Transmitted by the Chair of IWG MU

Informal document **GRBP-77-08**
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Agenda item 3

Proposal for a Revision 2 to the Document for Reference: A general approach how to handle measurement uncertainty (ECE/TRANS/WP.29/GRBP/2022/9/Rev.1)

Submitted by the Informal Working Group on Measurement Uncertainties*

The text below has been prepared by the Chair of the Informal Working Group on Measurement Uncertainties (IWG MU) to introduce a general guideline. The modifications to the existing text of the Document for Reference are marked in **bold** for new or ~~strikethrough~~ for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2022 as outlined in proposed programme budget for 2022 (A/76/6 (Sect.20), para 20.76), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Paragraph 1, amend to read:

"…European Union (EU) Regulation 2018/858~~1~~ (Marke~~d~~**t** Surveillance) …"

Paragraph 7, amend to read:

"…In table 7.1 below, the impact of the different quantities on these indicators has been estimated for the Run-to-run, Day-to-day, Site-to-site and Vehicle-to-vehicle situations. **This table is for M_1, N_1 and M_2 vehicles less than 3500 kg. A similar table for M_2 more than 3500 kg, N_2, M_3 and N_3 vehicles is shown in table 7.2**

Some of the different impacts are based on calculations from tolerances in the regulations, while others are based on experiences. Based on the probability distribution, the variance and the standard deviation is calculated. For each of the quantities, their contribution (in %) has been calculated and ~~the colour scheme~~ makes it easy to understand the influence of the quantity to the total uncertainty. Some of these quantities can be compensated for, like the influence of temperature and test track variations, while other is of random type, like instrumentation accuracy and cannot be compensated.

In the example shown below, the estimated total expanded uncertainty has been calculated to ~~±~~ 3~~.~~**,**46 dB (for a coverage factor of k = 2 (95 per cent level of confidence) according to table 7.1 **and ± 2,04 dB according to table 7.2.**"

Paragraph 7, table 7.1, amend to read:

"Table 7.1[**]
Example of calculation of uncertainties for UN Regulation No. 51:
Measurement uncertainty table for M_1, N_1 and M_2 vehicles less than 3500 kg[7]

Situation	*Input Quantity*	*Estimated deviations of the meas. result (peak-peak)*		*Impact on L_{urb}*	*Probability Distribution*	*Variance*	*Standard uncertainty*	*Share*	*Comb. stand. uncertainty*	*Uncertainty Budgets*			*Expanded uncertainty 95%*
		L_{wot}	*L_{crs}*							*Type Appro -val*	*CoP*	*Field Tests*	
Run to Run	Microclimate wind effect	1,60	1,50	1,57	gaussian	0,15	0,392	5,6%	0,53	0,53	0,53	0,53	1,1
	Driver #1: Deviation from centred driving	0,50	0,50	0,50	rectangular	0,02	0,144	0,8%					
	Driver #2: Start of acceleration	0,60	0,00	0,40	rectangular	0,01	0,144	0,5%					
	Driver #3: Speed variations of +/- 1km/h	0,30	0,50	0,50	rectangular	0,02	0,144	0,8%					
	Driver #4: Load variations during cruising	0,00	1,00	0,34	gaussian	0,01	0,085	0,3%					
	Varying background noise	0,40	0,40	0,40	rectangular	0,01	0,115	0,5%					
	Variation on operating temperature of engine (WOT) and tyres (WOT&CRS) => See ISO 362-1 note	0,80	0,80	0,80	rectangular	0,05	0,231	2,0%					
Day to Day	Barometric pressure (Weather +/- 30 hPa)	0,40	0,40	0,40	gaussian	0,01	0,100	0,4%	**0,92**	**0,92**	**0,92**	**0,92**	**1,8**
	Air temperature effect on tyre noise (5-10°C)	0,00	0,00	0,00	rectangular	0,00	0,000	0,02%					
	Air temperature effect on tyre noise (10-40°C)	2,20	3,60	2,67	rectangular	0,60	0,772	21,9%					
	Varying background noise during measurement	0,00	0,00	0,00	rectangular	0,00	0,000	0,0%					
	Air intake temperature variation	1,60	0,00	1,06	rectangular	0,09	0,305	3,4%					
	Residual humidity on test track surface	0,90	2,10	1,31	rectangular	0,14	0,377	5,2%					
Site to Site	Altitude (Location of Track) -100 hPa/1000m (fr.1015 to 915 hPa)	0,70	0,70	0,70	rectangular	0,04	0,202	1,5%	**1,24**		**0,62**	**1,24**	**2,5**
	Test Track Surface	3,40	5,50	4,11	rectangular	1,41	1,187	51,8%					
	Microphone Class 1 IEC 61672	1,00	1,00	1,00	gaussian	0,06	0,250	2,3%					
	Sound calibrator IEC 60942	0,50	0,50	0,50	gaussian	0,02	0,125	0,6%					
	Speed measuring equipment continuous at PP	0,10	0,10	0,10	rectangular	0,00	0,029	0,0%					
	Acceleration calculation from vehicle speed measurement	0,50	0,50	0,50	rectangular	0,02	0,144	0,8%					
Vehicle to Vehicle	Production Variation on Tyres; Aging of Tyres until delivery to customer (1dB after one year)	0,80	1,50	1,04	gaussian	0,07	0,259	2,5%	**0,57**		**0,57**	**0,57**	**1,1**
	Tyres at minimum tread depth	0,40	0,40	0,40	gaussian	0,04	0,209	1,8%					
	Variation on Tyre Size and Brand (non-OEM)	0,00	0,00	0,00	gaussian	0,00	0,000	0,0%					
	Production Variation in Power, incl. proper break-in of a brand-new engine	0,40	0,40	0,40	rectangular	0,01	0,115	0,5%					
	Battery state of charge for HEVs (3 dB(A))	0,00	0,00	0,00	rectangular	0,00	0,000	0,0%					
	Production Variability of Sound Reduction Components	1,10	0,00	0,73	gaussian	0,03	0,182	1,2%					
	Impact of variation of vehicle mass	1,60	1,60	1,60	rectangular	0,21	0,462	7,8%					

Overall Combined Uncertainty +/-	**Overall Expanded uncertainty (95%) +/-**
1,73	**3,46**

Expanded uncertainty (95%) +/-		
Type Approval	**CoP**	**Field Test**
2,12	**2,71**	**3,46**

[**] The acronyms and designations in tables 7.1 **and 7.2** follow the 03 series of amendments to UN Regulation No. .51

Paragraph 7, insert new table 7.2.:

Table 7.2**
Example of calculation of uncertainties for UN Regulation No. 51:
Measurement uncertainty table for M_2 more than 3500 kg, N_2, M_3 and N_3 vehicles

Situation	*Input Quantity*	*Estimated deviations of the meas. result (peak-peak)*		*Impact on L_{urb}*	*Probability Distribution*	*Variance*	*Standard uncertainty*	*Share*	*Comb. stand. uncertainty*	*Uncertainty Budgets*			*95% uncertainty*
		L_{wot}	*L_{ers}*							*Type Approval*	*CoP*	*Field Tests*	
Run to Run	Microclimate wind effect – head or tail	0	NA	0	gaussian	0,000	0,00	0,0%	0,30	0,30	0,30	0,30	0,59
	Deviation from centred driving	0,50	NA	0,50	rectangular	0,021	0,14	2,0%					
	Speed at BB' – Target vehicle speed (+/- 5 km/h), (target engine speed (+/-2%)	0,40	NA	0,40	rectangular	0,013	0,12	1,3%					
	Varying background noise	0,10	NA	0,1	gaussian	0,001	0,03	0,1%					
	Variation on operating temperature of engine and tyres => See ISO 362-1 note	0,80	NA	0,80	rectangular	0,053	0,23	5,1%					
Day to Day	Ambient temperature influence on sound transmission in air	0,6	NA	0,6	rectangular	0,030	0,17	2,9%	0,46	0,46	0,46	0,46	0,91
	Ambient barometric pressure influence on sound transmission in air	0,9	NA	0,9	rectangular	0,068	0,26	6,5%					
	Ambient humidity influence on sound transmission in air	0,1	NA	0,1	rectangular	0,001	0,03	0,1%					
	Ambient air temperature influence on engine power (based on R85)	1,0	NA	1,0	rectangular	0,083	0,29	8,0%					
	Ambient air temperature effect on ICE vehicles due to tyre noise (5-40°C)	0,4	NA	0,4	rectangular	0,013	0,12	1,3%					
	Barometric pressure effect on engine power (based on R85)	0,4	NA	0,4	rectangular	0,013	0,12	1,3%					
Site to Site	Altitude effect on combustion and sound propagation (Range: 1000 m) (95-105 kPa)	0,9	NA	0,9	rectangular	0,068	0,26	6,5%	0,50		0,50	0,50	1,0
	Test Track Surface	1,3	NA	1,3	gaussian	0,106	0,33	10,2%					
	Microphone Class 1 IEC 61672	1	NA	1	gaussian	0,063	0,25	6,0%					
	Sound calibrator IEC 60942	0,5	NA	0,5	gaussian	0,016	0,13	1,5%					
	Speed measuring equipment continuous at BB	0,1	NA	0,1	gaussian	0,001	0,03	0,1%					
Vehicle to Vehicle	Production Variation on Tyres; Aging of Tyres until delivery to customer (1dB after one year)		NA						0,70		0,35	0,70	1,4
	Tyre – generic dispersion (Normal, tread depth, inflation pressure, model etc)	2,8	NA	2,8	gaussian	0,49	0,70	47,2%					
	Production Variation in Power, incl. proper break-in of a brand-new engine		NA										
	Battery state of charge for HEVs (3 dB(A))		NA										
	Production Variability of Sound Reduction Components		NA										
	Test mass – variation as a consequence of the definition		NA										

Overall Combined Uncertainty +/-	**Overall Expanded uncertainty (95%) +/-**
1,02	**2,04**

Expanded uncertainty (95%) +/-		
Type Approval	**CoP**	**Field Test**
1,09	**1,64**	**2,04**

** The acronyms and designations in table**s** 7.1 **and 7.2** follow the 03 series of amendments to UN Regulation No. .51

II. Justification:

In the Informal Document GRBP-75-07, both table 7.1 and 7.2 were proposed to be deleted from the Working Document ECE-TRANS-WP.29-GRBP-2022-09 to enable an update of tables. In the rev.1 of this Working Document, table 7.1 was updated and some editorial changes made. Rev.1 has then been uploaded to the website for Document for References (GRB).

This Informal Document proposes some editorial changes and inclusion of a new table 7.2 with the uncertainty budget for vehicles of categories M2 > 3500 kg, N2, M3 and N3. The proposed changes will be included in the Rev.2 of GRBP-2022-09.

In general, the display of results in column “Comb. stand. Uncertainty” of tables 7.1 and 7,2 has been changed for easier understanding for regulatory purposes. The “variance” of the different situations has now been combined separately and has not been accumulated from top to bottom anymore (as ISO does in their documents). This has effect on “Uncertainties Budgets” due to “Type approval”, “COP” and “Field Tests”, including the “expanded uncertainty 95%”.

Some values in the column of COP have been reduced, since COP situations could be expected to be under control to a higher extent compared to an arbitrary test situation:

- For the Light Vehicle category of vehicles the uncertainty of the “Site-to-Site” in COP testing situation has been suggested to be half of the uncertainty of an arbitrary situation.
- For the Heavy Commercial vehicles similar principle applies to the “Vehicle-to-Vehicle” situation corresponding to COP testing.