

1 Discussion paper: BC fractions of PM emissions from railways

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

9 Tier 1

10 Tier 1 PM emission factors for diesel usage in general are shown in Table 3-1 in the guidebook chapter for
11 railways. No reference is given for these emission factors, and descriptions made as regards engine
12 technologies or exhaust after treatment technologies are also missing in the text. In order to keep a general
13 engine consistency with road transport heavy duty engines, for railways engines on a Tier 1 level (1995
14 average engine technology levels) it is recommended to use the f-BC fraction for Euro I road transport
15 engines (f-BC = 0.65) which are assumed to be equal to the engine technology level for railways engines in
16 1995.

17 Tier 2

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

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

28 Tier 3

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

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

Tier level	f-BC	+/- uncertainty (%)
Tier 1	0.65	20
Tier 2	0.65	20
Tier 3	0.5-0.75	20
Tier 3, DPF	0.15	30

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1 **Inclusion of f-BC values in the guidebook**

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

9 **References**

- 10 Halder M., Löchter, A. (2005). 'Status and future development of the diesel fleet'. Rail diesel study, WP1
11 final report. UIC, p. 54. www.uic.org/download.php/environnement/2006-01-dieselstudy-wp1.pdf
- 12 Ntziachristos, L., Mellios, G., Fontaras, G., Gkeivanidis, S., Kousoulidou, M., Gkatzoflias, D, Papageorgiou,
13 Th., and Kouridis, C. (2007), Updates of the Guidebook Chapter on Road Transport. LAT Report No 0706, p.
14 63.