A meeting was organized by the JRC on the 19th November 2007 on the improvement of transport emission inventories with the participation of more than 30 experts in the field. Road transport alone in EU is one of the main source of air pollutants (22% CO2, 41% NOx, 26% NMVOC, 16% PM10 and 30% fuel consumption). Due to their high impact, transport emission inventories still comprise an area which needs further improvement, despite they are relatively well developed compared to other sectors. Such improvements range from the need to cover new technologies of vehicles and fuels to improved emission factors for non-road transport activities.

For the definition of the needs, the main outcome and ideas from the meeting are reported below:

1. PRIORITIES FOR ROAD TRANSPORT INVENTORY

Martin Adams presented the interest of EEA in transport inventories and emphasized the importance of the engagement between TFEIP/JRC/EEA activities with key industry bodies, research networks etc. He also stressed the need of identifying key future research requirements across the transport inventory modes (road, marine, air, NRMM) and of the plan for future development of Guidebook Tier 3 methodologies for aviation and marine (what, who, when).

Leon Ntziachristos (LAT/AUTH) presented the different requirements from road transport inventories, depending on application (IPCC vs NEC, different spatial and temporal resolutions, use in impact assessments), and presented conclusions related to the use of road transport inventories from statistical data collected from COPERT users. He also emphasized the need to better describe the uncertainty of total emissions and presented a Monte-Carlo uncertainty characterisation conducted by JRC/IES on COPERT 3 in the past.

Bart Van Herbruggen (TML) presented the priorities for TREMOVE, which were mainly related to better categorizing the vehicle fleet. In particular using market segments instead of engine size classification for passenger car and to increase the number of classes for trucks.

Michel Andre (INRETS) focused on the possibility to use the traffic situation approach instead of average speed approach to calculate emission factors. Two different sets of
emission functions have been derived in ARTEMIS and INRETS suggested to compare these two sets of functions to estimate which better replicates the measured emission data, as a quality index for the dataset to be used. He also underlined that the Artemis methodology should be mentioned in the revised Guidebook as a potential Tier 3 methodology.

A list of priorities (see attached questionnaire) was prepared by JRC (Panagiota Dilara) and LAT (Leon Ntziachristos) to collect the views of all participants and produce a roadmap for future research needs.

2. UPDATE OF TRANSPORT CHAPTERS OF THE GUIDEBOOK

John Norris (AEAT) presented the proposal for updating the transport chapters of the revised Guidebook which comprise of:

- A general guidance for the selection of the level of calculation detail (Tier);
- A Tier1 method based on total freight/passenger transport activity or fuel consumption
- A Tier2 method distinguishing between different vehicle categories/aggregated technologies
- A Tier 3 method including all details for emission calculation.

The draft chapters need to become available for review by February 25, 2008. Suggestions about the update of the emission factors and of the methodologies are welcome. The needs for the revised transport sectoral chapters were to be better analysed in a meeting which was held the following day. The proposal of funding some technical experts in cooperating to the preparation of the guidebook is mentioned.

3. NON-ROAD

EXTREMIS was presented as a system for emission factors and activity data of non-road emission (aviation, rail and maritime). Two methodologies were presented in detail, for railways and navigation.

The improvements, in comparison to the previous methodologies, concern both the collection of new activity data and the aggregation of some emission factors, based on the vehicle age, using a TNO database, and the use of vehicle classification similar to the one present in EUROSTAT. EXTREMIS is considered to improve the rather outdated data used in the TRENDS model and the classification used for the maritime fleet.

It was suggested that a comparison for maritime sectors between the EXTREMIS and the ARTEMIS methodology should be performed, even it is too complicated.

Udo Lambrecht (IFEU) presented the study carried out in Germany for the updating of the emission factors and the methodology for the NRMM sector. Still better description is with regard to the actual use of NRMM, including their load factors and the total activity per year, as well as their age distribution. Moreover more efforts have to be done for obtaining more information both on off-cycle measurements (Mario Keller- INFRAS
proposal) and fuels used. Some analysis has also to be done for the use of lubricant oil in the 2-strokes engines. Leon Nitsiachristos suggested including these new emission factors in the revised NRMM of the new Guidebook, since the old chapter does not include emission factors for new technologies.

4. LIST OF ACTIONS

- the questionnaire should be send to all the participant of the EXPERT PANEL, the results analysed and used for the prioritisation of activities \( \textit{(JRC)} \)
- create and keep updated a web-site in order to share the information related to the emission inventory \( \textit{(JRC)} \)

5. CONCLUSIONS

Based on the discussions during the meeting and the questionnaire disseminated to the participants, the following conclusions may be drawn with respect to improvements related to road transport inventories. The conclusions are sorted with descending priority, based on the questionnaire evaluation.

1. Estimation of the overall uncertainty of emission models was considered as one of the most important elements in improving emission inventories. There has been some skepticism expressed on how this can be realistically achieved due to fundamental problems with data in models and gaps in knowledge. Overall uncertainty characterization was considered more important than just providing uncertainty ranges for the emission factors. However, the latter is also of high priority and emission factors should be accompanied with numerical uncertainty instead of qualitative uncertainty factors.

2. The improvement of our fundamental knowledge with regard to the emission behavior during cold-starts was also set as a priority. The impacts of emissions during cold start are expected to become increasingly important for new engines and aftertreatment systems in the future. It was considered reasonable to first discuss in detail which are the benefits and limitations of existing approaches (e.g. ARTEMIS, HBEFA, COPERT) and then consider additional refinements, including experimental measurements, in order to fill gaps.

3. The future will also bring several new technologies, which may differ in emission performance depending on the operation conditions, despite fulfilling the same emission standard. The need was prioritized to develop emission factors according to specific technology (engine, aftertreatment) instead of emission standard, and to cover retrofitted vehicles as well. In particular for hybrids, it has been proposed to develop test methods to take into account state of charging, before developing emission factors.

4. The characterization of emissions with use of biofuels and alternative fuels was considered to require more attention as well. This was thought to be a future priority though as it is not yet sure how many vehicles will be operating on such fuels. The impact of alternative fuels should be more important for non-regulated
pollutants. Also, the effect of biofuels on durability and vehicle emission degradation needs to be considered.

5. Better detailing the fuel consumption as a function of car class (SUVs, small engine capacities, etc) was also considered as a priority due to the large impact of fuel consumption calculations on GHGs estimates. The limiting factor in preparing highly disaggregated fuel consumption functions is whether correspondingly detailed activity data exist to feed the calculations.

6. Better information on activity data was also considered a priority and in particular with regard to the total mileage driven by HDVs but also motorcycles and mopeds. There were also some cautious views on whether new campaigns are required to collect this information. Developing best-practice guidance for activity data collection might be a first step in improving inventories. This also includes defining the larger uncertainties in the activity data used today. The use of information from intelligent transport systems to characterize travel patterns has been also suggested.

7. The validation of the emission factors used today has been also considered as a priority by several participants. However, there was not a unanimous agreement on which is the appropriate validation method. PEMS validation was perceived as a realistic representation of real-world emission behaviour by several participants. However, PEMS validation was considered to be confounded by several limiting factors (e.g. vehicle specificity, lack of repeatability of driving patterns, etc.). The other view expressed was more detailed chassis dynamometer measurements with more in-depth analysis of the emission behaviour.

8. Improvement of road transport projections was also considered important, since the development of national projections is mandated by the NEC directive. This has to be linked to robust socioeconomic assumptions to estimate activity data and reliable estimates for the emission performance of future emission technologies.

9. There is also a need expressed to better develop links between national and more local emission inventories. The latter might require a more detailed approach to calculate emission factors than the average speed approach. For example the use of traffic pattern specific emission factors. The limiting factor in going into too much detail is the existence of detailed enough activity data.

10. The improvement of our knowledge related to emission corrections, idling emissions, ultra-emitters, non regulated pollutants and non-CO2 GHGs from road transport were considered of rather moderate priority. The only issue that was identified as rather high priority was the effect of air-conditioner operation and in particular for GHG emissions.

11. Some priorities were also expressed from individual participants, which were not included in the questionnaire. Those referred to scientifically review and harmonize the several existing European methods and the activity data used, develop guidance on what model can better serve a particular level of application (e.g. national vs. local), and better study secondary particulate matter produced by road transport.
**ANNEX I**

**QUESTIONNAIRE RESULTS**

The results of the survey proposed for defining priorities for the improvement of road transport inventories are reported in the following table. The three rightmost columns show the number of responses each theme received, Number 1 stands for high priority, 2 for moderate priority and 3 for low priority.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Particular Issues</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Uncertainty characterization and sensitivity analysis</td>
<td>Perform Monte-Carlo or similar type of statistical treatment to models to identify most important variables, give guidance on the detail required for activity data, uncertainty range of final calculation</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Characterization of the emission factors quality/variability</td>
<td>Assign a quality index on each emission factor (e.g. A, B, C) or a coefficient of variation value to express uncertainty, explain/discuss uncertainty, provide guidance for uncertainty of different approaches</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>Provide rules/values for projections</td>
<td>Develop detailed good-practice guidance for road transport projections, produce assessments of emission factors for emerging technologies, refine methodologies for stock replacement</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Provide methods for spatial / temporal resolution</td>
<td>Develop good-practice guidance with regard to top-down and bottom-up approaches of road transport emission inventories, develop models to support such approach, streamline average-speed and traffic situation models</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Refine activity data</td>
<td>Conduct probe surveys on vehicle utilization, better describe vehicle classification (new, second-hand, deregistered, mopeds), collect and refine already available information from transportation statistics</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>Validate existing emission factors</td>
<td>Validate existing emission factors (mostly based on dynamometer studies) by means of tunnel or roadside concentration measurements or Portable Emission Measurement Systems (PEMS), air-quality measurements</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>Cold-start emissions</td>
<td>Better detail cold-start emissions, perform new measurements on new vehicle technologies, use PEMS to record cold over emissions, revise the methodology Characterize links of vehicle technology / fuel use / blend, for example E85 effect on Euro 3 passenger cars, second generation biofuels, CNG, LPG, Biogas, Non-regulated pollutants</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>Biofuels and alternative fuels</td>
<td>Develop emission factors, emission methodologies for new emission control technologies, such as strong hybrids, mild hybrids, SCR, GDI, Flexifuel</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>New technologies including hybrids</td>
<td>Develop more classes for CO2 emissions (e.g. diesel &lt;1.6 l, SUV, gasoline &lt;1.0 l, etc.), develop correction factors based on average weight / capacity, CO2 from urea consumption</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>CO2 / fuel consumption characterization</td>
<td>Perform new measurements to characterize N2O, CH4 based on vehicle technology, operation conditions, fuel use</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>11</td>
<td>Non-CO2 GHGs</td>
<td>Conduct studies to measure NH3, NO2/NO, NMVOC speciation, PM speciation, metals from fuel consumption, metals from lubricant, metals from attrition, ion emissions (sulfate nitrate ammonium), PAHs and POPs</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>
### Emission corrections

Corrections for ambient temperature, altitude, use of auxiliaries (air-con), vehicle age

### Idling emissions

Provide idling emission factors (g/h) which may be significant for parking lots, for school busses, etc. Estimate share of ultra-emitters by remote-sensing, provide emission factors for ultra-emitters, estimate the effect of OBD

### Ultra-emitters

Some comments made on the questionnaire by different participants (even when contrasting) are reported here:

<table>
<thead>
<tr>
<th>Theme</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Uncertainty characterization and sensitivity analysis | • Important to define the aggregation level where the uncertainty is to be established  
• Important, but many fundamental problems with data on models, so seems strange to quantify uncertainty in model we know are "incorrect". |
| Characterization of the emission factors quality/variability | • Not quality index, but ranges are needed  
• In particular for non-exhaust PM e.f. NOx from motorcycle |
| Provide rules/values for projections | • The model exists. The problem are activity data  
• Verify differences in emission between "limit value" and actual use of vehicles  
• Need (at least) of two "routes" or approaches: 1) one for "national level+" for EU general policy; 2) for member late needs (=means also local)  
• Especially relevant for road trucks  
• Mileage data  
• Would this complicate or simplify the input data?  
• PEMS won't enable validation for non regulated pollutants. Tunnel is too complex. |
| Provide methods for spatial / temporal resolution | • Not widely applicable  
• PEMS measurement will be more important since it effects the actual use  
• What need to be validated are real cycles i.e. driving behaviors.  
• First consider what already exists |
| Refine activity data | • Cold start will be more important dependent on new engine technologies in the future |
| Validate existing emission factors | • Small effect compared with required reduction in CO2.  
• Biofuels with EURO IV and V engine.  
• Special concern to durability and fuel proprieties  
• Seems like need technology-specific Efs, rather than EURO IV, V, etc… |
| New technologies including hybrids | • Develop new test methods such as for hybrid  
• Retrofitting has to be included  
• Clarify the effect of auxiliaries (air conditioning)  
• Important, but the fine the classes, the hardest it will be to find good data.  
• For HDV change from G/kWh to g/km in order to estimate CO2 emission based on actual work carried on. |
<p>| CO2 / fuel consumption characterization | • Test must be carried out during different driving condition |
| Non-registered pollutants | • NO2/NO and PM speciation is the most important |</p>
<table>
<thead>
<tr>
<th>No.</th>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Emission corrections</td>
<td>First to do the best use of the existing measurements (re-analysis ARTEMIS dataset PAH)</td>
</tr>
<tr>
<td>14</td>
<td>Idling emissions</td>
<td>Auxiliaries have high priority</td>
</tr>
<tr>
<td>15</td>
<td>Ultra-emitters</td>
<td>Can be used to &quot;fix&quot; low speed Efs in average speed approach</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not possible to find any ultra-emitters, except vehicles from the 8ies.</td>
</tr>
</tbody>
</table>