerns.		Identified issues with CVT and AT vehicles in reaching this target value
			This target curve derived from (European) in-use driving data. Works for Diesel and Gasoline engines.