Informal document GRB-77-xx
77th GRBP, 07-10 February 2023
Agenda item x

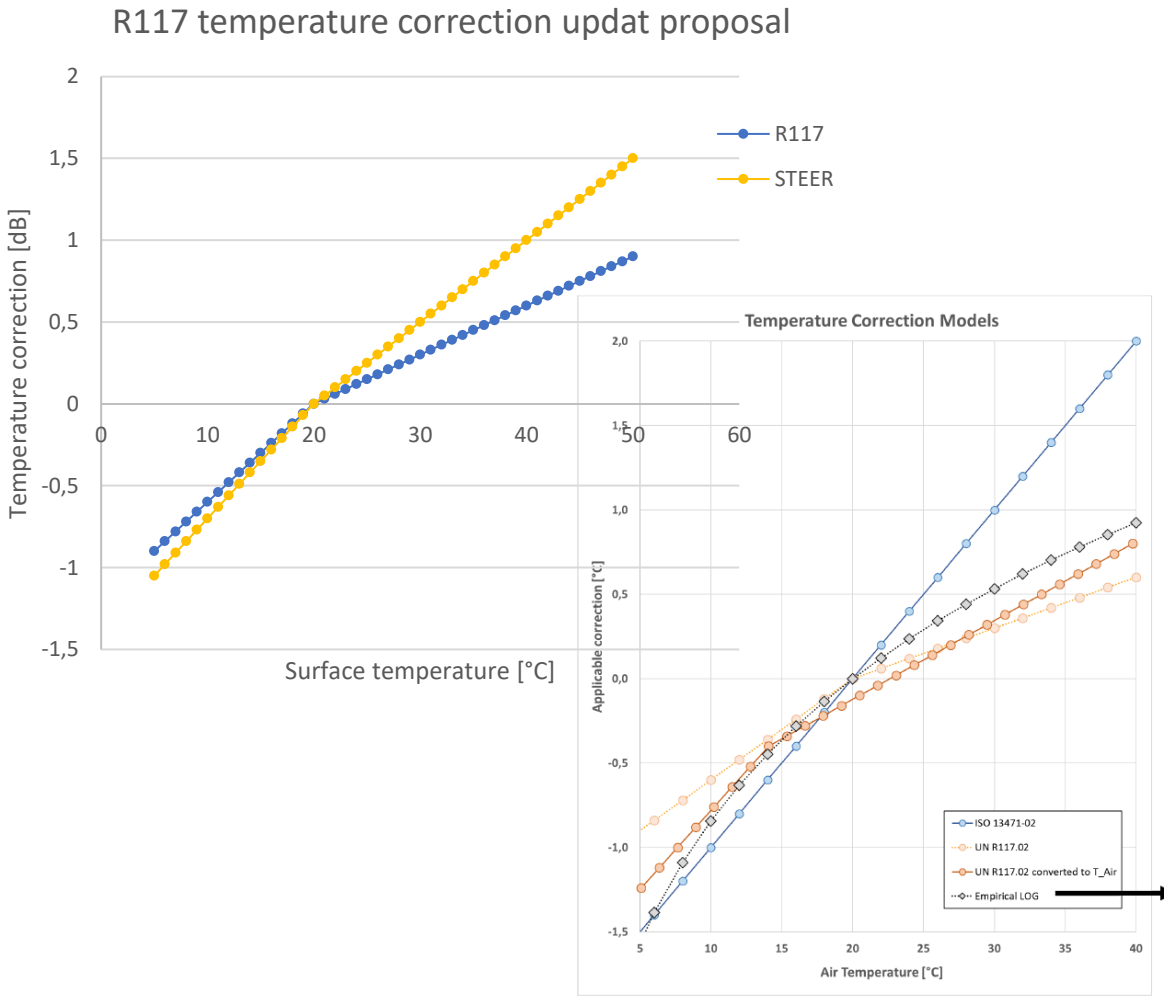
IWG-MU proposal for R117 C1 tyre rolling noise temperature correction update

Agenda

1. Introduction
2. Temperature sensitivity of C1 normal and 3PMSF tyres
3. Proposed updates
4. Summary

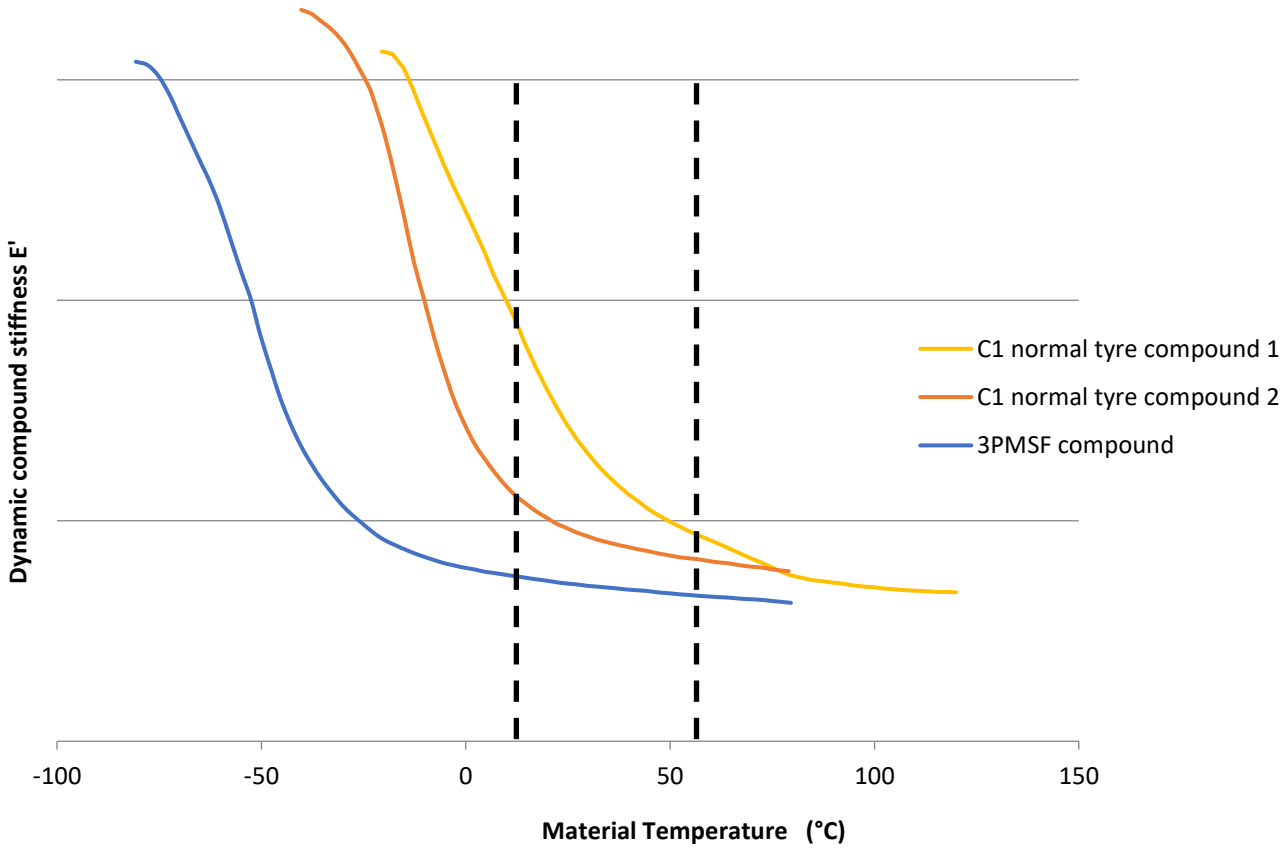
Update of the R117 C1 temperature correction

- Tyre rolling noise is affected by changes of the rubber stiffness for different temperatures. Even if the temperature sensitivity is not the main source of measurements uncertainty in R117, there is the need to correct measurements results to consider the temperature influence.
- **IWG-MU collected data for the following purpose:**
    1. **Validation of the current R117 temperature correction**
    2. **Proposals for improvements of the R117 temperature correction.**



Physical behavior of rubber / Dynamic stiffness E’

- Tyre rolling noise is highly influenced by the stiffness change of the tyre over temperature:
  - Different rubber compounds can show a wide spread of temperature sensitivity regarding their noise performance.
  - One of the main influencing factors is the rubber glass transition temperature.



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Verifying and updating the R117 C1 temperature correction

- In general, the available data of R117 measurements with the same tyres at a wide temperature range is very limited and often of a poor correlation between the temperature and the measured rolling noise (e.g., $R^2 < 0{,}5$)
- To improve this situation two test activities were performed in parallel:

①

- Proving ground investigation with a high effort to achieve a goal of $R^2 > 0{,}7$ for the correlation between temperature and tyre rolling noise

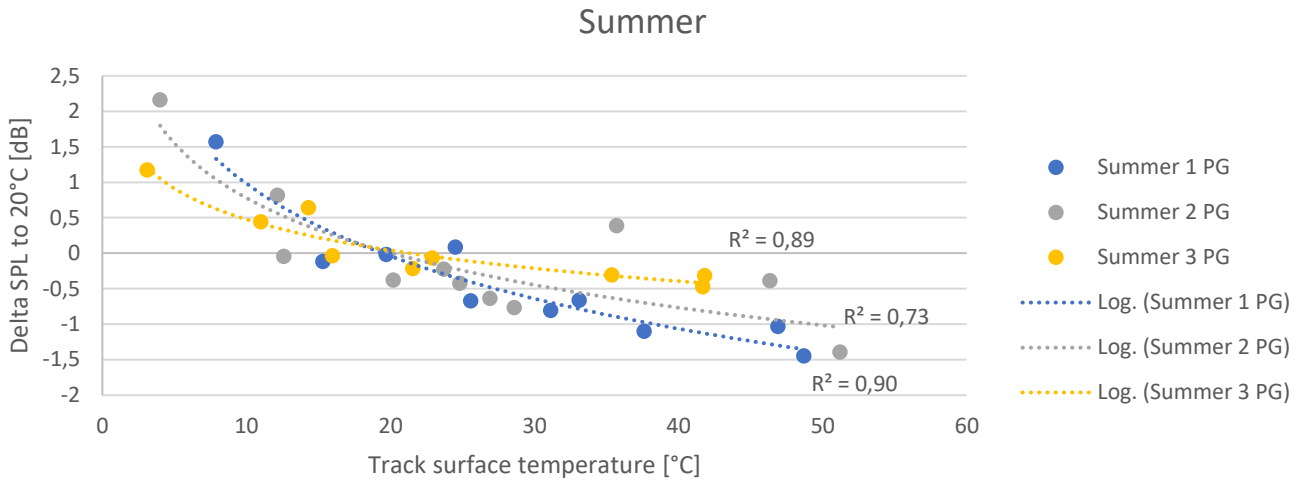
②

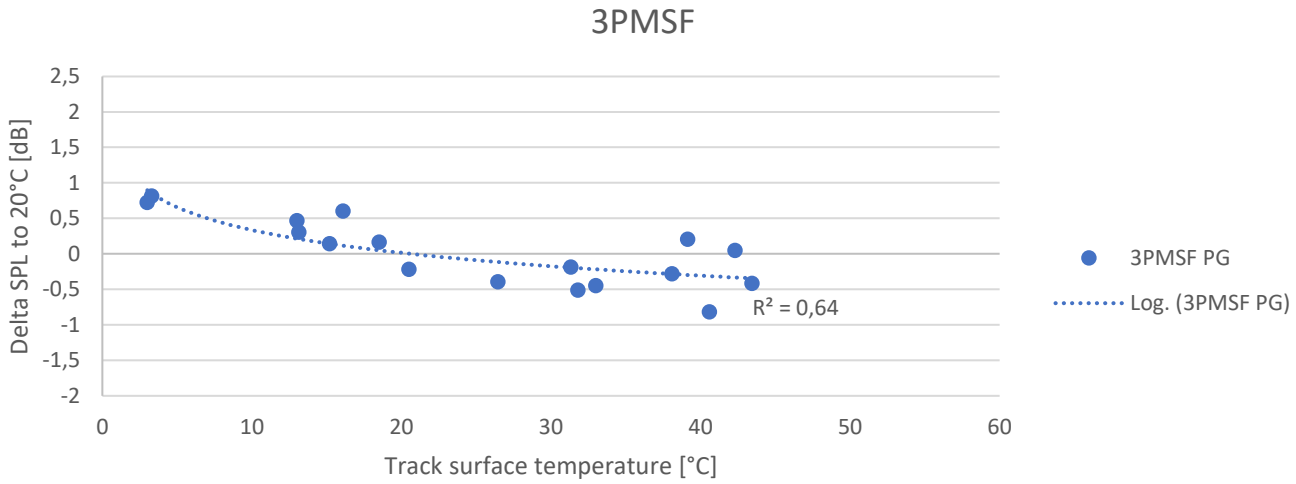
- Experimental drum investigation to exclude as many uncertainties as possible

①

Proving ground investigation

- Three C1 normal tyres and one 3PMSF tyre were tested at different temperatures.
- With the exemption of the 3PMSF tyre, the R^2 of the data is above 0,7.

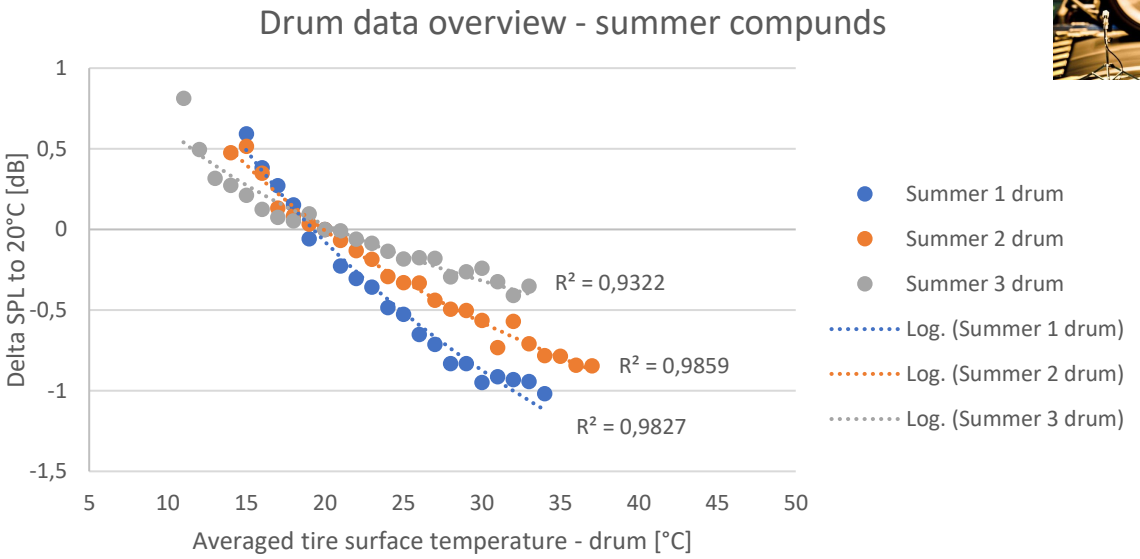


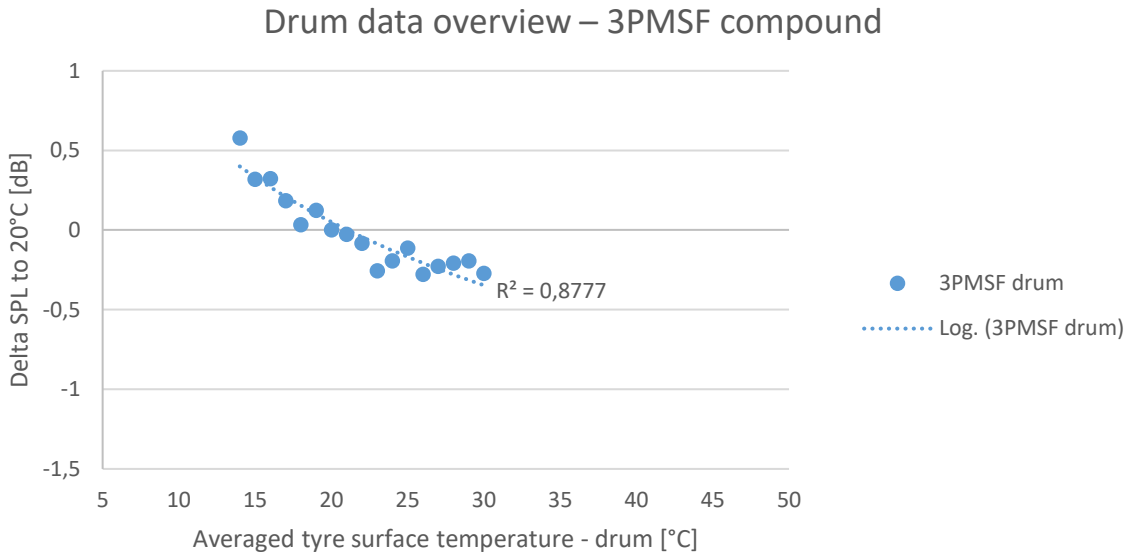


②

Drum investigation

- Four C1 tyres were built with identical pattern and identical construction.
- Changing only the tread compound:
  - **3x summer compounds**
  - **1x 3PMSF compound**
  - Tyres were stored at ambient temperatures < 15°C over night.
- Mounted at the test stand, using an ISO replica drum surface, measuring:
  - tyre rolling noise
  - tyre temperature during the warmup





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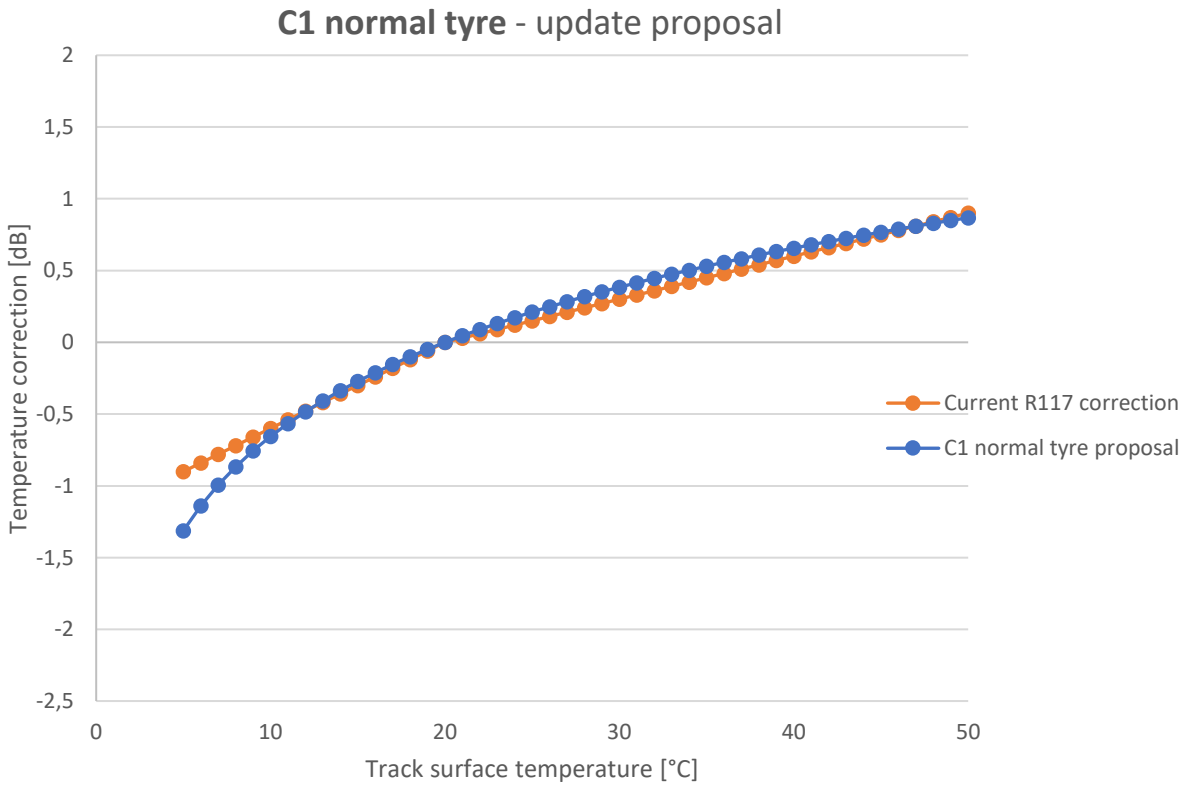
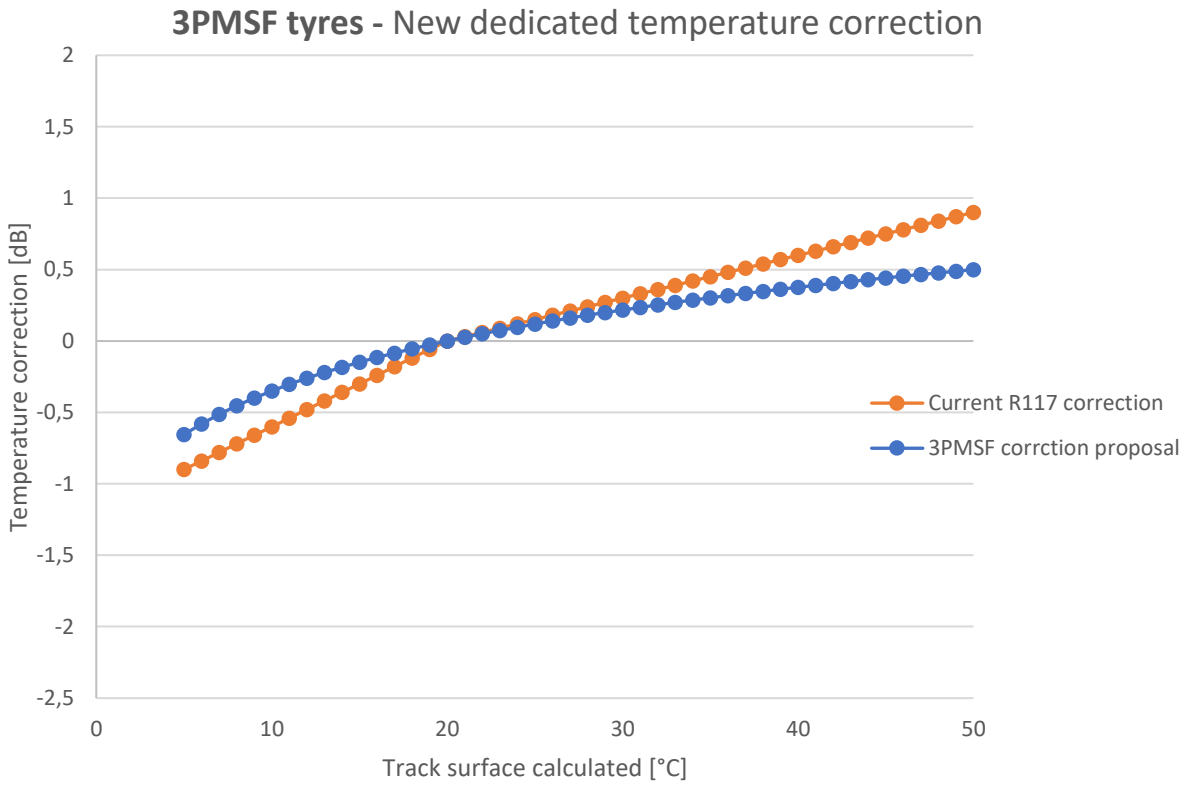
Investigation results





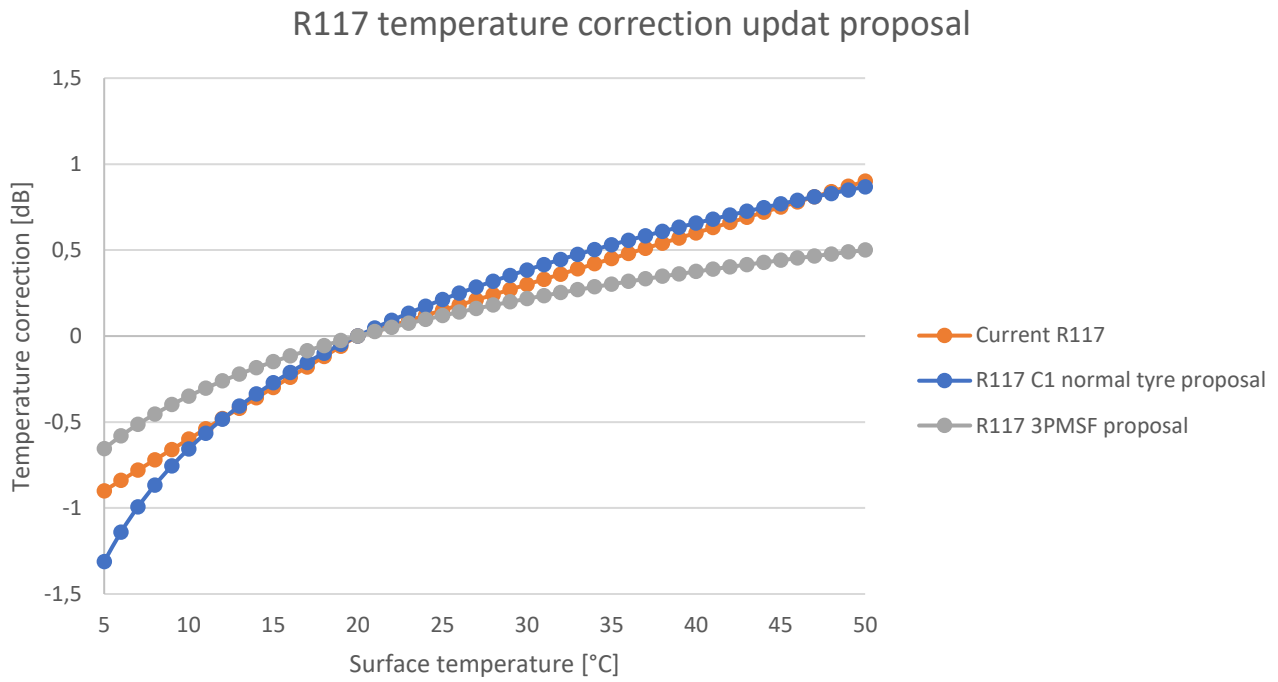
- Temperature sensitivity is described best using a logarithmic function
- The current R117 temperature correction is well adapted to cover the average temperature sensitivity of C1 normal tyres.

- 3PMSF tyres have a lower temperature sensitivity then C1 normal tyres and are over corrected by the current R117 temperature correction.

Proposal for R117 C1 temperature correction update

$$L_{corr} = -K1 \times LOG\left(\frac{\vartheta_{ref} + K2}{\vartheta_{test} + K2}\right)$$

	Summer	3PMSF
K1	2,18	1,35
K2	0	2,29
ϑ_{ref}	20	20



- The **collected data** from both the proving ground and the drum test **confirm a logarithmic shape** for the temperature correction **as already used in R51**

<u>IWG-MU proposal for R117 C1 tyres, based on the collected data:</u>

- **NORMAL TYRES:** the logarithmic shape shall be introduced in R117, by **updating the current correction equation**
- **3PMSF TYRES: introducing a dedicated logarithmic temperature correction** to better represent the lower temperature sensitivity of 3PMSF compounds

Validation of the proposed C1 temperature corrections

The proposed temperature correction updates have been assessed on 15 data sets using the two following metrics:

Standard deviation

	Summer	3PMSF
No temperature correction	0.47	0.28
Current R117	0.32	0.25
Proposed normal tyres LOG	0.32	
Proposed 3PMSF LOG		0.19

Slope regression

	Summer	3PMSF
No temperature correction	0.06	0.026
Current R117	0.031	0.016
Proposed normal tyres LOG	0.028	
Proposed 3PMSF LOG		0.009

The proposed changes reduce the measurement uncertainty for 3PMSF tyres.

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Summary and next steps

- The proposed introduction of a dedicated 3PMSF temperature correction reduces the measurement uncertainty for this category of tyres.
- The proposed update from a bi-linear towards a logarithmic function for the temperature correction is in line with the observed temperature behavior of rubber, observed both in material testing as well as in tyre rolling noise measurements.
- In a next step the temperature correction for C2 tyres will be evaluated.
- Regarding C3 tyres no changes are planed within R117 due to the low temperature sensitivity of C3 compounds in addition the high thermal inertia of these tyres.

Thank you.