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Work Package 3	**Noise and vibrations control at source – Acoustically green vehicles**
3.4	**Developing quiet tyre designs for quiet road surfaces**
3.4.5	**Effect of restrictions on studded tyres**
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Dissemination Level

PU	Public	✓
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restrictec to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for the members of the consortium (including the Commission Services)	

Nature of Deliverable

R	Report	✓
P	Prototype	
D	Demonstrator	
O	Other	

SEVENTH FRAMEWORK PROGRAMME

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0 EXECUTIVE SUMMARY

0.1 OBJECTIVE OF THE DELIVERABLE

In Europe a number of countries allow the use of studded tyres on their roadways: Belgium, Denmark, Estonia, Finland, France, Italy, Latvia, Lituania, Luxembourg, Norway, Slovakia, Spain, Sweden, Switzerland, Great Britain, Czech Republic and Austria [3].

1. Studded tyres create increased noise emmision (particularly at higher frequencies) due to stud impact and sliding.

2. Studded tyres create excessive tyre wear, which impose the road administrators to use rougher road surfaces with bigger max stone size.

3. Studded tyres contribute to air pollution by increasing the number of PM10 particles that are produced by the friction between the studs and the pavement [4].

The objective of this study is to evaluate the effects of restrictions on the use of studded tyres in the quiet zones regarding noise pollution produced by road traffic.

0.2 DESCRIPTION OF THE WORK PERFORMED SINCE THE BEGINNING OF THE PROJECT

Measurements have been performed on studded and non-studded tyres as well as on the reference tyre used for CPX-measurements.

0.3 MAIN RESULTS ACHIEVED SO FAR

The study shows that studded tyres emit 6-10 dBA higher noise levels than non-studded tyres for the tested speed range, tyre dimension and for the tested pavement type.

0.4 EXPECTED FINAL RESULTS

A maximum reduction of road/tyre noise in the order of 6-10 dBA by limiting the use of studded tyres in quiet zones can be expected during the winter season as measured with the CPX (Close Proximity) method. If the limitations are expanded to smoother road surfaces and to the exclusive use of hybrid electric vehicles, the total tyre/road noise reduction could be as high as 11-12 dBA.

0.5 POTENTIAL IMPACT AND USE[1]

Traffic noise reduction has two major benefits. First, citizens experiencing traffic noise as a disturbance and potential health risk can be provided with a much quieter and healthier traffic environment with less resident's disturbances.

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[1] *including the socio-economic impact and the wider societal implications of the project so far*

Secondly, areas, which are not populated due to traffic noise pollution, may be reconsidered as an appropriate area to build residential buildings once traffic noise reduction has been achieved.

0.6 PARTNERS INVOLVED AND THEIR CONTRIBUTION

ACL – Measurements and analysis.

0.7 CONCLUSIONS

The measurement by CPX method results reveal that measured studded winter tyres emit tyre/road noise 6 – 10 dBA higher compared to measured non-studded winter tyres of the same dimensions.

The maximum expected total noise reduction by combining effects such as lower tyre/road noise emission from non-studded tyres, smoother road surface and the use of hybrid electric cars could be in the order of 11-12 dBA in the winter season[2] for the speeds around 30 kmh.

This should be verified through further measurements.

[2] The expected noise reduction assumes that there is no snow on the road

1 BACKGROUND

1.1 TRAFFIC NOISE REDUCTION - IMPACT AND USE

Traffic noise reduction is a significant issue in urban areas experiencing high noise levels. The potential traffic noise reduction during the wintertime when using non-studded tyres is analysed in this study. In general, traffic noise reduction has two major benefits.

1) First, citizens experiencing traffic noise as an annoyance factor and potential health risks could, by the introduction of noise reduction by e.g. the quiet zone concept, be provided with a much quieter and a healthier traffic environment with less annoyance for the residents.
2) Secondly, areas with dense traffic flows, which are presently not populated due to noise pollution, may be reconsidered as an appropriate area to build residential buildings once traffic noise reduction has been achieved.

For urban areas with high population but limited space, traffic noise reduction therefore has a positive socio-economic effect as well as a positive effect on the population health.

Figure 1.1.1 Example of urban area in the southern part of Stockholm with dense population and high level of traffic noise

1.2 TRAFFIC NOISE REDUCTION – CURRENT STUDY

In Europe a number of countries allow the use of studded tyres on their roadways: Belgium, Denmark, Estonia, Finland, France, Italy, Latvia, Lithuania, Luxembourg, Norway, Slovakia, Spain, Sweden, Switzerland, Great Britain, Czech Republic and Austria.

In Sweden approximately 70% of all vehicles use studded tyres during the winter season [2].

Studded tyres create increased noise (particularly at higher frequencies) due to stud impact and sliding. Apart from the issue of increased noise emission, high concentrations of PM10 particles in cities during wintertime are largely caused by studded tire wear on the roadways (measurements and studies performed in Swedish cities such as Stockholm and Gothenburg) [4].

As the development of non-studded tyres are continuously performed by the tyre manufacturing industry the need for studded tyres in urban areas is decreasing. However, the impact of limiting the use of studded tyres in quiet zones, for instance, due to restricted speed limits or the possibility to use smoother road surfaces, is not yet fully investigated.

2 TEST CONDITIONS

Measurements with the aim to evaluate the difference in noise emission from studded and non-studded tyres were performed by Acoustic Control (ACL) with the CPX method using a single wheel trailer for tyre/road noise measurements.

The tested tyres brands, models and their dimensions are shown in the table below and in figures 2.1.1 and 2.1.2.

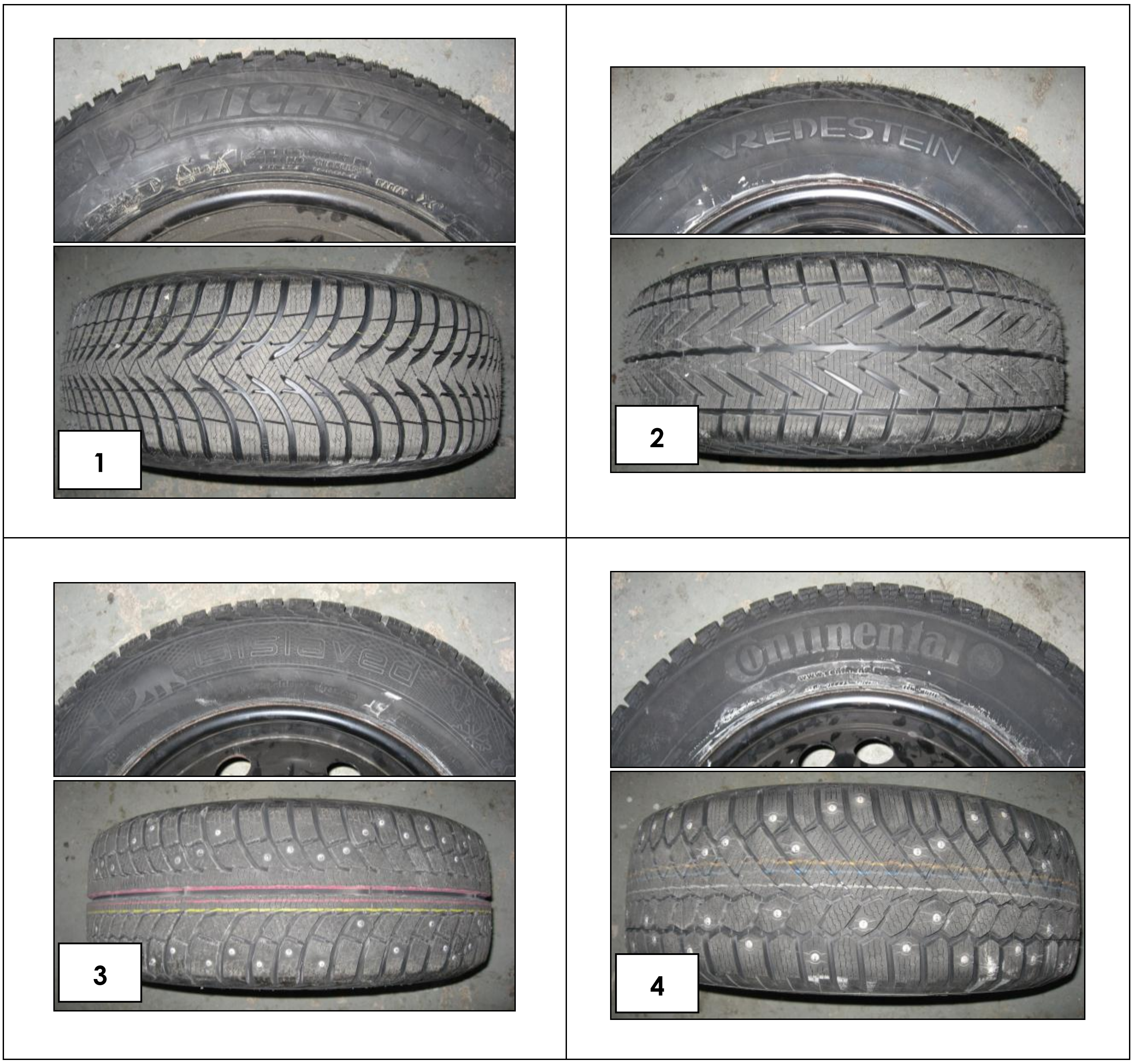

Figure 2.1.1 Winter Tires chosen for testing:
1.) Michelin ALPIN A4
2.) Vredestein Wintrac Xtreme
3.) Gislaved Nordfrost 5
4.) Continental IceContact

Figure 2.1.2 Reference tyre.

Brand	**Model**	**Dimensions**	**Type**	**Number in figure**
Michelin	ALPIN A4	225/60 R16 102V XL BSW	Non-studded	1
Vredestein	Wintrac Xtreme	225/60 R16 98H	Non-studded	2
Gislaved	Nordfrost 5	225/60 R16 102T XL	Studded	3
Continental	IceContact	225/60 R16 102T XL	Studded	4
Uniroyal	Tiger Paw AWP	225/60 R16 97S	Ref. tyre [1]	5

The tested tyres dimensions were chosen to coincide with the dimensions of the reference tyre normaly used for CPX-measurements. The road surface on which the tyres were tested is of type Viacotop 11, 160/220. The pavement of the road surface was performed in the summer of 2010.

3 NOISE REDUCTION

3.1 MEASURED TYRE/ROAD NOISE EMISSION

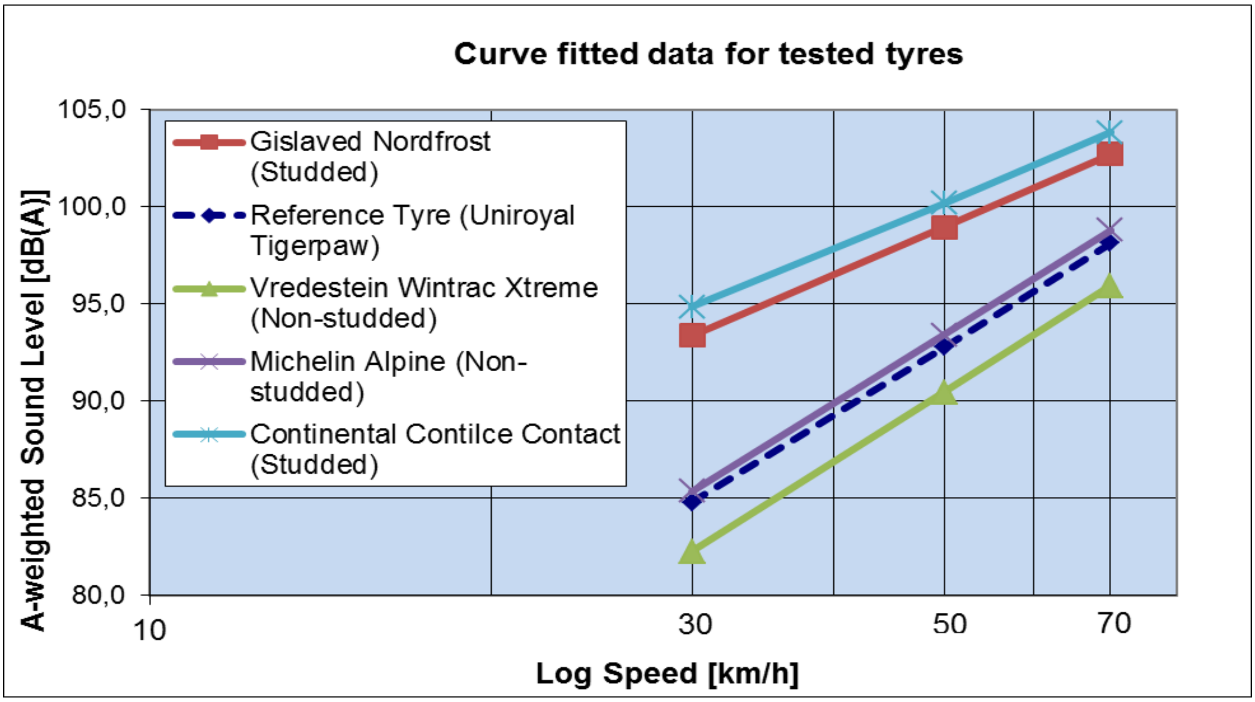

Figure 3.1.1 *A-weighted sound pressure levels for the tested tyres.*

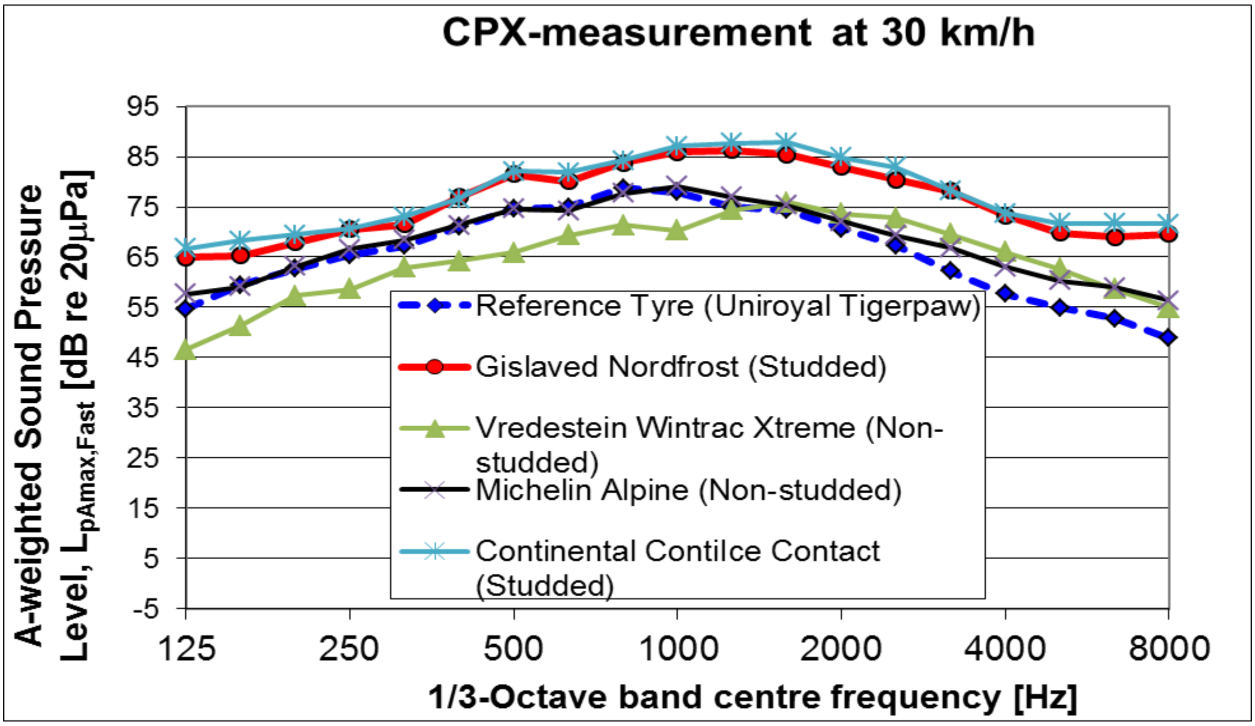

Figure 3.1.2 *A-weighted sound pressure levels for the tested tyres.*

3.2 MEASURED NOISE REDUCTION

The measurement results by CPX method reveal that measured studded tyres emit tyre/road noise 6 – 10 dBA higher compared to measured non-studded tyres of the same dimensions.

The averaged noise reduction, which could be achieved by switching from studded to non-studded tyres, is speed dependant. In figure 3.2 below it is shown that if tyre/road noise can be reduced with approximately 8-10 dB for typical urban traffic vehicle speeds.

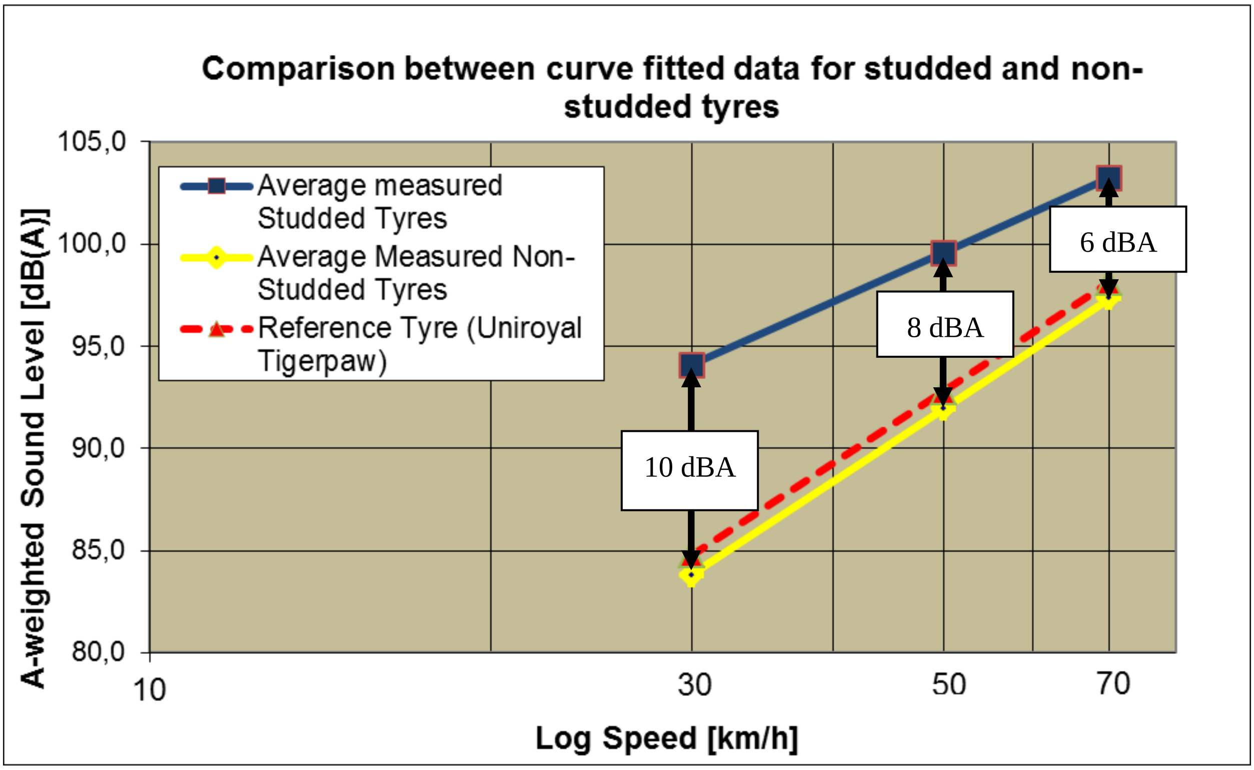

Figure 3.2.1 Averaged measured tyre noise studded for studded, non-studded tyres and reference tyre.

The measurement results also reveal that studded tyres emit tyre/road noise 5 – 9 dBA higher compared to the reference tyre.

In addition, the averaged result of the measured non-studded tyres tyre/road noise emission is of neglectable difference compared to the reference tyre.

4 EXPECTED NOISE REDUCTION - DISCUSSION

Passenger cars contain several sound sources contributing to the total noise level. However, for urban driving (low vehicle speeds) the main sound sources are confined to the driveline and tyre/road interaction only.

4.1 EFFECTS DEPENDANT ON VEHICLE TYPES

The total noise reduction that can be expected is dependent on the vehicle type and the road surface. Hybrid electric cars have in general a lower driveline noise compared to gasoline driven cars. According to a study performed for the Qcity Project[5] the difference in emitted driveline noise between a gasoline-driven car and a hybrid electric car is approximately 12 dBA at speeds in the range of 15-60 km/h. This means that for the mentioned speed range, the main noise source for electric hybrid cars is tyre/road noise.

The above also points towards a possible substantial decrease in total emitted noise for electric hybrid cars fitted with non-studded tyres as opposed to electric hybrids with studded tyres.

Correspondingly, since the driveline noise is predominant at speeds below 30 kmh for gasoline driven cars, the expected total decrease in emitted noise for gasoline driven cars fitted with non-studded tyres is lower as opposed to electric hybrid cars with studded tyres.

4.2 EFFECTS DEPENDANT ON ROAD SURFACE TYPES

A further implication of the impact of limiting the use of studded tyres in quiet zones is the possibility to use smoother road surfaces. A road surface with a maximum stone size of 4 mm generates approximately 1 dBA lower tyre/road noise compared than corresponding road surface with a maximum stone size of 8 mm. [6] Tyre/road noise emission for non-studded winter tyres on different road surfaces should be verified by further measurements.

4.3 JOINT EFFECTS - DISCUSSION

The maximum expected total noise reduction by force of joining effects mentioned in chapters 3.2, 4.1 and 4.2 could be around 12-13 dBA for the speeds around 30 kmh. That is for an electric hybrid car fitted with non-studded winter tyres driving on a road surface with a maximum stone size of 4 mm compared to a gasoline driven car, fitted with studded tyres on rough asphalt. This should be verified through further measurements.

5 REFERENCES

[1] Morgan, P., Sandberg., van Blokland, G., The selection of new reference test tyres for use with the CPX method, to be specified in ISO/TS 11819-3, InterNoise2009, 2009

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[3] STRO (The Scandinavian Tire & Rim Organization) – Rules for studded tyres in Europe, http://www.stro.se

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[5] Stenlund, F., Nilsson, N., Quantification of driveline and tyre/road noise from a hybrid electric passenger car (Toyota Prius), 2008, *Qcity Project*

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