Proposal for a Nordic project on heavy vehicle tyre/road noise - A pilot study

By Ulf Sandberg

Swedish National Road and Transport Research Institute (VTI)

Final version 2012-10-28
## CONTENTS

**SUMMARY** 3

1. **INTRODUCTION** 5

2. **PURPOSE** 6

3. **IDENTIFICATION OF THE PROBLEM** 6

4. **PRESENT AND PLANNED LEGISLATION OF INTEREST** 7
   4.1 Vehicle noise limits in the EU and in ECE, effective from 1996 7
   4.2 Tyre noise limits in the EU, effective from 2001 7
   4.3 Tyre noise limits in the EU, effective from 2012 9
   4.4 Tyre labelling regulation in the EU, effective from 2012 10
   4.5 ECE Regulations on truck tyre noise 12
   4.6 New vehicle noise limits in the EU and in ECE 12
   4.7 Truck tyres which are exempt from the noise limiting or labelling 14

5. **EXPECTED DEVELOPMENT OF HEAVY TRAFFIC** 15

6. **SOME INTERESTING TRENDS AND PRACTICES** 15
   6.1 General 15
   6.2 Wide-base single tyres replacing dual-mounted narrower tyres 16
   6.3 Lower rolling resistance 16
   6.4 Tyre labelling effects 16
   6.5 Winter tyres on trucks and busses 17
   6.6 Retread tyre market development 17

7. **TONAL NOISE FROM TRUCK TYRES** 18

8. **EARLIER STUDIES OF NOISE LEVELS OF TRUCK TYRES** 19

9. **TYRE TERMINOLOGY** 22

10. **SUGGESTED OBJECTIVES OF THE PLANNED PROJECT** 23

11. **LIMITATIONS AND OBJECTIVES OF THE PLANNED PROJECT** 24

12. **MEASUREMENT AND ANALYSIS METHODS** 25
13. CAN DRUM OR TRAILER MEASUREMENTS BE USEFUL? 27
14. OPTIONAL ROLLING RESISTANCE MEASUREMENTS 28
15. OPTIONAL SKID RESISTANCE MEASUREMENTS 28
16. ACCESS TO A REFERENCE ISO SURFACE 28
16. ACCESS TO A SUITABLE TEST VEHICLE 29
17. ACCESS TO AND SELECTION OF TEST TYRES 29
   17.1 Tyre dimensions 29
   17.2 Number of tyres of different types 30
   17.3 How to acquire the test tyres 32
18. EXPECTED DURATION OF THE PLANNED PROJECT 33
19. COMMUNICATING RESULTS AND GETTING FEEDBACK 34
20. ESTIMATED FUNDING NEEDED FOR THE PLANNED PROJECT 34
21. FINDING FUNDING 36
22. REFERENCES 37
SUMMARY

This report attempts to raise interest in conducting research on the noise emission from tyres on heavy vehicles in Europe. One reason is that this type of tyre noise is severely under-researched; probably due to the higher costs and difficulty of studying such heavy equipment. Another reason is that while truck traffic in Europe is predicted to increase dramatically over the next few decades, almost no noise reduction can be predicted from present and planned efforts to reduce noise from heavy vehicle tyres by setting maximum limits to vehicle or tyre/road noise.

The main aspects of the problem which are dealt with in this report include the following:

- Noise limits for truck tyres in the first set of limits (EU Directive 2001/43/EC) were meaningless, since they eliminated at most only very exceptional tyres from the market.

- Noise limits for truck tyres in the second set of limits (Regulation EU No. 661/2009 with implementation starting in 2012) are somewhat more stringent but will eliminate so few tyres, that it is unlikely to be noticed in the community noise.

- Winter truck tyres, which will be increasingly used in the Nordic countries, are given an extra 1-2 dB allowance in the noise limits, on top of the requirement for "traction tyres".

- Cheap but lower-quality tyres from Asia are becoming popular due to the much lower price. It will take some years until all of these have to meet the European maximum limits, but one may suspect that they will not be quieter than absolutely necessary.

- Many types of tyres are exempted from both the noise limits and from the noise labelling requirement; in fact more than 50 % of the truck tyres on our roads will be exempted, most of them being retread tyres.

- Truck traffic proportion in total traffic is growing. For example, a predicted growth in Swedish heavy vehicle traffic of 34 % from 2012 to 2030 (see Chapter 5) would change the traffic noise map of Sweden quite substantially within a fairly short time period. The situation is even worse in some other European countries.

- While overall vehicle noise for light vehicles will be "reasonably reduced" due to planned regulations, trucks will probably not be subject to any significant noise reductions.

- In night time and for maximum noise events, trucks are dominating the exposure on most highways and motorways, and this will only become more and more pronounced. Sleep disturbance will thus be worsened.

Due to all these issues combined, the legislators and authorities are building up a severe truck noise emission problem in Europe; instead of alleviating it as is the ambition regarding practically all other environmental issues. This will create a substantially unhealthier acoustical environment for the next generation of Europeans.
Therefore, tyre/road noise from heavy traffic must receive much more attention and this report outlines a project that could provide authorities, legislators and the scientific community with quantified data in order to help putting the problem into focus.

Consequently, the purpose of this document is to outline a Nordic project for studying noise emission properties of heavy truck and bus tyres (so-called C3 tyres) and providing the justification for this project. This document may, for example, be used as a background document for a call for proposals to conduct such a NordFoU project beginning in 2013.

The project suggests including a minimum of 20 truck tyre lines in the study, which shall be conducted mainly according to the measurement method required in the relevant regulations. New high-quality tyres from major European and/or Japanese tyre manufacturers shall be included, but also a few sets of retread tyres and cheap Asian tyres should be included in the test tyre selection since these are tyres commonly used on Nordic highways.

One or two heavy trucks will need to be available for the study for a considerable time, since testing truck tyres is time-consuming. The tests must be conducted on a track having a surface approved in the regulations, which means a so-called ISO surface. There is a severe problem to get access to such test tracks in the Nordic countries, but ways to get around the problem are mentioned. In addition it is proposed to measure the noise emission on a real road, subject to traffic and paved with a common surface on Nordic highways and motorways, as it is expected that such a surface may give quite different results from the ISO surface. Noise levels shall be measured according to the regulations but it is also suggested to check whether there are signs of significant tonal noise emitted by the tyres. This may be suspected to be the case at least from retread tyres or from cheap Asian tyres.

In addition to noise measurements by the coast-by method, it is proposed that measurements are made of rolling resistance coefficients of the tyre selection on a drum facility, also these in accordance with the EU regulations. Then it may be a relatively low extra cost to include measurements of noise also on the drum facility. This may provide extra valuable information for purposes of future measurement methods and for more detailed studies of possible tonal noise from the tyres.

Overall, this project will be relatively expensive to conduct and will require substantial efforts in time and technical resources (vehicles, tyres and test surfaces). A cost estimation results in a total cost around 3 million SEK. It is suggested that this project may also constitute a part of the surveys and monitoring of tyre noise and rolling resistance of C3 tyres which are assumed to be made by all EU (and probably also EEA) member countries in the next few years to meet the requirements in Regulation (EU) 1222/2009. In this way, the costs may be shared with activities that would, anyway, have to be made by the Nordic authorities responsible for following-up the new tyre regulations.
1. INTRODUCTION

It is universally agreed that noise reduction at the source is the most effective way to improve our acoustic environment. This applies not the least to road traffic [Kropp et al, 2007].

It has also been well documented that the major noise source for road traffic is the tyre/road interaction; for light traffic at speeds higher than approx 30 km/h and for heavy traffic at speeds higher than approx 50 km/h [Sandberg & Ejsmont, 2002].

Very substantial efforts have been made and are still being made for developing and improving low noise road surfaces. This is one part in the tyre/road interaction. The other part is the role of the tyre. Tyre manufacturers are doing very comprehensive work to improve tyres. This is especially focussed on safety, rolling resistance and visual appearance, but also tyre wear and tyre cost are important. With regard to noise, when noise is a selling argument, extensive efforts have been made to provide tyres which may give low noise inside cars and some other light vehicles. Efforts have also been focused on exterior noise; mainly to avoid tonal noise emission from periodical tread patterns, with a view to randomize the tread patterns and thus distribute the acoustic energy in wider frequency bands rather than at single frequencies. Apart from that, noise has generally been a low-priority factor in tyre design; with some recent exceptions where a few tyre lines have been made in order to provide low exterior noise to the market, where vehicle manufacturers have required low noise tyres in order to pass the noise emission limit, or where a specific tyre line has had a problem to pass the legal noise limit.

To support the development of tyres in a direction of noise reduction, when market mechanisms fail, it is therefore important for public organizations to do own work in this subject. For example, this is important for collecting data and as preparations for legislative actions to reduce noise. Such publicly financed work has been very limited since the subject became recognized as an important one in the 1970's. In the latter decades very little has been made outside the tyre companies on this matter. This means that the authorities and public organizations have a very weak position when it comes to discuss lowering of noise emission limits and similar legislative actions, as a contrast to the tyre industry which consistently and aggressively claims that tyre manufacturers are unable to reduce noise by better tyres except for very marginal improvements.

An excellent exception is the NordTyre project (NordTyre - Tyre labelling and Nordic traffic noise), sponsored within NordFoU. This project deals with noise emission from passenger car tyres, a comprehensive report has already been issued [Berge, 2012], and more work is underway.

At the February 2012 meeting of the NordTyre project the author stressed that although the car tyre project focussing on car tyres is very useful, the most needed and urgent work is for heavy vehicle tyres, since these tyres have received too liberal noise limits in the new EU and corresponding ECE Regulations, while at the same time a substantial increase in heavy vehicle traffic is expected to occur in Europe in the next couple of decades. Originally, the EU Commission proposed more stringent and quite effective noise limits for truck and bus tyres, but later decisions in the EU Parliament and in the Council almost entirely eliminated the improvements.
Heavy vehicle traffic in some Nordic countries is especially of concern as these countries allow 24 m long vehicles, having up to 26 tyres, and since some Nordic countries are large and have some extremely long freight distances. Also, it is discussed on a European level to allow longer trucks than the present 18 m limit, and it seems likely that this will be the norm in a few years time. Furthermore, it is also important to consider retreaded tyres, which are presently totally neglected.

2. PURPOSE

The purpose of this document is to outline a Nordic project for studying noise emission properties of heavy truck and bus tyres (C3 tyres). This document may, for example, be used as a background document for a call for proposals to conduct such a NordFoU project beginning in 2013.

3. IDENTIFICATION OF THE PROBLEM

The following is a list of issues which altogether justify that special concern should be given to truck tyre noise emission in the near future:

- Noise limits for truck tyres in the first set of limits (2001) were totally meaningless, since they eliminated at most only very exceptional tyres from the market.

- Noise limits for truck tyres in the second set of limits (2012) are somewhat more stringent but will eliminate so few tyres that it is unlikely to be noticed in the community noise.

- Winter truck tyres, which will be increasingly used in the Nordic countries, are given an extra 1-2 dB allowance in the noise limits, on top of the requirement for "traction tyres".

- Cheap but lower-quality tyres from Asia are becoming popular due to the much lower price. It will take some years until all of these have to meet the European maximum limits, but one may suspect that they will not be quieter than absolutely necessary.

- Many types of tyres are exempted from both the noise limits and from the noise labelling requirement; in fact more than 50 % of the truck tyres on our roads will be exempted, most of them being retread tyres.

- Truck traffic proportion in total traffic is ever-increasing and is already dominating traffic noise exposure along many major roads. In some European countries, this constitutes a dramatic increase. For example, the predicted growth in Swedish heavy vehicle traffic of 34 % from 2012 to 2030 (see Chapter 5) would change the traffic noise map of Sweden quite substantially within a fairly short time period.

- While vehicle noise for light vehicles will be "reasonably reduced" due to the planned regulations, trucks will probably not be subject to any significant noise reductions, which will mean that truck noise will be increasingly important in the future for this reason too.

- In night time and for maximum noise events, trucks are dominating the exposure on most highways and motorways, and this will only become more and more pronounced. This will cause increased sleep disturbance.
Truck tyre noise is severely under-researched; probably due to the higher costs and difficulty of studying such equipment.

Due to all these issues combined, the legislators and authorities are building up a severe truck noise emission problem in Europe; instead of alleviating it. This will create a substantially unhealthier acoustical environment for the next generation of Europeans. The issues listed above will be dealt with in the next chapters of this report and a project will be outlined that could provide authorities, legislators and the scientific community with quantified data to help putting the problem into focus.

4. PRESENT AND PLANNED LEGISLATION OF INTEREST

4.1 Vehicle noise limits in the EU and in ECE, effective from 1996


Vehicle noise is tested with the heavy vehicles accelerating with full throttle on various gear settings past two microphones (one on either side), starting from a speed in the range 15-50 km/h. The highest noise level, truncated to integer values and subtracting by 1 dB, is retained as the final result. With regard to tyres used during the test, it is required "The tyres used for the test are selected by the vehicle manufacturer and shall comply with commercial practice and be available on the market; they shall correspond to one of the tyre sizes designated for the vehicle by the vehicle manufacturer and meet the minimum tread depth of 1.6 mm".

The combination of using max throttle acceleration and unladen vehicle without any trailer means a very high torque and thus slip on the tyres of the test vehicle. For this reason, tyres with minimum tread depth are allowed, since such tyres increase noise relatively little when tyres are exposed to significant slip. Nevertheless, for some heavy vehicles, tyre/road noise may have a marginal influence on the measured value, but this is irrelevant for the noise limitation of tyres due to the combination of high torque, worn tread and relative freedom in choosing test tyres.

This is not the case for car tyres, where tyres are sometimes the biggest contributor to the total vehicle noise; see 28.5 in [Sandberg & Ejsmont, 2002].

4.2 Tyre noise limits in the EU, effective from 2001

The first direct limitation of noise emission of tyre/road noise was specified in EU Directive 2001/43/EC. The limits in this Directive are listed in Table 1. The dates given in the footnotes in Table 1 were originally stated but in practice they were never applied. The limits were introduced for new tyres gradually, beginning in 2003.

Also the levels reported in accordance with Directive 2001/43/EC are adjusted compared to the actual measurement. The measured noise level is truncated to the integer value (the
decimal is simply dropped) and 1 dB is subtracted, to give the final reported result. It means that, in practice, actually measured levels may be up to 1.9 dB higher than the nominal limits.

Table 1: Noise emission limits for new tyres in the EU according to Directive 2001/43/EC. Note that the values in the third and fourth columns are only indicative. Final values were to be decided after further studies had been made by the Commission.

<table>
<thead>
<tr>
<th>Type of tyre, section width [mm]</th>
<th>Limit value [dB(A)]</th>
<th>Limits after 1st tightening</th>
<th>Limits after 2nd tightening</th>
</tr>
</thead>
<tbody>
<tr>
<td>For cars (C1)****:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤145</td>
<td>72*</td>
<td>71*</td>
<td>70</td>
</tr>
<tr>
<td>&gt;145 ≤165</td>
<td>73*</td>
<td>72*</td>
<td>71</td>
</tr>
<tr>
<td>&gt;165 ≤185</td>
<td>74*</td>
<td>73*</td>
<td>72</td>
</tr>
<tr>
<td>&gt;185 ≤215</td>
<td>75**</td>
<td>74**</td>
<td>74</td>
</tr>
<tr>
<td>&gt;215</td>
<td>76***</td>
<td>75***</td>
<td>75</td>
</tr>
</tbody>
</table>

| Light trucks (C2):              |                     |                            |                             |
| Normal                           | 75                  |                            |                             |
| Snow                             | 77                  |                            |                             |
| Special                          | 78                  |                            |                             |

| Heavy trucks (C3):              |                     |                            |                             |
| Normal                           | 76                  |                            |                             |
| Snow                             | 78                  |                            |                             |
| Special                          | 79                  |                            |                             |

* Limit values in column 2 shall apply until 30 June 2007; Limit values in column 3 shall apply as from 1 July 2007
** Limit values in column 2 shall apply until 30 June 2008; Limit values in column 3 shall apply as from 1 July 2008
*** Limit values in column 2 shall apply until 30 June 2009; Limit values in column 3 shall apply as from 1 July 2009
**** Reinforced car tyres have 1 dB higher limits
*****“Special” car tyres have 2 dB higher limits

Figure 1 below presents a comparison of measured values and limits for heavy vehicle tyres. It appears that for the C3 tyres only one of the measured tyres was eliminated by the limits. This happened to be an extremely noisy tyre which had been designed with "suction cups" in the tread, as required by a vehicle customer believing that this would give excellent friction performance, despite the tyre manufacturer warned that this was not correct.

It may be concluded that the tyre noise limits of 2001/43/EC were totally ineffective for truck (C3) tyres.

Fig. 1. Measured sound levels of 45 truck tyres at 80 km/h (C2 tyres) and at 70 km/h (C3 tyres), on ISO surfaces in the Netherlands, Austria and Germany, compared to the EU limits. Data from 3 different studies; see [FEHRL - Sandberg, 2006].
4.3 Tyre noise limits in the EU, effective from 2012

The 3rd and 4th columns in Table 1 were meant to be introduced after the Commission had made studies to confirm that they were feasible. The Commission gave that task to FEHRL. FEHRL made a comprehensive study and reported the conclusions in [FEHRL, 2006]. Table 2 shows the recommendations by FEHRL, where the limits had been chosen in order to eliminate approx. 50% of the C3 tyres of today after the second step (in 2012).

Table 2: Proposed tyre noise limits for C2 and C3 tyres (rounding to nearest integer). Data from the FEHRL report to the Commission [FEHRL, 2006].

<table>
<thead>
<tr>
<th>Tyre category</th>
<th>Nominal section width (mm)</th>
<th>First step (2008)</th>
<th>Relative decrease compared to current limit value</th>
<th>Second step (2012)</th>
<th>Relative decrease compared to current limit value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>73</td>
<td>3.5</td>
<td>71</td>
<td>5.5</td>
</tr>
<tr>
<td></td>
<td>Snow (M+S)</td>
<td>74</td>
<td>4.5</td>
<td>72</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>Special</td>
<td>76</td>
<td>3.5</td>
<td>74</td>
<td>5.5</td>
</tr>
<tr>
<td>C3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>73</td>
<td>4.5</td>
<td>71</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>Snow (M+S)</td>
<td>75</td>
<td>4.5</td>
<td>73</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>Special</td>
<td>77</td>
<td>3.5</td>
<td>75</td>
<td>5.5</td>
</tr>
</tbody>
</table>

The EU Commission essentially accepted the FEHRL proposal. However, in the political negotiations in the Parliament and the Council, the limit values for C3 tyres were substantially relaxed. The final decision is presented in Regulation (EU) No. 661/2009. It appears that most limits are reduced by 3 dB in comparison to those which were decided in 2001.

Table 3: Tyre noise limits for C2 and C3 tyres according to Regulation (EU) No. 661/2009.

<table>
<thead>
<tr>
<th>Tyre category</th>
<th>Nominal section width (mm)</th>
<th>Nominal limit [dB]</th>
<th>Relative decrease compared to 2001/43/EC</th>
<th>Actual limit compared to measurements [dB]</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>72</td>
<td>3</td>
<td>73.9</td>
</tr>
<tr>
<td></td>
<td>Traction</td>
<td>73</td>
<td>4</td>
<td>74.9</td>
</tr>
<tr>
<td></td>
<td>Snow (M+S)</td>
<td>75</td>
<td>3</td>
<td>76.9</td>
</tr>
<tr>
<td>C3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>73</td>
<td>3</td>
<td>74.9</td>
</tr>
<tr>
<td></td>
<td>Traction</td>
<td>75</td>
<td>3</td>
<td>76.9</td>
</tr>
<tr>
<td></td>
<td>Snow (M+S)</td>
<td>76</td>
<td>3</td>
<td>77.9</td>
</tr>
</tbody>
</table>
Given the very liberal limits in 2001/43/EC, the reductions of 3 dB in Regulation (EU) No. 661/2009 are relatively small. The time of implementation for so-called replacement tyres (tyres sold as replacement to tyres that are original equipment on new vehicles) is 1 November 2012, whereas implementation time for original-equipment tyres is not until 2016.

When comparing these limits for C3 tyres with the data given in Figure 5.2 in [FEHRL, 2006], it appears that approx 10 % of the present tyres will be eliminated by the limits, which will have hardly marginal influence on the $L_{eq}$ levels of traffic noise (much less than 1 dB). Considering that retreaded tyres are not subject to noise limits, see Section 4.7, less than 5 % of the C3 tyres in traffic after 2016 will be eliminated by these limits, which is totally negligible.

Regulation (EU) No. 661/2009 contains also maximum limits for rolling resistance.

### 4.4 Tyre labelling regulation in the EU, effective from 2012

In 2009, with implementation from 1 November 2012, the Regulation (EU) No. 1222/2009 requires that new tyres sold in the Union shall be labelled with their noise levels, as well as classes of energy consumption and "wet grip". The label is shown in Fig. 2.

![Tyre Label](image)

**Fig. 2**: Example of how one tyre manufacturer announces one of its tyres, i.e. the label filled-in with the values for the tyre in question. Picture from the same tyre dealer as in Fig. 3, for the 4th tyre from above.

Some new tyres are already announced on the web with labelling values, see Fig. 3, which is an example from one tyre dealer in Sweden, accessed in September 2012.
Fig. 3: Example of how one tyre dealer announces its special deals, including the labelling values

It is hoped that the tyre labelling may have a better influence on the market than the limiting levels, but this is uncertain since noise levels are not very interesting for heavy vehicle owners unless there are such requirements set up by some organization which has an influence on the vehicle owner. One could imagine that such requirements (for noise) could be set up by public transportation organizations and by large transportation companies which would like to display concern for the environment towards society.
4.5 ECE Regulations on truck tyre noise

The UN ECE Regulation R117 contains essentially the same requirements as the Regulation (EU) No. 661/2009. The most important difference is that R117 contains requirements not only for noise and rolling resistance, but also for "wet grip".

4.6 New vehicle noise limits in the EU and in ECE

The existing vehicle noise regulations have been in force since 1996 (see Section 4.1). The development of these levels over the time period 1965-2015 is shown in Fig. 4. After a relatively fast development in reducing vehicle noise levels at the end of the previous century, everything has suddenly made a halt after 1996.

![Fig. 4: Development of vehicle noise limits since 1965 in Europe, Japan and USA. Diagram extended in time from [Sandberg, 2001].](image)

The frustration due to the inefficiency of the tightening of noise limits as reported in [Sandberg, 2001], which was blamed on failure to reduce tyre/road noise, initiated work on revising the measurement method ISO 362. Since a few years there is a new ISO 362, designated ISO 362-1, which describes a modified measurement method, which will be the used in forthcoming vehicle noise standards. For light vehicles, the new method uses more complicated driving conditions and calculations, with the intention to represent more common driving conditions than earlier. This has made tyre/road noise the dominating contribution for many, if not most vehicles. Thus, future noise limits will influence tyre/road noise for new vehicles equipped with original equipment (OE) tyres. Simply, light vehicle manufacturers will order low noise tyres from the tyre manufacturers.

But this does not apply to heavy vehicles. During type approval testing, heavy trucks and busses shall reach an end speed during full-throttle operation of 35 km/h (a target value with
± 5 km/h tolerance). The vehicle shall be loaded up to 75 % of the maximum allowed load on the rear axle. This means a heavy acceleration, giving substantial slip on the tyres, but since the vehicle is loaded it is not worse than when accelerating in actual traffic.

The tyres shall be appropriate for the vehicle and inflated to the pressure recommended by the tyre manufacturer for the test mass of the vehicle. The tyres for such a test are selected by the vehicle manufacturer, and correspond to one of the tyre size and type designated for the vehicle by the manufacturer. The tyre is or will be commercially available on the market at the same time as the vehicle. The minimum tread depth shall be at least 80 % of the full tread depth.

The Commission has proposed a noise limit for N3 vehicles (trucks and busses with engine power 150 kW or more) of 81 dB in a first step and 78 dB in a third step. Since then, various countries and organizations have proposed higher limits and/or longer time before enforcement.

Is tyre/road noise important during this test? There is not much data available regarding tyre/road noise from heavy vehicles, especially not at 35 km/h. However, Table 3 gives a clue, assuming the following:

- The drive axle of a truck is equipped with traction tyres, for which Table 3 gives a limit value of 75 dB, which is for an average speed of 70 km/h and on an ISO 10844 surface.

- It is assumed that the "average" traction tyre will emit 73 dB, to have a reasonable margin to the noise limit. The data in [de Graaf et al, 2004] support this assumption, given that for comparison to limits one should subtract an average of 1.5 dB from measured levels.

- Doubling of speed causes 10 dB of noise increase and halving of speed causes 10 dB noise decrease. This is based on Table 9.1 in [Sandberg & Ejsmont, 2002] which suggests a speed constant B in [Sandberg & Ejsmont, 2002] of approx. 35, which gives 10.5 dB for a halving of speed from 70 to 35 km/h

- At 35 km/h on an ISO surface then 63 dB is a reasonable average noise level for heavy trucks and busses (this is based on the rules of the Regulations which skips the decimal and subtracts 1 dB, so the real measured values would be on average 1.5 dB higher).

- Tyres are subject to significant slip during fill throttle acceleration. Assuming a noise increase due to this, the noise level increases by (say) 4 dB, thus the A-weighted noise level during testing will be 67 dB.

If the limit would be 78 dB (at the third step), as the Commission proposed, tyre/road noise alone would be approx 10 dB below the power unit (engine, transmission and exhaust) contribution. This means that tyre/road noise will be negligible during heavy truck and bus vehicle noise testing. Of course, it is very likely that the test speed was chosen with this in mind.
It is thus concluded that truck tyres will not be affected by the new vehicle noise limits, whereas passenger car tyres will be so. What will be dimensioning for heavy truck tyre/road noise will be only the Regulation (EU) No. 661/2009.

4.7 **Truck tyres which are exempt from the noise limiting or labelling**

Only tyres in new un-used condition are subject to the above-mentioned regulations. Furthermore, the following truck tyre categories are excluded from the maximum noise limit regulations:

- Retreaded tyres
- Professional Off Road tyres
- Studded tyres (*if there are any studded truck tyres?*)
- Tyres produced before 1 July 2012

The following truck tyre categories are excluded from the labelling requirement:

- Retreaded tyres
- Professional Off Road tyres
- Studded tyres (*if there are any studded truck tyres?*)
- Tyres designed to be fitted on vehicles registered for the first time before 1 October 1990
- Tyres produced before 1 July 2012 (Date of Production Code < “2712”)
- Tyres the speed rating of which is less than 80 km/h

There are plans to introduce labelling requirements to retreads, according to [ETRMA, 2012]. However this will be decided after an impact assessment is performed by the Commission. The Commission shall present the result of this assessment no later than by March 2016.
5. EXPECTED DEVELOPMENT OF HEAVY TRAFFIC

Fig. 5 shows a prediction of the development of freight transport by trucks in EU27 [Rich & Hansen, 2009]. Although the truck traffic work development for Denmark, Finland and Sweden is expected to be slower than for the majority of countries, it still means an average of approx 20 % increase between 2005 and 2030. More freight in tonne-km means more tyre/road noise. This will no doubt mean a substantial increase in the number of noise exposed people in the Nordic countries, if no countermeasures are taken. For Europe as a whole, the growth is alarmingly high and for many countries the growth will result in substantially worsened truck noise emission.

Fig. 5: Predicted growth in tonne-km transported by trucks in EU27 from 2005 to 2020 and 2030 [Rich & Hansen, 2009].

However, the growth mentioned above is far from what is predicted by the HBEFA model used in Swedish traffic predictions by VTI [Keller, 2010][Björketun, 2007]. A calculation in that model made for this author, using the latest figures, indicated a 41 % growth in heavy-vehicle-km between 2005 and 2030 in Sweden, as compared to Rich's & Hansen's 22 % shown in Fig. 5, and 34 % between the present time (2012) and 2030. It is not known what causes these dramatic differences.

6. SOME INTERESTING TRENDS AND PRACTICES

6.1 General

A few interesting current time trends for heavy vehicle tyres are mentioned in the following sub-chapters. As a general summary one can conclude that most trends suggest that noise issues for truck tyres will become more and more important when time goes by.
6.2 Wide-base single tyres replacing dual-mounted narrower tyres

The most remarkable time trend seems to be the change in tyre dimensions. For drive and trailer axles, it has over the last 50 years or so been common to mount tyres in dual mounting, which means that two tyres are mounted close beside each other at either side of the truck or trailer. In this way the load capacity can typically be increased by 90-95% in comparison to mounting the same tyre single.

However, starting in the 1990's and becoming very fashionable in the 2000's, the dual mounting has gradually been replaced by so-called "super-singles" or "wide-base" tyres; i.e. much wider tyres meant to be mounted as single tyres, which can carry approx the same load as two "traditional" tyres. While the older tyres intended for dual mounting typically have widths of 215-315 mm, the wide single tyres typically are 365-495 mm wide, although also tyres 275-385 mm wide are common in single mounting; especially on steer axles. The wider tyres versus the dual-mounted narrow ones are said to reduce rolling resistance and also cost in general.

Quite little is known on how the single wide tyres compare to dual-mounted narrow truck tyres in terms of noise emission. It is in fact difficult to isolate the effect, since it is very difficult to find tyres with the same tread pattern and rubber compounds, and where only width and number of tyres differ. Furthermore, to be fair, loads should also be the same.

In [Roovers & van Blokland, 2002] it is indicated that the noise difference is only marginal (within one decibel) if super-single tyres and dual-mounted regular tyres for the same load capacity are tested for the two cases.

Consequently, although this is a remarkable trend, there is no reason to expect that it will have a significant effect on truck noise emission.

6.3 Lower rolling resistance

As for car tyres, lower rolling resistance is the most popular marketing topic in recent years, although also wear is very important for truck operators. Lower rolling resistance has been achieved by improved tyre geometry and rubber compounds.

Neither this trend is expected to have a significant effect on noise emission.

6.4 Tyre labelling effects

The new tyre labelling requirements for truck (C2 and C3) tyres include noise and fuel efficiency (rolling resistance) but not skid resistance. The reason for the latter is that there were no reference tyres for heavy vehicles available when the regulation was written. However, recently such tyres have been standardized by ASTM, and thus ECE/GRB has started to consider extending the labelling also to skid resistance ("wet grip"). Since information about skid resistance for truck tyres has been very sparse, this will mean that customers will have another objective parameter to consider, albeit not in the next few years.

The labelling also means that noise will be such a new parameter to consider, but it is not expected to have any significant effect until "green transport" is required, e.g. by public authorities, and will consider also noise emission. But the potential is there.
6.5 Winter tyres on trucks and busses

In recent years a number of accidents involving heavy trucks and busses on winter roads, plus an increasing number of trucks from the European continent getting stuck in snowy and icy roads, have caused a discussion regarding introducing a requirement to use winter tyres on winter roads in Sweden. A major problem is the question on how to define winter tyres, since there are no rules for this. It is up to the tyre manufacturers to mark their tyres as they desire; in the case of winter tyres they are generally marked "M+S". Nevertheless, tyres with tread patterns with higher air/rubber ratio used to give optimum traction on drive axles (irrespective of season) are also frequently used in winter climates; these are generally called "traction" tyres. To make it even more confusing, many of these traction tyres are also marked M+S. The technical differences between M+S tyres for optimum winter use and traction tyres for more general use is not clear-cut, but it may often be that the M+S tyres have a rubber compound and tread pattern which is more optimized for driving on ice and in snow.

Nevertheless, the Swedish Government has now proposed that winter tyres shall be required on drive axles on heavy trucks and busses under the same conditions as are valid for car tyres. The proposal presently is submitted to the EU Commission for notification and approval. It may be a decision implemented from 1 December 2012, but valid only for one year since simultaneously, the ETRTO has agreed on a test for drive axle heavy vehicle tyres to determine whether they qualify as winter tyres. The proposal has been submitted to the ECE [Däcknytt, 2012].

One may expect that most truck operators will purchase new winter tyres and mount them on the drive axle before winter begins; then – depending on how fast they are worn - they will move them to trailer axles in the spring or summer and continue to use them over the warmer seasons, but when a new winter comes, the process is repeated. This is essentially the same procedure as is common on drive axles with today's drive axle tyres (often referred to as traction tyres). Therefore, we may expect that the winter tyres will be used much longer than just in winter time and not just on drive axles; although with lower tread depths.

Winter tyres for heavy vehicles are given extra high noise limits in comparison to "normal" tyres; thus this trend may be negative to noise emission.

6.6 Retread tyre market development

Currently, about 12 % of the EU's scrap tyres are retreaded and reused. This is for all tyres; for truck tyres in middle Europe the market share of retread tyres is approx. 40 %. However, in Sweden and Finland it is approx. 65 % [Arktrans, 2012].

What is more important than market shares, is how much of the traffic work by heavy vehicles that is made on retread tyres compared to on new tyres. The author has not found such information. One may expect that retread tyres run somewhat shorter distances before they are worn out than new tyres do. Therefore, the 65 % mentioned above should probably be adjusted to 50-60 % when it comes to traffic work.

Professionals assume that the proportion of retreaded tyres on the market will continue to grow [Arktrans, 2012]. This is logical, since recycling is a clear trend in society. However, the retread market feels an increasing competition from cheap Chinese tyres, which are considered to be of lower quality but being sufficiently cheap to compete with retreads. One
may of course fear that the Chinese tyres might be noisier than most European brands. But irrespective of whether cheap Chinese tyres take market shares or whether retreads do so; in both cases this is likely to be a challenge in terms of noise.

7. **TONAL NOISE FROM TRUCK TYRES**

A special problem with truck tyres is that some of them exhibit tonal properties; i.e. they have their main sound energy concentrated at one or a few frequencies in the frequency spectra. This is due to periodic features in the tread patterns. Since this is very annoying, light vehicle tyres and most heavy vehicle tyres have their tread patterns randomized. Engineers at some European tyre producers have told the author that most European tread patterns for trucks are randomized due to the concern for tonal noise here, but they have also said that this is not so often the case in North America.

The author once, in 2009, when driving on a highway in Canada, heard a tremendously pronounced high-level tonal tyre noise from a truck carrying asphalt mix. The author followed the truck until it stopped at a re-paving site, talked to the truck driver and shot some photos of the tyres; see Fig. 6. The tyres appeared to be Goodyear G177. This is a typical tyre for civil engineering construction work in North America, where temporary off-road capabilities are needed.

![Fig. 6: The Goodyear G177 tyre which gives exceptionally tonal noise. Photo shot by the author 2009 in Ontario, Canada.](image-url)
The Goodyear G177 tyre is probably not sold on the European market, but it is still available on the North American market. Nevertheless, when studying marketing ads, brochures and web content, there are some tyres in Europe with rather similar rugged tread patterns, especially retread ones, and some of them do not appear to have an easily spotted randomization. Especially, one may fear that the cheap Asian tyres becoming popular due to the price may not have proper randomization.

The author has several times noticed highly tonal tyre noise from trucks passing-by on highways, and a few times followed such trucks in Sweden for several miles hoping for an opportunity to talk to the driver at a stop, and to identify the tyre in question, but so far without success.

To measure tonality when using the coast-by metod is not trivial since there is a so-called Doppler effect (sound at the microphone position changes from a higher to a lower frequency during the coast-by, see 14.3 in [Sandberg & Ejsmont, 2002]). Assuming that the frequency spectra are captured at the time of maximum noise level and this will occur when the source is travelling maximum 7.5 m before until 7.5 m after the microphone position, the relative sound speed from the source in the direction of the microphone varies by around ± 4 % from the nominal 330 m/s and thus perceived frequency varies by the same amount. Third-octave band spectra have a nominal 22 % bandwidth, which means that in a majority of cases the frequency shift due to the Doppler effect will be contained within one third-octave band. In cases where the tonality hits a frequency between two third-octave bands, one may miss detection of the tonality; however, this should not happen too often. Thus, with the coast-by method one will detect a conservative and somewhat underestimated tonality effect.

In case supplementary noise measurements are made on laboratory drums, the tonality will be easy to measure, and in such cases one may even (optionally) record noise in 12th octave bands.

8. EARLIER STUDIES OF NOISE LEVELS OF TRUCK TYRES

Rather few studies of noise emission of truck tyres have been made over the years. One of the first, made purely on radial truck tyres, is illustrated in Figs. 7-8 [Sandberg, 1991]. VTI then measured 20 heavy truck tyres (dimension 12R22.5) using a special truck CPX trailer, which still exists.

The results are summarized in Fig. 8, which is for a DAC 12 surface located on a test track. Measurements were made on three other surfaces too, two of which were actual road surfaces. The spread in noise levels was only half as large on the road surfaces as the results on the test track surface illustrated in Fig. 8.

In 1992-93, as preparations for the Directive 2001/43/EC, the French UTAC and British TRL laboratories measured tyre noise by the coast-by method later used in the Directive, including the use of ISO 10844 surfaces which had been constructed based on drafts of the ISO 10844 standard which was being prepared in the beginning of the 1990's. Results are shown in Fig. 8.4 in [Sandberg & Ejsmont, 2002]. These were the only results for truck tyres on which the limits in the Directive were based.
Fig. 7: Twenty truck tyres (size 12R22.5), measured in 1987 by VTI with an "old" (truck trailer) CPX method [Sandberg, 1991].

Fig. 8: Tyre/road noise from 20 truck tyres (size 12R22.5), measured in 1987 with an "old" (truck trailer) CPX method on a dense asphalt concrete surface (ABT12) [Sandberg, 1991].
As a background for the Regulation (EU) No. 661/2009, FEHRL was commissioned by the EU Commission to prepare a compilation of measurements. These appear in Chapters 4 and 5 in [FEHRL - Sandberg, 2006], where measurements of truck tyres in coast-by on ISO 10844 surfaces are presented from Austria, France, Germany, and the Netherlands. Almost all of these tyres passed the limits of Directive 2001/43/EC. Somewhat newer data from the Netherlands were summarized in [Sandberg, 2008].

Retreaded truck tyres were studied in Germany, the results of which appear in Section 6.2 in [FEHRL - Sandberg, 2006]. All these tyres passed the limits of Directive 2001/43/EC.

Finally, a study made by SP in Sweden shall be presented. This is of extra importance to this project as it may suggest how such a study can be made, and it also contains relevant and (still) interesting results.

This special study was made in 2007 by the SP Technical Research Institute of Sweden to measure noise levels of market tyres of various types [Jonasson, 2007]. The most important result for heavy vehicle tyres (C3) is presented in Fig. 9. Note that in this figure there is no subtraction of 1 dB and no rounding to the nearest lower integer, which is required in the Directive.

Fig. 9: Sound levels measured by SP in Sweden for 9 truck (C3) tyres at 70 km/h, on an ISO surface (Volvo Hällered) and on an actual road surface (7 years old DAC 0/16). The rounded symbol is for a steering axle tyre (the leftmost data pair only), the other ones for either drive axle or M+S tyres (it also includes a super-single drive-axle tyre). Data processed by this author from [Jonasson, 2007].

1 The reason why reference to the author’s reports is made rather than to each original study is that it will be much easier for the reader to find the most essential data in this way, and some of the original references are very difficult to get hold of today. The original references are found in the indicated references.
There are two sets of values in the diagram, one measured on an ISO 10844 surface on the Volvo Hällered test track and the other on an actual road which was subject to traffic. The surface on the road was a 7-year-old DAC 0/16 for the C3 tyres.

The results show that the tyres vary approx. 5 dB on the ISO surface, but less than 4 dB on the actual road surface. The correlation between levels on the road surface and the ISO surface are poor. All tyres are well below the limits in Directive 2001/43/EC, and they would also pass Regulation (EU) No. 661/2009, except the noisiest tyre (the rightmost blue symbol in Fig. 7).

The reported measurements did not say anything about possible tonal noise from the truck tyres; a topic which is not normally explored. The exception was [Sandberg, 1991] where it was found that some of the tyres had tonal noise emission.

9. TYRE TERMINOLOGY

Researchers and engineers outside the tyre industry and authority experts are not often aware of the correct terms for different tyre products. When one refers to a specific tyre brand (manufacturer) and a specific product or trademark (tyre) that this manufacturer offers at different dimensions, the appropriate term as used in the tyre industry is "tyre line". The tyres represented in Figs. 3 and 7 are all of different tyre lines. Laymen may call them "tyre types" or "tyre models" but these are not really correct terms here. "Tyre type" may refer to, for example, bias ply and radial ply tyres. Here is a summary:

**Tyre brand** = usually refers to the manufacturing company of the tyre, e.g. Michelin, Bridgestone, Goodyear

**Tyre category** = refers to the size/load of the tyres; where C1 = car tyres, C2 = van and light truck tyres, C3 = heavy truck tyres.

**Tyre range** (sometimes called *tyre application*) = usually refers to the use of tyres, such as summer, winter (M+S), all-weather, highway, regional, city and off road.

**Tyre line** = refers to a specific tyre product of similar design and construction (usually offered in several dimensions); e.g. *Energy Saver* or *X MaxiTrailer* (by Michelin), *Blizzak* or *M711* (by Bridgestone), and *Eagle NCT5* or *Marathon LHS II+* (by Goodyear). The term trademark could be an alternative term but is not used frequently in this meaning by the tyre industry.

In addition, the author would like to point out the doubtful meaning of the term "rolling sound" or "rolling noise" frequently used in European-based regulations. Sound or noise is rarely "rolling", although it may be heard is such when there is thunder or loud explosions in a canyon creating multiple reflections lasting for several seconds. Also avalanches may sound as if the noise is repetitive or "rolling". The term probably comes from a not so successful early translation to English of the German term "Rollgeräusch" which means "noise from rolling" (of tyres) and/or the French term "Bruit de roulement" with the same meaning.
The term which has been standardized by ISO (and thus CEN) is "tyre/road noise" (ISO 11819-1). If one is focusing on only the tyre properties, one may perhaps write it just "tyre noise". Tyre/road noise is a term which very clearly expresses both the source(s) and what phenomenon one refers to, while "rolling noise" is just confusing.

10. SUGGESTED OBJECTIVES OF THE PLANNED PROJECT

It is proposed that the planned project outlined in this report shall have the following major objectives:

- Report noise levels of a selection of current truck tyres of category C3 in new (but run-in) condition; measured in accordance with Regulation (EU) No. 661/2009/EC which refers to the method in UNECE Regulation R117.02.

- Explore whether the tonality of the tyres is a problem; i.e. if tonal components according to ISO 1996-2 exist in the tyre selection. If the project will show that tonal noise is a problem for today's tyres, measures to control it shall be proposed.

- Study the correlation between noise levels (and tonality) measured on the ISO 10844 surface and a representative road surface subject to traffic. The latter is recommended to be an SMA surface on a trafficked road with max. aggregate size in the range 11-16 mm; in order to determine whether it is worthwhile to suggest the use of a second reference surface in the regulations in order to make regulations more effective in the real-world situation.

- Study whether there is a significant noise emission difference between retreaded and new tyres in the chosen tyre selection.

- Study whether there is a significant noise emission difference between European-made and Asian-made tyres in the chosen tyre selection.

- Make a survey of labelled values for the tyres on the market.

There are several thousands of different tyres on the market, considering the tyre lines, the dimensions, tread patterns and reinforcements. There is no project in the world that will be able to representative of the world market for truck tyres. Of course, the project budget will not allow a fully representative tyre selection; consequently, the three last bullets above will provide only a "snapshot" of the actual situation. To make this as meaningful as possible, given the limited budget and the high costs, the project will have to spend considerable efforts on finding an optimum choice of test tyres. "Optimum" should include tyres which are popular on the market and trying to match tread patterns and tyre construction between European versus Asian, and retread versus new tyres.
11. LIMITATIONS AND OBJECTIVES OF THE PLANNED PROJECT

It is proposed that the planned project has a limited ambition in terms of the following topics:

- Only C3 tyres (for heavy vehicles) considered; i.e. C2 tyres will not be considered. Tyres for light trucks, mini-busses and vans (C2 tyres) might be the subject of a later project. It will be too expensive to carry out studies of both C2 and C3 tyres simultaneously.

- The number of tyre lines and sizes selected should be between 20 and 30, depending on the available funds and resources. The higher number of tyres, the better. This includes only new tyres (but run-in).

- The speed range is limited to that required in the tyre noise regulation (60-80 km/h). However, if measurement can be made also at a nominal speed of 50 km/h, perhaps with fewer test runs, this is an advantage.

It is proposed that the planned project shall meet at least the following requirements:

- A state-of-the-art report summarizing measured results (noise) for truck tyres in Europe from the last 25 (or so) years; if possible attempting to see any time trends for noise levels

- A compilation of labelled values for the truck tyres on the market (noise level, wet grip and fuel efficiency) by checking internet sites of tyre dealers and tyre manufacturers, and by visiting tyre dealers physically

- Noise levels of selected truck tyres, shall be measured in accordance with Regulation (EU) No. 661/2009, which is similar to UN ECE R117.02 (revision 2, September 2011)

- This implies that one shall use a truck running over the test area in coast-by, equipped with four tyres, two for testing and two special tyres on the steering axle, and also that an ISO surface shall be used (ISO 10844 according to the Regulation)

- Additionally, frequency spectra shall be measured at the time of maximum coast-by A-weighted level

- The existence of tonal noise shall be identified by some standard procedure (Annex C or D in ISO 1996-2 is proposed)

- At least 5 retreaded tyres shall be included in the selected tyre sample for testing

- At least 4 relatively inexpensive tyres from companies based in East and/or South Asia shall be included in the selected tyre sample for testing, for example from China, Taiwan, Thailand, India, but not from Japan or Korea

- The tyre selection shall include at least 4 tyres having a width of 365 mm or higher (super-single tyres), and at least 10 tyres having a width of 315 mm or lower (tyres useful for dual-mounting)
Apart from tests on the ISO 10844 surface, testing shall be made also on an actual road paved with a "representative" surface. In this case it is proposed to be an SMA surface. The SMA surface shall have a maximum aggregate size of between 11 and 16 mm, and its MPD shall be at least 1.0 mm.

The number of tyres mentioned in the three preceding bullets refer to the different tyre lines and dimensions. For the testing, two tyres of each is required (on the test vehicle rear axle) which means that the number of test tyres is doubled.

The main tyre selection includes only tyres in new or near new condition (maximum 2 mm tread wear). However, if a few tyres of the same type can be tested in worn condition (maximum half of the original tread depth remaining) it is an advantage.

The report shall compare the actually measured noise levels for each tyre with the formal limit value for the same tyre type and size according to the first phase of Regulation (EU) No. 661/2009. It shall also report whether there is tonal noise in the frequency spectra.

Compare measured results with values found in the labels of tyres to see how they differ (this is obviously possible only for those new tyres where such labelling has already been done).

12. MEASUREMENT AND ANALYSIS METHODS

It is proposed that the planned project is carried out utilizing the following measurement methods:

Coast-by measurements according to method specified in UNECE Regulation R117.02 (Revision 2, 15 September 2011, Annex 3) or any later version of R117 if available when the project is conducted. This means that requirements there with regard to test vehicle, tyre load, tyre inflation, reference surface (ISO 10844) shall be met.

The above requires the use of a heavy truck using only two axles, fitted with a total of 4 tyres.

In the case of test tyres (having load index above 121), two of these tyres of the same type and range shall be fitted to the rear axle of the test vehicle; the front axle shall be fitted with tyres of size suitable for the axle load and planed down to the minimum (legal?) depth in order to minimize the influence of tyre/road noise while maintaining a sufficient level of safety. This will require special preparation of two steer axle tyres for this test.

As it is unclear whether the front axle tyres will affect total tyre/road noise significantly for certain combinations of tyres and surfaces, an attempt shall be made to estimate the contribution of the front tyres to the total tyre/road noise at some typical and critical cases.

For C3 tyres, there shall be no temperature correction. Nevertheless, air and road surface temperature (the latter is only optional) shall be measured, and one shall plan the testing in order to avoid large temperature variations.
With regard to the **reference surface** (ISO 10844) it is noted that there are at the time of writing two versions: the original 10844:1994 (published 1994), and an updated version published 2011. Annex 4 of R117.02 is in all essential details identical to ISO 10844:1994. However, work is going on to replace the old standard with the new one (ISO 10844:2011) in Regulation 117.02. If this is officially done before the planned project starts, testing shall be made on a reference surface meeting requirements in ISO 10844:2011. If such a surface is unavailable within reasonable distance the project shall use a surface meeting the ISO 10844:1994 version.

The planned project shall also test the tyres on an **actual road surface**. This is proposed to be an SMA having a maximum aggregate size of either 14 or 16 mm. In case such a surface, suitable for coast-by testing, is difficult to find, an SMA with 11 or 12 mm maximum aggregate size may be used. However, one shall make sure that MPD of the SMA surface is no less than 1.0 mm.

**Justification:** The SMA 16 is the reference surface used in the Swedish traffic noise prediction model, and this pavement, or remixes of it with similar properties, is the surface that dominates the Swedish highways and virtually all high-volume roads. Also SMA surfaces with smaller maximum aggregate size (but rarely below 11 mm) are used in urban areas. The situation is similar in Norway and Finland. In Denmark, 16 mm is much less frequently used (due to lack of studded tyres); instead 11 mm is common. The SMA 11 is very common in Denmark and is also very common in many other European countries. A mix of SMA 11 and DAC 11 have been chosen as the European virtual reference surface in projects HARMONOISE, IMAGINE and now finally in CNOSSOS. The reason why a relatively high macrotexture (MPD) value is required (and therefore also a large maximum aggregate size, preferably > 11 mm) is that especially on such surfaces, the correlation of tyre/road noise levels on the ISO surface and actual road surfaces is poor. See [Sandberg, 1991].

It should also be allowed to choose a DAC surface, but only provided its MPD is no less than 1.0 mm. It may be hard to find such high macrotexture on a DAC, but it is possible on DAC 16. This is, by the way, the reference surface in the Netherlands (but without an MPD requirement).

**Simplified testing on the road site:** Since road site measurements are impractical to make and may consume substantial time, it is allowed to make some simplifications in the testing that are not expected to influence the results significantly:

- It is enough to make measurements on one side of the road (the right side), since microphone placement on the other side may be unsafe.
- The requirement of a hard paved surface below and surrounding the microphone may be relaxed. It is enough if the requirements in ISO 11819-1 are satisfied.
- The requirement regarding equal spread of speeds (from 60 to 80 km/h) around the average 70 km/h shall be more relaxed; it is enough if there are at least 3 measurements below and 3 measurements above 70 km/h, but still a minimum of 8 acceptable measurements in total, and there is no need for "equal spread" of speeds.
- For safety reasons, the test truck’s engine must not be shut-off during the pass-by, but shall be in idling condition (and clutch engaged) in order not to disturb the measurement. By separate tests at standstill, with the engine idling, it shall be verified that the overall A-weighted sound level in that condition is 10 dB or more below the tyre/road
noise for the quietest tyre at the lowest speed used during testing (obviously, one would avoid testing at speeds close to 60 km/h for this reason).

13. CAN DRUM OR TRAILER MEASUREMENTS BE USEFUL?

The author expects that the range between the quietest and noisiest tyres will be around 5 dB. This means that measurements uncertainties should be less than 1 dB in order to distinguish properly between tyres. If measurements with other methods than the coast-by required in the Regulations are made, one will have an extra uncertainty due to the correlation between such measurements and the required ones. Generally, it means that for the results to be credible among stakeholders it is necessary to keep to exactly the required coast-by method.

Additional studies by using a laboratory drum facility having replica road surfaces (such as those in the Technical University of Gdansk – TUG - or in the German Federal Highway Institute - BAST) may give useful supplementary data, but they can not replace the coast-by measurements mentioned in Chapter 12, since the major purpose with the planned project is to supply information related to the present and forthcoming regulations, which only accept coast-by measurements. Furthermore, the correlation between coast-by and drum measurements has not yet been verified to be so good that one can use it with high confidence.

The same applies to trailer measurements, even though such would be less different from coast-by than drum measurements. There are not many trailers available for such measurements; maybe the most interesting (and only?) one is owned by the M+P in the Netherlands, but it has not been used for many years. The trailer used by VTI [Sandberg, 1991], still exists but it does not allow the high loads of present-day tyres, and it would need some restoration after being out-of-service for more than 20 years.

The trailer method can be used in two variants: towing a trailer in pass-by between microphones located as in the regular coast-by method, and towing the trailer with microphones close to one or two test tyres, as in the so-called CPX method (ISO/DIS 11819-2). With the latter method one may save on test tyres: one will need only half the number. However, since the intention is to resell the test tyres, there is not much to earn there. Both the trailer coast-by method and the CPX method will require rental of a towing truck with driver, run-in of the test tyres, tyre/rim change, balancing, etc, more or less as for the regular coast-by method, so there is not any substantial time or cost to save by using a trailer. In the CPX method, the noise levels will not have an established correlation with measurements made according to the EU or ECE regulations; thus the value/usefulness of the test results is seriously reduced.

Consequently, the author believes that only the regular coast-by method required in the EU and ECE regulations are useful for the purposes of this project, but that drum measurements may give useful supplementary information for only a small extra cost.

In case rolling resistance measurements are made (see below) it would be just a little more expensive to do also noise measurements on the drum facility. That would be an excellent "not-to-miss" opportunity to establish the correlation between drum and coast-by measurements for future purposes.
14. **OPTIONAL ROLLING RESISTANCE MEASUREMENTS**

Since the new noise limit and the labelling regulations include measurement of rolling resistance of truck tyres, it is an advantage if the planned project can include rolling resistance measurements too. This may be made on a laboratory drum facility. The measurement method shall be identical to the method specified in the regulations (i.e. in UNECE R117.02). Results shall be presented both as rolling resistance coefficient and corresponding fuel efficiency class (the latter for the labelling regulation). For some tyres such measured values and corresponding classes may be compared to what the label says for the specific tyres.

These measurements may not mean a substantial cost increase to the project, as they can be made in a laboratory (such as that in the Technical University of Gdansk) and for only one tyre sample of each tyre line. Such measurements may also make the project more interesting for a truck company to take part in.

15. **OPTIONAL SKID RESISTANCE MEASUREMENTS**

Current regulations in the EU or UNECE do not require skid resistance measurements (it is called "wet grip" in the R117.02) for truck tyres (C3). This is purely (?) because the "wet grip" test requires comparison with a reference tyre, and reference tyre(s) for the C3 category did not exist when the regulation was written. Recently, such reference tyres were indeed specified by ASTM International; thus work is going on to introduce this measurement (and limits) in the R117.

In Fig. 2 it is shown that wet grip classification is already included in the labelling of truck tyres; before it is officially mandatory in the Regulation.

Thus, "wet grip" tests may be, or is even likely to be required in a newer version of R117 when the planned project is started. This would justify including such measurements in this project. However, due to the substantially increased cost for such measurements, it is not currently recommended to include wet grip in the project.

Instead it is recommended to consider doing "wet grip" measurements in a later project, provided the test tyres are saved for this purpose. Such measurements may be made by a different organization with focus more on tyre safety than on tyre/road noise. However, it may be a case for negotiation in case a truck company is chosen as a partner in this planned project, since the truck company may be interested in such data.

16. **ACCESS TO A REFERENCE ISO SURFACE**

Recent activities in which the author has been involved has shown how very difficult it is to get access to an ISO surface for measurements. In this case, one will probably need approximately 10 working days to conduct the measurements on each surface type. To get access to an ISO surface in one of the Nordic countries for such an extended time period will be almost impossible, unless it is part of a cooperation with the test track owner.
One possibility may be if the company that has taken over the Saab facilities in Trollhättan (National Electric Vehicle Sweden AB - NEVS) would decide to put down a new ISO surface or restore the present one (which will not meet the ISO 10844:2011) and would allow an external customer to rent the track. Reasonably, NEVS will need to have an ISO surface available if they are going to do some development work in Sweden, and according to a statement on their website at the time of writing they will do so. The author has made enquiries about cooperation, but NEVS answered that it was still too early to decide on this.

Thus, unless the NEVS option will materialize, one may have to look for an ISO surface outside the Nordic countries, or one will need to have a cooperation with an owner of a test track; for example Volvo Trucks.

See also the end of Chapter 21.

16. ACCESS TO A SUITABLE TEST VEHICLE

Unless the performing organization owns a suitable test truck, which meets the present noise limit, allows fitment of all test tyres and allows the proper loads, one may rent a new or almost new truck from a truck dealer, such as Volvo or Scania. It is likely that rental for at least 4-6 weeks is needed, in case of poor weather longer time will be needed. Cost would probably be something like 5000 SEK per day (incl driver), which would mean 100 000 – 150 000 SEK for 4-6 weeks. To allow for reasonably poor weather, rental over a 6-9 weeks period may be more realistic; thus adding 50 % to the estimated costs. Maybe one would get a discount for such a long time.

One option would be if the project can be regarded as so attractive by a truck manufacturer that the truck company would be willing to supply for free or with a substantial discount a test truck. In the optimum case this could include access to an ISO test track. The author believes that especially Volvo Trucks could be worthwhile contacting for such an option. For this to be successful, the author believes that inclusion of rolling resistance measurements in the project would greatly enhance the chances of attracting the truck company.

Free access to a test truck and test track may thus be worth approximately 200 000 – 300 000 SEK to the project. On the other hand, the truck company would get a lot of useful test data which can be used for tyre selection for its fleet.

17. ACCESS TO AND SELECTION OF TEST TYRES

One of the most critical parts of the planned project is to get access to a suitable set of test tyres. Here are some proposals.

17.1 Tyre dimensions

First, some words about selection of tyre dimension. It has already been proposed that only C3 tyres are considered; i.e. tyres for heavy trucks and full-sized busses. It has also been proposed that some of the tyres shall be of the wide-base type ("super-singles", called "wide" below) which are meant to replace dual-mounted single tyres (called "narrow" below).
Tyre rims should have a diameter of 22.5” since this is and has been for a long time the dominating rim dimension for heavy (long-haul) trucks. The exception may be for the "wide" tyres, where the rim diameter of 19.5” is very common. It should be up to the project manager to decide on whether wide tyre rims should be of the lower diameter or not, depending on availability of test tyres and practical matters.

Tyre aspect ratio is recommended to be 60, 70 or 80 % for the narrow tyres, and 45, 55 or 65 % for the wide tyres (but always lower for the wide than for the narrow tyres). Whatever the choice is, it is recommended that the same aspect ratio is used for all narrow tyres (say 70 %), respectively for all wide tyres (say 55 %), to make tyre comparison easier.

Regarding the remaining tyre dimension, namely tyre width, the question is: shall one choose one dimension for the single tyres possible to use in dual-mounting ("narrow" tyres), and one dimension for the "super-singles" ("wide" tyres), or shall one attempt to select several different dimensions?

The author recommends choosing the first alternative: one dimension for the "narrow" tyres, and one dimension for the "wide" tyres. For the narrow tyres, the width should be 295, 305 or 315 mm; for the wide tyres the range should be within 385-445 mm. Table 4 summarizes the proposed tyre dimensions. Whatever the choice is, it is recommended that the same aspect ratio is used for narrow, respectively for wide tyres. The reason is that it makes tyre comparison easier.

Table 4: Proposed range of dimensions for the test tyres. Note that for comparison purposes it is preferred that all narrow tyres are of the same dimension and all wide tyres are of the same dimension, chosen within the ranges suggested below. However, aspect ratio for wide tyres shall be lower than the chosen aspect ratio for narrow tyres.

<table>
<thead>
<tr>
<th>Tyre type</th>
<th>Rim diameter</th>
<th>Aspect ratio</th>
<th>Section width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow (possible for dual mounting)</td>
<td>22.5&quot;</td>
<td>One of 60, 70, 80 %</td>
<td>One of 295, 305, 315 mm</td>
</tr>
<tr>
<td>Wide (super-single)</td>
<td>19.5&quot; or 22.5&quot;</td>
<td>One of 45, 55, 65 %</td>
<td>One within the range 385-445 mm</td>
</tr>
</tbody>
</table>

17.2 Number of tyres of different types

The Regulation R117.02 and Regulation (EU) No. 661/2009 distinguish between the following C3 tyre types of use: normal, traction, snow and special. The author thinks that all but the last one shall be tested in the project.
One would want to include the following types:

Types of use: Normal, traction, snow (marked M+S)

Width: Narrow – wide

New or recycled: New and retread

Geographic origin: European and (inexpensive) Asian

Altogether, the above makes $3 \times 2 \times 2 \times 2 = 24$ types. If one would like to test each type independently, one may want to have at least 5 samples (tyre line) of each type. This would mean 120 tyres to be tested.

120 tyres is absolutely not a realistic number. The author believes that, for the project to be meaningful and give convincing results, the number of test tyres should be at least 20. It would be much better with (say) 30 tyres, but it may result in a project too expensive to find funding for. In the following part of this sub-chapter it is assumed that the number of tyres will be 20-30.

First it is suggested to test retread tyres only of the types "Normal/Traction" and "narrow", with a minimum of 3 retreads of normal and 2 retreads of traction type.

Second, it is suggested to test "wide" tyres only of types "Normal/traction", with a minimum of 2 normal and 2 traction types.

Third, it is suggested to test Asian tyres only of the types "Normal/Traction" and "narrow", with a minimum of 2 of normal and 2 tyres of traction type.

With regard to the types of use, it is suggested that a minimum of tyres according to the following is included: 8 normal, 5 traction, 2 snow.

Example 1: A reasonably "balanced" selection that would meet the above, ending in a total of 20 tyres would be this:

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Traction</th>
<th>Snow</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW and NARROW and EUROPEAN</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>Total: 7</td>
</tr>
<tr>
<td>NEW and NARROW and ASIAN</td>
<td>2</td>
<td>2</td>
<td></td>
<td>Total: 4</td>
</tr>
<tr>
<td>NEW and WIDE and EUROPEAN</td>
<td>2</td>
<td>2</td>
<td></td>
<td>Total: 4</td>
</tr>
<tr>
<td>RETREAD and NARROW and EUROPEAN</td>
<td>3</td>
<td>2</td>
<td></td>
<td>Total: 5</td>
</tr>
</tbody>
</table>

The overall total is 20 tyres. Of these, there are 11 new European tyres, of which 4 are wide. There are 4 new Asian tyres, of which 2 are normal and 2 traction types. There are in total 10 normal, 8 traction and 2 snow tyres.
**Example 2:** A well balanced selection that would end in a total of 30 tyres would be this:

<table>
<thead>
<tr>
<th>Type</th>
<th>Normal</th>
<th>Traction</th>
<th>Snow</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW and NARROW and EUROPEAN</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>NEW and NARROW and ASIAN</td>
<td>3</td>
<td>3</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>NEW and WIDE and EUROPEAN</td>
<td>3</td>
<td>2</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>RETREAD and NARROW and EUROPEAN</td>
<td>5</td>
<td></td>
<td>4</td>
<td>9</td>
</tr>
</tbody>
</table>

The overall total is 30 tyres. Of these, there are 15 new European tyres, of which 5 are wide. There are 6 new Asian tyres, of which 3 are normal and 3 traction types. There are in total 15 normal, 12 traction and 3 snow tyres.

### 17.3 How to acquire the test tyres

Of course one may simply purchase the test tyres from a tyre dealer. Here are some "typical" costs in SEK and inclusive of VAT:

- European new tyre 315/80R22.5: 4000–8000 kr
- Asian new tyre 315/80R22.5: 3000–5000 kr
- New, wide, European tyre: 6000-9000 kr

For "Example 1" above, with two tyres of each line, this may mean a total cost of very roughly 200 000 SEK, incl VAT. For "Example 2" it may mean very roughly 300 000 SEK incl VAT. An example of a useful link for planning is this one: [http://www.dackonline.se/Lastbilsdack.html](http://www.dackonline.se/Lastbilsdack.html)

It is suggested that one makes an agreement with the tyre dealer to return the tyres after testing, at a reduced price, say approx 75 %. In such a case, the cost for test tyres will be reduced dramatically (to 50 000 – 75 000 SEK in the above examples).

An additional cost is the tyres to be used on the steer axle. These shall be worn down to the minimum (legal?) tread depth and they should be of a "quiet design" in order to give negligible noise emission compared to the test tyres on the drive axle. Perhaps one can buy these at a retread tyre factory; asking that the factory shall aid in finding the best possible tyres for this purpose.

One would have to purchase rims too. It would be a good idea to have 6 rims available, in order to be able to change tyres on 2 rims while another 2 rims are used during testing, plus 2 rims on the steer axle. Two extra rims for wide tyres are needed, thus 8 in total would be practical to have. One may probably agree with a dealer on purchase and return of such new rims too. Steel rims will cost very roughly 4000 – 6000 SEK incl VAT; light metal rims will be around 40 % higher.
If the planned project can get a truck manufacturer on-board, that company may have rims and some of the tyres available, which could cut costs.

18. EXPECTED DURATION OF THE PLANNED PROJECT

As written above, it is expected that testing will need effectively 4-6 weeks if 20 tyres are included in the test selection. If 30 tyres are included, testing will need 6-10 weeks. In addition there should be an allowance for unsuitable weather and unexpected problems. Therefore, one should plan for two full months of testing for a volume of 20 tyres, and three full months for 30 tyres. Thus, a full summer season should be scheduled. If the weather is as lousy as in the summer and autumn of 2012, the duration may be even longer; therefore, measurements should ideally start already in May.

In planning of the project one shall not forget that all tyres, if purchased in non-used condition, will need to be run-in for at least 100 km before testing. This may take an extra two hours per tyre set before testing can commence. That would also be a good way to warm-up the tyres before testing.

In order to get the best access to an ISO surface, the testing on this surface may be the best to schedule for the summer vacation period.

Possible rolling resistance measurements may require an additional month of testing, preferably made in the autumn after the noise measurements.

To acquire test tyres, rims and test trucks will probably take approx. three months; depending on how active one is. Analysis, data compilation and reporting would probably need something around four months. Including planning, it is reasonable to estimate project duration to at least 10 months; more realistically 12-15 months of active project work if also including review of the report. However, this assumes that the project can start at a time which means that the measurements may be conducted within the time period May-September. Well before the project starts actively, however, the project manager should make preliminary enquiries with possible partners among truck manufacturers; essentially Volvo and Scania, since such agreements may take a long time. This also applies to the search for an accessible ISO surface.

A time schedule may look something like this:

- 6 months before project start: start enquiring the interest of truck manufacturers to cooperate; also start looking for access to ISO surface
- January – February: preparations for the project, decide about the above issues, look for suitable road site for testing, and produce state-of-the-art report. Start survey of labelled values for new tyres (may be a help for tyre selection later).
- March – April: acquire test tyres and rims, agree about test truck (if not done already), make texture measurements on the test surfaces, survey of labelled values continues
- May - June: noise measurements on the road site
- July: noise measurements on the ISO track
- August – September: continue measurements not yet finished
- October (optionally): rolling resistance measurements
• September – December: analyses of the results, data compilation, reporting, seminar, return or sell the test tyres (if applicable)
• January – March: there may be some time needed for review of the report, and to finalize the report after that.

19. COMMUNICATING RESULTS AND GETTING FEEDBACK

It is recommended to have an external reference group for the project, just as for the work made so far regarding car tyres. It may be suitable to have a first seminar in April, a few weeks before measurements start, to report the status of the project, discuss problems and get feedback. It would then be suitable to have a second seminar in November-December, to report the first results of the project, discuss problems and get feedback for the draft report. Finally, in (say) beginning of February, a seminar reviewing the draft report would be feasible.

The ambition is dissemination of the results and its consequences depends on the final results: if results call for changes in the noise policy one should be very ambitious and include all stakeholders; thus the final results should be reported as widely as possible; at conferences, at GRB meetings, for the Commission in Brussels, for politicians, etc. However, if the results do not suggest that significant policy changes are needed, there is no need to be so ambitious in dissemination of the results and reporting my aim mainly at the scientific community.

20. ESTIMATED FUNDING NEEDED FOR THE PLANNED PROJECT

The author has tried to make a very rough estimation of project costs. This should not be taken too seriously since it is subjective; albeit based on 38 years of professional experience. As a cost per personmonth (160 hours), 150 000 SEK has been used. This very much depends on the overhead cost policy of the performing organization; it seems that present personmonth costs vary between approx. 100 000 and 190 000 SEK in Scandinavia; thus 150 000 was used as a "reasonable" average.

The total project cost according to Table 5 ends up at a little more than 3 million SEK; a much higher cost than the author anticipated. Therefore, no calculation has been made for the option where 30 truck tyres are tested; it would probably mean higher costs than what it is possible to find funding for.

Table 6 presents a calculation based on the assumption that a truck company, such as Volvo or Scania, is a partner in the project, in which case the truck company is assumed to supply test truck, including driver, test rims and test track free of charge. It may be possible that the truck company might have a few tyres that could be used too, but as the saving would be rather low (as purchased tyres would be sold back), it is not included in the calculation. This option (Table 6) would save approx. 450 000 SEK, which is substantial, but as proportion of the total in Table 5 it is not a dramatic saving. The project does not necessarily depend on whether a truck company is on-board or not.

Furthermore, it appears that the extra costs of rolling resistance and noise measurements on the TUG drum facility is relatively low (7-8 % of the total cost). Since the value of such extra measurements is rather high, it is suggested that it is effective from a cost/benefit view to
include such measurements; or the reverse: to save money by excluding them does not seem to be a good idea.

This calculation illustrates the high costs of doing experimental work with truck tyres. This has been a reason why this subject has been "under-researched" so far.

Table 5: Estimation of project costs, by type of activity. Costs in SEK. Current exchange rates are approximately 1.15 SEK = 1 DKK = 1 NOK. Costs assume a volume of 20 test tyres. In this example, a cost of 150 000 SEK per personmonth has been used.

<table>
<thead>
<tr>
<th>Type of activity</th>
<th>Working time in person-months</th>
<th>Corresponding cost</th>
<th>Other costs (e.g. material, travels, rental, consultancy)</th>
<th>Total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration, planning, etc</td>
<td>1</td>
<td>150 000</td>
<td>20 000</td>
<td>170 000</td>
</tr>
<tr>
<td>Finding partners, test truck, ISO surface</td>
<td>1</td>
<td>150 000</td>
<td>20 000</td>
<td>170 000</td>
</tr>
<tr>
<td>State-of-the-art report</td>
<td>1</td>
<td>150 000</td>
<td></td>
<td>150 000</td>
</tr>
<tr>
<td>Survey of labelling values, compilation</td>
<td>1</td>
<td>150 000</td>
<td>10 000</td>
<td>160 000</td>
</tr>
<tr>
<td>Tyre and rim selection</td>
<td>0.8</td>
<td>120 000</td>
<td>230 000</td>
<td>350 000</td>
</tr>
<tr>
<td>Selling test tyres and rims after testing</td>
<td>0.2</td>
<td>30 000</td>
<td>-170 000</td>
<td>-140 000</td>
</tr>
<tr>
<td>Tyre changing, balancing, transport</td>
<td></td>
<td></td>
<td></td>
<td>100 000</td>
</tr>
<tr>
<td>Test vehicle rental, incl driver</td>
<td></td>
<td></td>
<td></td>
<td>150 000</td>
</tr>
<tr>
<td>Test track rental (ISO)</td>
<td></td>
<td></td>
<td>50 000</td>
<td>50 000</td>
</tr>
<tr>
<td>Texture measurements</td>
<td>0.2</td>
<td>30 000</td>
<td>5 000</td>
<td>35 000</td>
</tr>
<tr>
<td>Noise measurements (2 persons)</td>
<td>8</td>
<td>1 200 000</td>
<td>30 000</td>
<td>1 230 000</td>
</tr>
<tr>
<td>Noise measurements (pre- &amp; post work)</td>
<td>1.5</td>
<td>225 000</td>
<td></td>
<td>225 000</td>
</tr>
<tr>
<td>Production of reports, incl revisions</td>
<td>2</td>
<td>300 000</td>
<td></td>
<td>300 000</td>
</tr>
<tr>
<td>Seminars (project participants' costs)</td>
<td>0.3</td>
<td>45 000</td>
<td>20 000</td>
<td>65 000</td>
</tr>
<tr>
<td>Rolling resistance measurements (TUG)</td>
<td>0.2</td>
<td>30 000</td>
<td>90 000*</td>
<td>120 000</td>
</tr>
<tr>
<td>Noise measurements on drums (TUG)</td>
<td>0.2</td>
<td>30 000</td>
<td>80 000</td>
<td>110 000</td>
</tr>
</tbody>
</table>

Overall total: 2 610 000 635 000 3 245 000

* Includes 20 000 SEK for transportation of 40+2 test tyres to/from Gdansk
Table 6: As Table 5, but cooperation with truck company having access to ISO track and test rims, and carrying its own costs, is assumed.

<table>
<thead>
<tr>
<th>Type of activity</th>
<th>Working time in person-months</th>
<th>Corresponding cost</th>
<th>Other costs (e.g. material, travels, rental, consultancy)</th>
<th>Total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration, planning, etc</td>
<td>1</td>
<td>150 000</td>
<td>20 000</td>
<td>170 000</td>
</tr>
<tr>
<td>Finding partners, test truck, ISO surface</td>
<td>0.8</td>
<td>120 000</td>
<td>20 000</td>
<td>140 000</td>
</tr>
<tr>
<td>State-of-the-art report</td>
<td>1</td>
<td>150 000</td>
<td></td>
<td>150 000</td>
</tr>
<tr>
<td>Survey of labelling values, compilation</td>
<td>1</td>
<td>150 000</td>
<td>10 000</td>
<td>160 000</td>
</tr>
<tr>
<td>Tyre and rim selection</td>
<td>0.8</td>
<td>120 000</td>
<td>200 000</td>
<td>320 000</td>
</tr>
<tr>
<td>Selling test tyres and rims after testing</td>
<td>0.2</td>
<td>30 000</td>
<td>-150 000</td>
<td>-120 000</td>
</tr>
<tr>
<td>Tyre changing, balancing, transport</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Test vehicle rental, incl driver</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Test track rental (ISO)</td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Texture measurements</td>
<td>0.2</td>
<td>30 000</td>
<td>5 000</td>
<td>35 000</td>
</tr>
<tr>
<td>Noise measurements (2 persons)</td>
<td>8</td>
<td>1 200 000</td>
<td>30 000</td>
<td>1 230 000</td>
</tr>
<tr>
<td>Noise measurements (pre- &amp; post work)</td>
<td>1.5</td>
<td>225 000</td>
<td></td>
<td>225 000</td>
</tr>
<tr>
<td>Production of reports, incl revisions</td>
<td>2</td>
<td>300 000</td>
<td></td>
<td>300 000</td>
</tr>
<tr>
<td>Seminars (project participants’ costs)</td>
<td>0.3</td>
<td>45 000</td>
<td>20 000</td>
<td>65 000</td>
</tr>
<tr>
<td>Rolling resistance measurements (TUG)</td>
<td>0.2</td>
<td>30 000</td>
<td>90 000*</td>
<td>120 000</td>
</tr>
<tr>
<td>Noise measurements on drums (TUG)</td>
<td>0.2</td>
<td>30 000</td>
<td>80 000</td>
<td>110 000</td>
</tr>
<tr>
<td>Overall total:</td>
<td></td>
<td>2 550 000</td>
<td>245 000</td>
<td>2 795 000</td>
</tr>
</tbody>
</table>

* Includes 20 000 SEK for transportation of 40+2 tyres to/from Gdansk

21. FINDING FUNDING

It is supposed that funding of this project may be provided by common Nordic research funds. However, the following sources of funding should also be explored.

It is suggested that the project may be regarded as fulfilling the obligation by the participating member states (supposed to include Norway as EEA member) to check the labelled classes
and values for C3 tyres during the two years when this project is conducted, and thus funds for such checks may support this project. In article 22 of Regulation (EU) 1222/2009 it reads:

"Compliance with the provisions on labelling by suppliers and distributors is essential in order to achieve the aims of those provisions and to ensure a level playing field within the Community. Member States should therefore monitor such compliance through market surveillance and regular ex-post controls”.

The member states should thus have funds available for such monitoring, and since this project may provide checks of at least rolling resistance and noise (i.e. the current mandatory parts of the labelling for C3 tyres), it is reasonable that the results collected in this project may satisfy the monitoring for C3 tyres assumed to be part of the obligation to meet the labelling regulation. It is reasonable if this would apply to the three Nordic member states, possibly including Norway as an EEA member. This would be an opportunity for these countries to meet their obligations at a very reasonable and shared cost, while at the same time providing a substantial part of the budget for this project. In Sweden, this monitoring and surveillance obligation is the responsibility of Energimyndigheten.

One more possibility shall be mentioned. The Swedish Government in October 2012 issued a proposition to the Riksdag on research and innovation\(^2\) in which it is suggested that an additional 50 million SEK shall be made available to VINNOVA in 2013-2016 for funding of test- and demonstration facilities. Reading the text (from page 131 and forward) this does not seem to exclude establishment of a national resource in terms of an ISO surface. Therefore, if the Riksdag does not delete this part of the proposition, it should be suggested to VINNOVA that a part of the funds would sponsor an ISO surface which would be available for research, surveys and monitoring related to (for example) Regulations (EU) 661/2009 and 1222/2009.

Rather soon such a facility must be established, anyway, if Sweden is to fulfil its obligations of monitoring compliance with the regulations, and this extra funding for test- and demonstration facilities provides a golden opportunity to realise this obligation. If all involved authorities (Trafikverket, Transportstyrelsen, Energimyndigheten, Naturvårdsverket) express their support for such a solution, chances for funding an ISO surfaces in this way should be very good.

One may want to consider whether an ISO surface in southern Sweden (say within 500 km from the Nordic capitals, excluding Iceland) could be used for similar purposes by the other Nordic countries, in this way sharing the costs even more efficiently.

22. REFERENCES


\(^2\) Regeringens proposition 2012/13:30 (11 October 2012)

de Graaf, D.F.; Peeters, A.A.A.; Peeters, H.M. (2004): "Tyre/road noise measurements of truck tyres". Report number M+P.DWW.03.7.1, M+P Raadgevende ingenieurs bv, Vught, the Netherlands.


Roovers, M.S.; and van Blokland, G.J. (2002): "Literature study on the Rolling Noise of Truck Tyres". M+P.MVW.01.7.1, M+P, ’s-Hertogenbosch, the Netherlands.

