

## 1 Discussion note f-BC fractions for non-road engines

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

9 For diesel engines < 130 kW f-BC fractions for diesel cars are used, and for diesel engines >= 130 kW f-BC  
10 fractions for heavy duty trucks are used (c.f. road transport discussion note). In the case of gasoline 2-  
11 stroke and 4-stroke engines data from Kupiainen and Klimont (2004) is used. The same source is behind the  
12 average factor of 0.15 for LPG (+/- range = 50 %).

13 Table 1 Proposed f-BC fractions as an input for aggregated Tier 1 and 2 f-BC fractions for non-road engines

Technology	Diesel < 130 kW		Diesel >= 130 kW		Gasoline (2/4 stroke)	
	f-BC	+/- (%)	f-BC	+/- (%)	f-BC	+/- (%)
<1981	0.55	10	0.5	20	0.05	50
1981-1990	0.55	10	0.5	20	0.05	50
1991-Stage I	0.55	10	0.5	20	0.05	50
Stage I	0.8	10	0.7	20	0.05	50
Stage II	0.8	10	0.7	20	0.05	50
Stage IIIA	0.8	10	0.7	20		50
Stage IIIB	0.15	50	0.15	20		50
Stage IV	0.15	50	0.15	30		50

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### 15 Tier 1

16 Using the proposed f-BC fractions from Table 1, Tier 1 level f-BC fractions will be calculated from the  
17 detailed Danish inventory as average f-BC fractions for 2006 (Winther, 2012).

### 18 Tier 2

19 Using the proposed f-BC fractions from Table X, technology specific f-BC fractions for Tier 2 will be derived  
20 from the Danish emission inventory for the year 2006 (Winther, 2012).

### 21 Tier 3

22 The following Table 4 contains the proposed f-BC fractions and +/- uncertainty ranges for the Tier 3  
23 methodology described in the guidebook for non-road machinery. For diesel engines < 130 kW f-BC  
24 fractions for diesel cars are used, and for diesel engines >= 130 kW f-BC fractions for heavy duty trucks are  
25 used (c.f. road transport discussion note). In the case of gasoline 2-stroke and 4-stroke engines data from  
26 Kupiainen and Klimont (2004) is used.

27 Table 4 Proposed Tier 3 f-BC fractions for non-road engines

Table no.	Technology	Engine size	f-BC	+/- (%)
3-10	Uncontrolled diesel	< 130 kW	0.55	10

		>= 130 kW	0.5	20
3-11	Stage I diesel	< 130 kW	0.8	10
		>= 130 kW	0.7	20
3-12	Stage II diesel	< 130 kW	0.8	10
		>= 130 kW	0.7	20
3-13	Stage III diesel	< 130 kW	0.8	10
		>= 130 kW	0.7	20
3-14	Stage I-II diesel, agriculture	< 130 kW	0.8	10
		>= 130 kW	0.7	20
3-15	Stage III diesel, agriculture	< 130 kW	0.8	10
		>= 130 kW	0.7	20
3-18	2-stroke uncontrolled gasoline	-	0.05	50
3-19	4-stroke uncontrolled gasoline	-	0.05	50

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## 2 **Inclusion of f-BC values in the guidebook**

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

## 10 **References**

- 11 Kupiainen, K. & Klimont, Z., 2004: Primary emissions of submicron and carbonaceous particles in Europe  
 12 and the potential for their control. Interim Report IR-04-079. IIASA, Austria, 115pp.
- 13 Ntziachristos, L., Mellios, G., Fontaras, G., Gkeivanidis, S., Kousoulidou, M., Gkatzoflias, D., Papageorgiou,  
 14 Th., and Kouridis, C. (2007), Updates of the Guidebook Chapter on Road Transport. LAT Report No 0706, p.  
 15 63.
- 16 Winther, M. 2012: Danish emission inventories for road transport and other mobile sources. Inventories  
 17 until year 2010 (under preparation).