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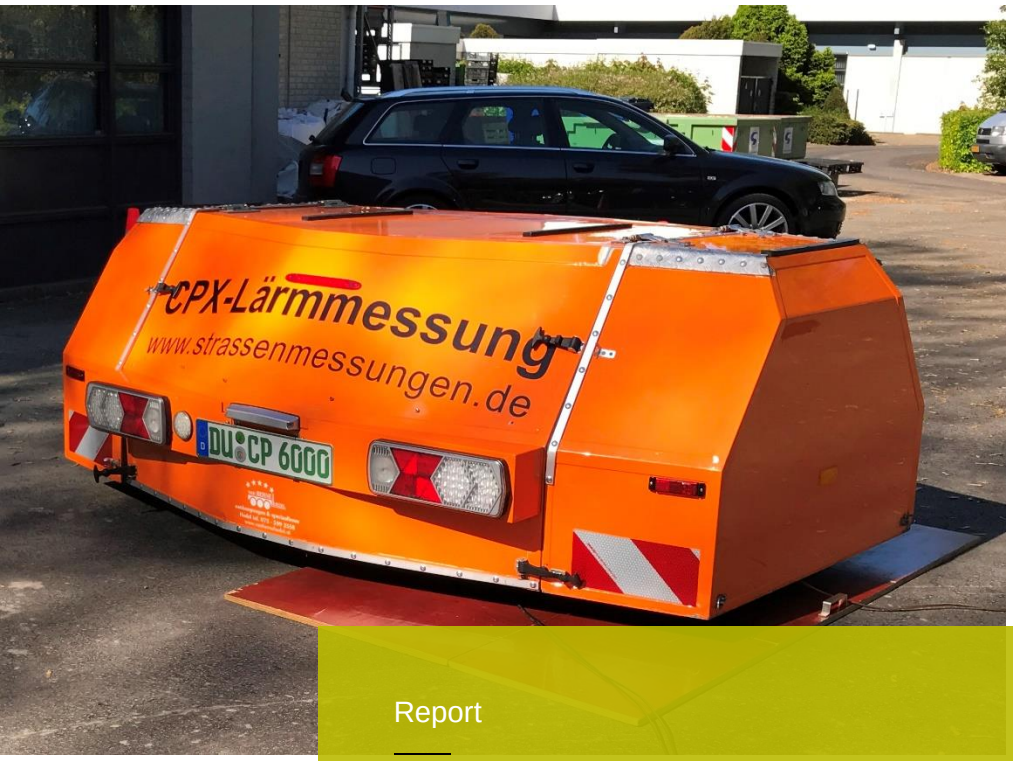

Report

Calibration of the SCRIM CoMeT CPX-trailer (XL9CPX75010095490)

Colophon

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Summary

The acoustic properties of the SCRIM *CoMeT* CPX-trailer with chassis number (VIN) XL9CPX75010095490 have been determined and compared to the demands that are specified in Annex A of ISO 11819-2: ”Acoustics – Measurement of the influence of road surfaces on traffic noise - Part 2: The close-proximity method”.

Device correction

The influence of the enclosure of the SCRIM *CoMeT* CPX-trailer has been determined according to ISO 11819-2. In the following table the correction for the enclosure of the CPX-trailer (Cd_f) is presented. This correction must be applied to all measurements with tyres SRTT and Avon Supervan AV4. The device correction does not exceed 3,0 dB in any 1/3-octave band, so the SCRIM *CoMeT* CPX-trailer fulfils the requirement of ISO 11819-2.

The device correction (Cd_f) of the SCRIM CoMeT CPX-trailer (XL9CPX75010095490) in 1/3-octave bands

frequency [Hz]	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
front and rear mandatory microphones (1 and 2)													
left side [dB(A)]	1,4	0,5	1,8	-1,0	0,0	-0,5	0,5	-1,1	0,2	-0,1	-0,6	-0,8	0,0
right side [dB(A)]	1,4	0,2	1,7	-1,1	-0,3	-0,3	0,2	-1,1	0,1	-0,4	-0,4	-0,7	0,3

Influence of passing vehicles

The *CoMeT* CPX-trailer is suitable for in-traffic measurements. In some cases the measurements can be influenced by passing vehicles. Especially heavy trucks passing at higher driving speeds can have an influence on the results of the measurement. If this is the case, the 20 m segments influenced by the passing vehicle must be evaluated afterwards.

Contents

1 Introduction

1.1 Background

The SCRIM *CoMeT* CPX-trailer (VIN: XL9CPX75010095490) is part of a measurement system to perform Close-proximity (CPX)-measurements according to ISO 11819-2 [1]. With this measurement method the rolling noise of a tyre on a road surface is measured close to the tyre.

According to the ISO-standard the acoustical properties of the CPX-trailer have to be measured. This calibration should be repeated at least once every two years.

1.2 Approach

ISO 11819-2 gives a detailed description of the measurement setup and procedure, the geometry of the measurement system and the data analysis. The demands for the acoustic properties of the entire measurement system are also given. These procedures are used to determine the acoustical properties of the SCRIM *CoMeT* CPX-trailer.

1.3 Contents of this report

In chapter 2 the *CoMeT* CPX-trailer is described. In chapter 3 the measurement methods used to determine the acoustical properties of the SCRIM *CoMeT* CPX-trailer are presented. The results of these measurements are given in chapter 4. Here the results are also compared to the demands as stated in ISO 11819-2. The conclusions can be found in chapter 5.

2 The *CoMeT* CPX-trailer

The *CoMeT* CPX-trailer is designed to measure the rolling noise of a tyre on a road surface according to the Close-proximity (CPX)-method. Measurements can be done in-traffic on designated or arbitrary parts of a road.

2.1 Design

The *CoMeT* CPX-trailer is designed to perform the measurement in both wheel tracks simultaneously. Therefore a measurement tyre is mounted on each side of the trailer. Each tyre has its own acoustical enclosure. This ensures that the tyre-road noise from one side does not influence the measurement on the other side. The microphones are mounted between the measurement tyres. Each microphone is positioned relative to the non-deflected sidewall of the tyre. The microphone positions are prescribed in ISO 11819-2. Figure 1 shows a picture of the *CoMeT* CPX-trailer and figure 2 shows a schematic overview.

figure 1 *The SCRIM CoMeT CPX-trailer*

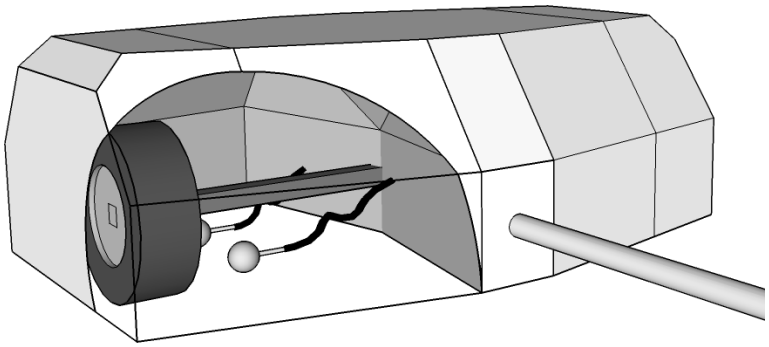

figure 2 *Schematic view of the CoMeT CPX-trailer with the positions of the measurement tyres and the microphones (mandatory positions)*

In ISO 11819-2 Annex E.6 a minimum distance of 3 m is recommended between the tyres of the towing vehicle and the microphones inside the CPX-trailer. This recommendation has been taken into account in the design of the *CoMeT* CPX-trailer. Furthermore the track width of the *CoMeT* CPX-trailer is 1,9 m which complies with the recommendations in Annex E.4 of the ISO-standard.

2.2 The enclosure

The *CoMeT* CPX-trailer is designed for in-traffic measurements. Therefore it has an enclosure. This enclosure prevents disturbing noise from reaching the microphones so only the rolling noise of the measurement tyres is recorded. It is important to make sure that the reflections from sound against the inside of the enclosure do not influence the measurement. From an acoustical point of view, the enclosure should represent a free-field situation. To suppress the diffuse sound field within the enclosure, the inside of the enclosure is covered with absorbing material.

The applied absorbing material in the *CoMeT* CPX-trailer is Tecnocell® which is produced by Merford noise control. It is an open-cell polyurethane foam with a density of 25 kg/m^3. The thickness of the material applied in the *CoMeT* CPX-trailer is 51 mm.

2.3 Measurement tyres

In ISO/TS 11819-3 [2] two reference tyres are specified. This concerns the ASTM-standardized ‘Standard Reference Test Tire’ (SRTT) [3] and the Avon Supervan AV4 tyre. They are called ‘P1’ and ‘H1’ respectively. Tyre P1 is representative for the tyre-road noise of passenger car tyres and tyre H1 is representative for the tyre-road noise of heavy vehicle tyres. In figure 3 both tyres are shown.

figure 3 *Measurement tyres P1 (SRTT, left) and H1 (Avon Supervan AV4, right)*

2.4 Static tyre load

The static tyre load of the measurement tyres must equal 3200 N ± 200 N per tyre as stated in ISO 11819-2 §10.9.

3 Measurement methods

To determine the acoustical properties of the SCRIM *CoMeT* CPX-trailer the measurement methods as described in ISO 11819-2 are used. In the next paragraphs these methods are described in more detail.

3.1 Influence of the enclosure

3.1.1 Measurement description

Acoustical absorbing material is applied on the inside of the enclosure of the *CoMeT* CPX-trailer to represent a free-field situation from an acoustical point of view. In practice the enclosure will not fully represent a free-field situation and therefore the reflections of the noise will influence the measurement results. The correction for the influence of the enclosure is called the device correction (Cd_f). The device correction can be determined with the measurement method described in Annex A of ISO 11819-2.

A tyre mock-up with integrated loudspeaker is placed on a reflecting plate. The loudspeaker is located 30 mm above the plate and produces broadband noise that is significantly higher than the background noise. The tyre mock-up is placed on the position of the measurement tyre and the microphones are placed on the prescribed positions (see figure 4).

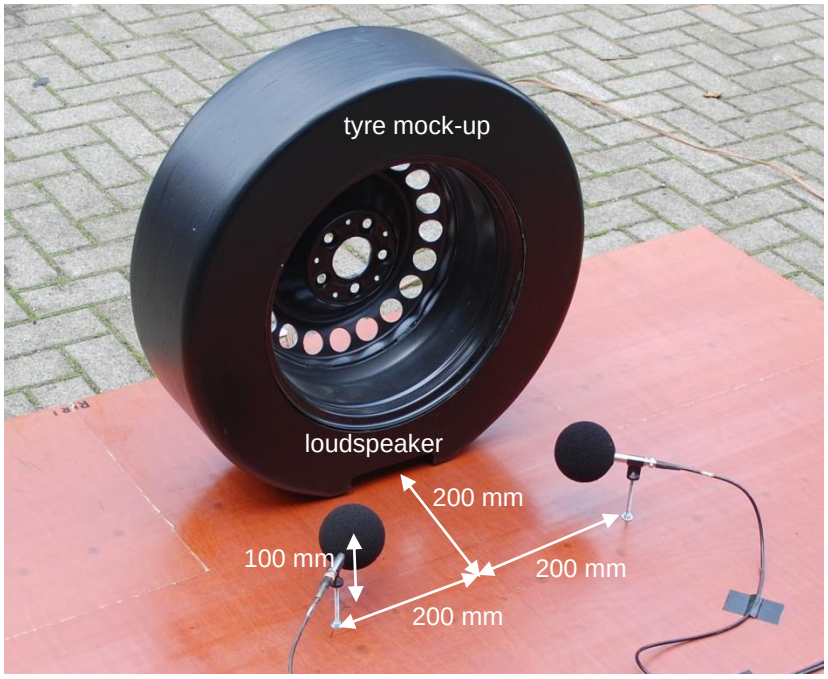

figure 4 *The measurement setup used to determine the device correction*

With this setup, measurements are performed with enclosure and in free-field situation. The sound levels of both microphones are averaged. The correction for the influence of the enclosure (device correction Cd_f) is determined by subtracting the 1/3-octave band levels in the enclosure from the results in free field.

According to the ISO 11819-2 all future measurements must be corrected. The device correction may not exceed 3,0 dB in any 1/3-octave band from 315 till 5000 Hz. If it does, the enclosure does not fulfil the requirement and the CPX-trailer can not be used for measurements according to the CPX-method.

3.1.2 Measurement procedure

The measurement procedure to determine the device correction (Cd_f). is prescribed in Annex A.2.2 of ISO 11819-2:

- measure inside the enclosure (one side) until a stable sound level is obtained;
- measure free field situation the same way;
- subtract the 1/3-octave band spectrum in the enclosure from 1/3-octave band spectrum in free field situation;
- repeat previous three steps;
- if the difference between the two calculated differences is larger than 0,5 dB in any 1/3-octave band, the first three steps have to be repeated till the largest difference of two results is less than 0,5 dB. The average of these two results is the final device correction (Cd_f) for that side of the enclosure;
- repeat all steps for the other side of the enclosure.

It has shown that it can be difficult to perform good, repeatable free field measurements. Disturbing noise and wind can be of significant influence. Therefore M+P has extended the measurement procedure with an extra check before determining the Cd_f. The following procedure was used (each measurement is 20 seconds L_{eq}):

- measure the free field situation three times;
- measure the left side of the enclosure three times;
- measure the free field situation three times;
- measure the right side of the enclosure three times;
- measure the free field situation three times;
- correct each measurement for the variation in the speaker signal (direct output from the amplifier);
- determine the difference between the free field measurements. If the peak to peak difference in any 1/3-octave band is larger than 0,5 dB, the measurements have to be repeated;
- calculate the average of all free field measurements;
- determine the difference between the enclosure measurements (each side separately). If the peak to peak difference in any 1/3-octave band is larger than 0,15 dB, the measurements have to be repeated;
- calculate the average per side of all measurements inside the enclosure;
- subtract the average 1/3-octave-band spectrum in the enclosure from the average 1/3-octave band spectrum in free field situation. The difference is the device correction Cd_f per side.

3.2 Influence of passing traffic

The *CoMeT* CPX-trailer is developed for use in in-traffic situations. Therefore the influence of passing vehicles has to be determined. It is not necessary to determine this influence for each *CoMeT* CPX-trailer separately. Results of measurements performed on one *CoMeT* CPX-trailer are applicable for all *CoMeT* CPX-trailers of the same type.

ISO 11819-2 states that the influence of any unwanted noise or reflection may not influence the measurement signal more than 2,0 dB in the 315 Hz and 400 Hz 1/3-octave bands. In the 500 Hz till 5000 Hz 1/3-octave bands the influence may not exceed 1,0 dB. The difference between the overall A-weighed measurement signal and the disturbing noise must be at least 10 dB.

The measurement method to determine the disturbing noise of passing vehicles is prescribed in Annex A.5.2 of ISO 11819-2. Therefore the *CoMeT* CPX-trailer is placed adjacent to a public road with a dense asphalt concrete. The microphones in the enclosure are mounted on the standard positions. The measurement setup is shown in figure 5.

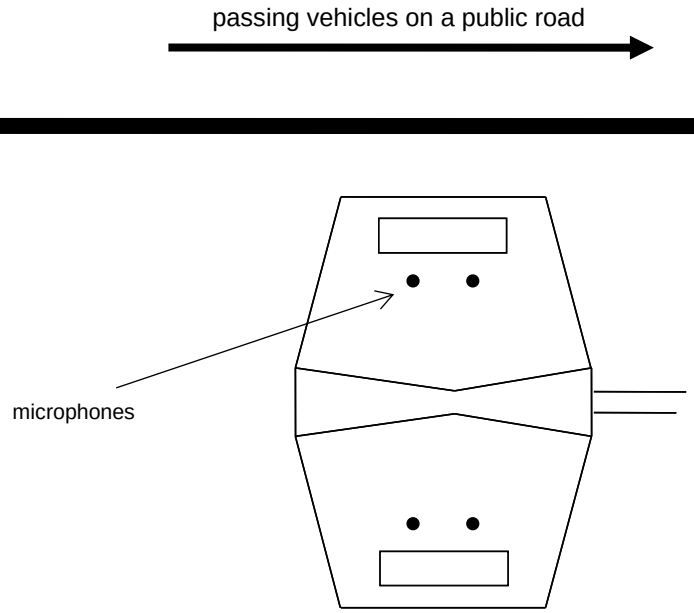

figure 5 *Measurement setup to determine the influence of passing vehicles*

The 1/3-octave band spectrum of passing light and heavy vehicles on the adjacent lane is measured. The measurement is performed on passing vehicles with an average driving speed of 80 km/h. The 1/3-octave band spectra of the passing vehicles are compared to the1/3-octave band spectra of a CPX-measurement at 80 km/h on the same road section. The influence of the passing traffic is determined by the difference in the sound spectra and can be compared to the demands.

An additional comparison is made between the results from the passing vehicles at 80 km/h and a CPX-measurement at 50 km/h. The minimum differences in sound levels (at the microphone positions) between passing traffic and the CPX-levels are shown in table I.

table I *Minimum difference between passing traffic and CPX-levels per 1/3-octave band*

	difference [dB]													
frequency [Hz]	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	overall
minimum	2,5	2,5	6	6	6	6	6	6	6	6	6	6	6	10

If during a CPX-measurement a situation occurs in which the demands with regard to passing vehicles is not met, the data must be evaluated afterwards according to Annex F.4 of ISO 11819-2.

4 Results SCRIM *CoMeT* CPX-trailer

4.1 Influence of the enclosure

The measurements for the influence of the enclosure of the SCRIM *CoMeT* CPX-trailer with chassis number XL9CPX75010095490 have been carried out on April 8th, 2021 In figure 6 the determined device correction (C_{df}) is shown per 1/3-octave band.

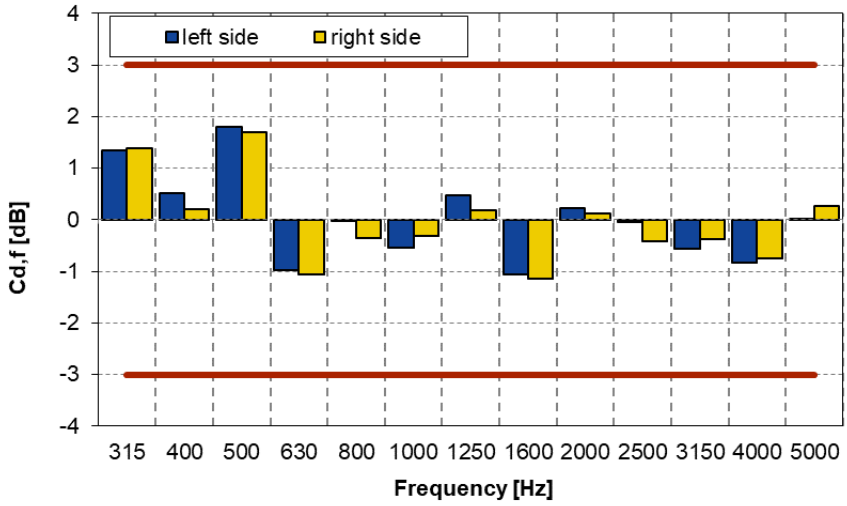

figure 6 *Device correction (C_{df}) of the SCRIM CoMeT CPX-trailer in 1/3-octave bands for the measurement tyre P1 and similar sized tyres for the mandatory microphone positions 1 and 2*

As can be seen in figure 6 there is no 1/3-octave band in which the device correction exceeds 3,0 dB. The SCRIM *CoMeT* CPX-trailer fulfils the demand stated in ISO 11819-2. A correction for the influence of the enclosure must be applied on the measured sound levels of a CPX-measurement. Numerical values for the device correction (C_{df}) are given in table II.

table II *Device correction (C_{df}) of the SCRIM CoMeT CPX-trailer for the mandatory micrphone positions 1 and 2*

frequency [Hz]	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
left side [dB]	1,4	0,5	1,8	-1,0	0,0	-0,5	0,5	-1,1	0,2	-0,1	-0,6	-0,8	0,0
right side [dB]	1,4	0,2	1,7	-1,1	-0,3	-0,3	0,2	-1,1	0,1	-0,4	-0,4	-0,7	0,3

4.2 Influence of passing traffic

The possible influence of disturbing noise from passing vehicles has been determined for the *CoMeT* CPX-trailer. The influence is determined by calculating the difference between the sound levels of the passing vehicles and the sound levels of the CPX-measurement per 1/3-octave band. The passing vehicles are measured at 80 km/h, the CPX-measurements are performed at 50 and 80 km/h. All measurements are performed with the microphones at the inner positions inside the enclosure.

The results in 1/3-octave bands are shown in figure 7. The 1/3-octave band spectra of a CPX-measurement with the P1 (SRTT) on the same road surface are also shown.

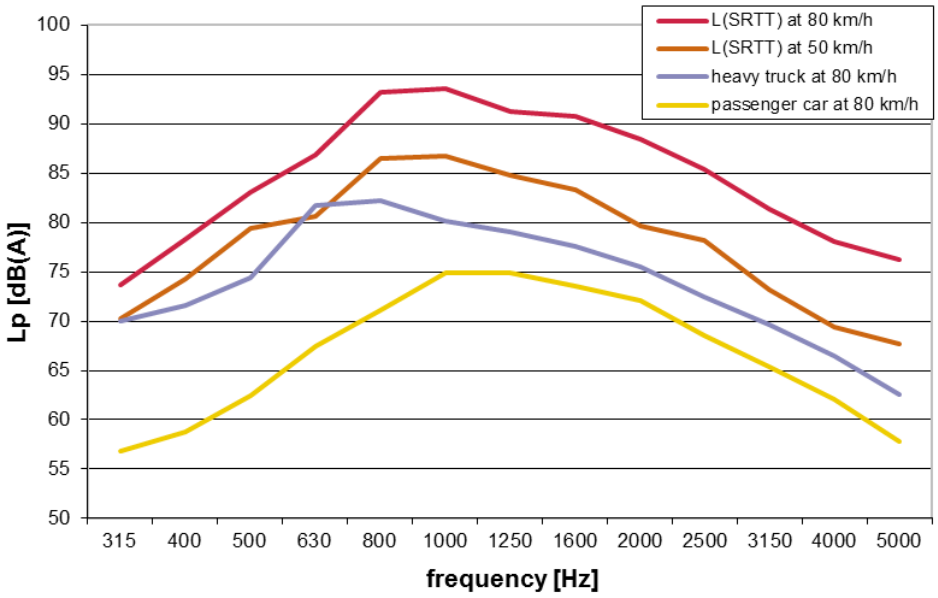

figure 7 *Measured 1/3-octave band spectra for light and heavy vehicles at 80 km/h and the 1/3-octave band spectra of the CPX-measurement with the P1 (SRTT) at 50 and 80 km/h*

The difference per 1/3-octave band of passing vehicles at 80 km/h and CPX-measurements at 50 and 80 km/h are shown in table III and table IV respectively.

table III *Difference between passing vehicles at 80 km/h and a CPX-measurement with the P1 (SRTT) at 50 km/h per 1/3-octave band*

	difference [dB]													
frequency [Hz]	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	overall
light traffic	13	16	17	13	15	12	10	10	8	10	8	7	10	11
heavy traffic	0	3	5	-1	4	7	6	6	4	6	4	3	5	4

table IV *Difference between passing vehicles at 80 km/h and a CPX-measurement with the P1 (SRTT) at 80 km/h per 1/3-octave band*

	difference [dB]													
frequency [Hz]	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	overall
light traffic	17	20	21	19	22	19	16	17	16	17	16	16	19	18
heavy traffic	4	7	9	5	11	13	12	13	13	13	12	12	14	11

From the results can be concluded that the demanded minimum difference as mentioned in table I is not always met. If during a measurement influence of a passing vehicle is suspected, the measured data has to be evaluated and excluded if necessary.

In practice the noise level of a passing vehicle can never be predicted. The operator of the CPX-measurement must be aware of passing vehicles and their possible influence.

4.3 Static tyre load

The static tyre load of the SCRIM *CoMeT* CPX-trailer with chassis number (VIN) XL9CPX75010095490 has been determined. The values are shown in table V. As can be seen the static tyre loads fulfil the requirement of 3200 N ± 200 N per tyre.

table V *Static tyre load on the measurement tyres of the SCRIM CoMeT CPX-trailer*

	left tyre	right tyre
static tyre load [N]	3061	3002

5 Conclusions

The acoustical properties of the SCRIM *CoMeT* CPX-trailer with chassis number (VIN) XL9CPX75010095490 have been determined.

The influence of the enclosure has been measured. There is no 1/3-octave band in which the device correction (C_{df}) exceeds 3,0 dB, so the SCRIM *CoMeT* CPX-trailer fulfils the requirement stated in ISO 11819-2. The device correction (C_{df}) must be applied on the measured sound levels of a CPX-measurement.

The CoMeT CPX-trailer is designed to be used in regular traffic. There is very little chance that passing vehicles on the adjacent lane will disturb the CPX-measurement. In practice the noise level of a passing vehicle can never be predicted. Therefore the operator of the CPX-measurement should always be aware of passing vehicles and their sound levels. If during a measurement influence of a passing vehicle is suspected, the measured data has to be evaluated. A 20 m segment that has been disturbed, must be discarded before analysis.

6 References

[1] ISO 11819-2:2017, “Acoustics - Measurement of the influence of road surfaces on traffic noise -- Part 2: The close-proximity method”, March 2017;

[2] ISO/TS 11819-3:2017, “Acoustics -- Measurement of the influence of road surfaces on traffic noise - Part 3: Reference tyres”, March 2017;

[3] ASTM F2493 - 14: Standard Specification for P225/60R16 97S Radial Standard Reference Test Tire.