Discussion paper: BC fractions of PM emissions from railways

Basically the same diesel engine technologies are used by railway locomotives and heavy duty trucks in road transport, however, measurement data for BC and PM are scarce for the engines used by railways as such. Hence, for railways the decision is to use the f-BC fractions and +/- uncertainty ranges proposed for road transport heavy duty engines, as the f-BC figures for these engines are derived from a comprehensive literature survey of EC and OC fractions of total exhaust PM made by Ntziachristos et al. (2007), as explained in the discussion note for road transport in this project. The examined OC data from Ntziachristos et al. (2007) can be input for the further assessment of OC fractions of PM (f-OC) in a future project.

Tier 1

Tier 1 PM emission factors for diesel usage in general are shown in Table 3-1 in the guidebook chapter for railways. No reference is given for these emission factors, and descriptions made as regards engine technologies or exhaust after treatment technologies are also missing in the text. In order to keep a general engine consistency with road transport heavy duty engines, for railways engines on a Tier 1 level (1995 average engine technology levels) it is recommended to use the f-BC fraction for Euro I road transport engines (f-BC = 0.65) which are assumed to be equal to the engine technology level for railways engines in 1995.

Tier 2

Tier 2 emission factors are shown in the Tables 3-2, 3-3 and 3-4 for line haul locomotives, shunting locomotives and rail cars, respectively: The EMEP/EEA emission factor values are derived from the Rail diesel study by UIC (Halder et al. 2005) for shunting locomotives, rail cars and line haul locomotives based on a questionnaire send out to railway operating companies. No details in terms of the distribution into engine technologies or exhaust after treatment technologies are provided by Halder et al. (2005). The latter source, however, finds relatively high average ages for rail cars (16 years) and locomotives (27 years).

For road transport engines, the f-BC fractions vary between 0.50 and 0.75 for increasing engine technology levels going from conventional to Euro V engines (c.f. discussion note for road transport). Since no details are provided by the source for PM emission factor information in the guidebook (Halder et al., 2005), 0.65 as an average number is recommended to be used for f-BC at the Tier 2 level for railways.

Tier 3

For Tier 3, no explicit PM emission factor information is given. Instead, countries are advised to seek information themselves: “More Tier 3 emission factors can be found in the technical reports of the Artemis project (Boulter and McCrae, 2007)” In this case it is recommended to use the f-BC fractions proposed for road transport heavy duty engines for railways engines without filters installed (f-BC range between 0.50 and 0.75), and 0.15 for railways engines with filters installed.

Table 1 Proposed f-BC fractions and +/- uncertainty ranges for Tier 1-3 for railways

<table>
<thead>
<tr>
<th>Tier level</th>
<th>f-BC</th>
<th>+/- uncertainty (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1</td>
<td>0.65</td>
<td>20</td>
</tr>
<tr>
<td>Tier 2</td>
<td>0.65</td>
<td>20</td>
</tr>
<tr>
<td>Tier 3</td>
<td>0.5-0.75</td>
<td>20</td>
</tr>
<tr>
<td>Tier 3, DPF</td>
<td>0.15</td>
<td>30</td>
</tr>
</tbody>
</table>
**Inclusion of f-BC values in the guidebook**

The inclusion of the new f-BC information in the guidebook can be made in several ways and needs to be agreed by the transport expert panel prior to the update of the individual chapters. For railways, one approach can be to place the final version of the present note as an annex to the guidebook chapter, and make references to the relevant PM emission factor tables in the chapter. Another approach can be to include directly the f-BC fractions in the relevant PM emission factor tables, or as footnotes to the tables. References can then be made to the annex description, or alternatively a brief summary of the discussion note can be put somewhere central in the chapter.

**References**
