

## 2.L(a) - Handling of Bulk Products

### Short description

Under category 2.L(a) - *Handling of Bulk Products* dust emissions from bulk material handling (loading and unloading) including agricultural bulk materials offsite the fields are reported. Emissions from quarrying and mining of minerals and from point source emissions are excluded.

### Methodology

For 1990 to 1996, only simplified estimates without a differentiation of handled materials and products exist. For all following years, emissions are calculated using a tier1 method taking into account detailed data on handled materials and products.

### Activity data

Official statistics are of limited use in determining handling of bulk products. There are only transport statistics available providing the amounts of several transported materials.

During a research project carried out by (Müller-BBM) <sup>1)</sup>, activity data was derived from primary statistical data from the Federal Statistical Office for Germany (Statistisches Bundesamt, Destatis) and the Federal Motor Transport Authority (Kraftfahrt-Bundesamt, KBA). Here, data on goods transported by railways and ships is gathered by Destatis whereas data for road transport is collected by the KBA.

Here, for all years until 2009, the collection of data for transported goods followed the official **NST/R (1968) nomenclature and regulation** (Eurostat, 2014a) <sup>2)</sup>.

As of 2010, statistical data following the newly implemented **NST-2007** <sup>3), 4)</sup> **nomenclature and regulation** from Destatis and KBA is applied instead.

Table 1: Overview of primary activity data sources over time

|                     |                                                                   |
|---------------------|-------------------------------------------------------------------|
| = <b>1990-1996</b>  | simplified estimates without differentiation of handled materials |
| = <b>1997-2009</b>  | statistical data following NST/R nomenclature                     |
| = <b>as of 2010</b> | statistical data following NST-2007 nomenclature                  |

Here, NST/R allowed the distribution of a broad variety of goods and materials (e.g. barley, corn, oats, rice, rye, and wheat), whereas NST-2007 provides only a very condensed list of classes of goods (e.g. 'crops').

Due to these methodological breaks, activity data and emissions show inconsistencies (especially on the level of specific goods and materials) that cannot be eliminated at the moment. Nonetheless, on a aggregate level, these breaks are balanced out more or less automatically as the total amount of transported dry materials does not change too much with changing statistical approaches.

For estimating the amount of moved bulk materials as well as emissions from the loading and unloading of bulk materials, these primary activity data (PAD, including the amounts of imported and exported goods as well as goods transported within Germany) have to be calculated from the amounts of transported goods:



$$PAD_{\text{material } i} = PAD_{\text{import}} + PAD_{\text{export}} + 2 * PAD_{\text{domestic handling}}$$

with

1.  $PAD_{\text{import}}$  = amount of imported good or material,
2.  $PAD_{\text{export}}$  = amount of exported good or material and
3.  $PAD_{\text{domestic handling}}$  = amount of good or material transported only within Germany

As the basic statistics provide only total amounts of imported, exported and domestically transported dry goods without any distinction into bulk and packed goods, the shares of bulk goods had to be estimated via expert judgement during the workshop mentioned above.

During this workshop, experts, for comparable kinds of dry bulk material, discussed specific shares displaying which part of the total amount of dry material  $i$  loaded and/or unloaded within Germany might be transported as bulk material thus causing PM emissions.

So the activity data finally used for estimating specific particulate matter emissions for every bulk material is calculated as a specific share  $s$  of the amount of this material  $i$  loaded and/or unloaded within Germany:



$$AD_{\text{bulk material } i} = PAD_{\text{bulk material } i} * s_{\text{bulk share}}$$

Table 2: Amounts of dry, dusty bulk goods handled in Germany 2010-2019, in tonnes

|                              | transport mode     | 2010       | 2015       | 2016          | 2017          | 2018          | 2019          |
|------------------------------|--------------------|------------|------------|---------------|---------------|---------------|---------------|
| <b>other herbal products</b> | inland vessel      | 5.523.633  | 39.189.603 | 38.498.874    | 34.508.319    | 30.305.094    | 30.305.094    |
|                              | railways           | 1.242.916  | 470.000    | 547.545       | 532.253       | 445.547       | 445.547       |
|                              | heavy-duty vehicle | 20.847.400 | 34.166.200 | 22.918.493,25 | 24.118.587,36 | 35.511.099,79 | 35.511.099,79 |
|                              | sea-going vessel   | 4.052.384  | 6.376.068  | 7.164.149     | 6.953.293     | 6.614.999     | 6.614.999     |
| <b>raw mineral chemicals</b> | inland vessel      | 6.794.922  | 2.366.579  | 2.573.770     | 2.696.029     | 11.798.872    | 11.798.872    |
|                              | railways           | 9.827.059  | 9.273.000  | 9.627.577     | 9.885.631     | 10.634.917    | 10.634.917    |
|                              | heavy-duty vehicle | 78.928.400 | 82.363.000 | 10.043.512,6  | 11.351.314,18 | 63.713.624,39 | 63.713.624,39 |
|                              | sea-going vessel   | 5.550.621  | 7.905.516  | 7.888.208     | 8.131.408     | 7.386.700     | 7.386.700     |
| <b>raw organic chemicals</b> | inland vessel      | 6.299.350  | 57.126     | 114.803       | 175.726       | 6.667.823,3   | 6.667.823,3   |
|                              | railways           | 16.287.803 | 21.094.000 | 18.661.643    | 18.339.593    | 0             | 0             |
|                              | heavy-duty vehicle | 11.345.600 | 4.570.800  | 0             | 828.915,62    | 12.601.907,86 | 12.601.907,86 |
|                              | sea-going vessel   | 3.638.264  | 2.478.579  | 2.341.016     | 2.413.459     | 2.463.615     | 2.463.615     |
| <b>iron ore</b>              | inland vessel      | 25.728.177 | 25.203.179 | 25.755.504    | 25.193.580    | 22.796.286,2  | 22.796.286,2  |
|                              | railways           | 38.565.334 | 37.708.000 | 37.434.377    | 37.586.847    | 38.252.864    | 38.252.864    |
|                              | heavy-duty vehicle | 203.800    | NE         | 1.764.223,28  | 534.846,2     | 1.680.884,75  | 1.680.884,75  |
|                              | sea-going vessel   | 13.922.885 | 13.967.430 | 13.365.447    | 14.810.135    | 14.761.129    | 14.761.129    |
| <b>crops</b>                 | inland vessel      | 9.816.233  | 11.243.918 | 10.046.500    | 9.546.963     | 7.715.976,9   | 7.715.976,9   |
|                              | railways           | 2.982.548  | 4.583.000  | 3.545.040     | 3.759.205     | 2.985.786     | 2.985.786     |
|                              | heavy-duty vehicle | 65.464.800 | 70.614.200 | 58.304.412,81 | 61.639.153,5  | 58.957.569,61 | 58.957.569,61 |
|                              | sea-going vessel   | 9.319.143  | 12.142.981 | 10.735.948    | 8.851.781     | 7.672.262     | 7.672.262     |
| <b>potatoes</b>              | inland vessel      | 1.383      | 0          | 0             | 1.056         | 0             | 0             |
|                              | railways           | 17.135     | 0          | 0             | 4.581.528     | 4.896.748     | 4.896.748     |
|                              | heavy-duty vehicle | 10.627.000 | 9.956.800  | 4.683.479,8   | 5.039.904,39  | 9.621.800,34  | 9.621.800,34  |
|                              | sea-going vessel   | 29.296.456 | 21.170.067 | 20.406.870    | 22.490.149    | 20.701.636    | 20.701.636    |

|                                                   | <b>transport mode</b> | <b>2010</b>   | <b>2015</b>   | <b>2016</b>     | <b>2017</b>      | <b>2018</b>      | <b>2019</b>      |
|---------------------------------------------------|-----------------------|---------------|---------------|-----------------|------------------|------------------|------------------|
| <b>coal products</b>                              | inland vessel         | 2.409.311     | 1.361.655     | 2.003.004       | 2.129.778        | 1.560.991,4      | 1.560.991,4      |
|                                                   | railways              | 22.499.503    | 6.721.000     | 6.610.955       | 6.456.917        | 8.421.754        | 8.421.754        |
|                                                   | heavy-duty vehicle    | 11.801.600    | 15.401.600    | 7.065.313,67    | 8.549.595,42     | 13.182.781,81    | 13.182.781,81    |
|                                                   | sea-going vessel      | 802.164       | 48.778        | 43.760          | 135.197          | 25.450           | 25.450           |
| <b>proiducts from grinding and shelling mills</b> | inland vessel         | 1.782.712     | 4.133.053     | 5.180.094       | 5.368.877        | 5.275.004,5      | 5.275.004,5      |
|                                                   | railways              | 2.852         | 0             | 465.039         | 381.098          | 349.419          | 349.419          |
|                                                   | heavy-duty vehicle    | 97.539.400    | 99.568.200    | 75.685.582,42   | 69.634.714,07    | 99.763.916,17    | 99.763.916,17    |
|                                                   | sea-going vessel      | 3.104.125     | 3.525.359     | 3.586.612       | 3.747.650        | 3.788.108        | 3.788.108        |
| <b>mineral fertilisers</b>                        | inland vessel         | 760.174       | 305.202       | 281.603         | 255.398          | 197.705          | 197.705          |
|                                                   | railways              | 4.122.535     | 3.424.000     | 3.619.997       | 3.581.858        | 3.224.654        | 3.224.654        |
|                                                   | heavy-duty vehicle    | 7.923.200     | 4.322.000     | 1.338.907,89    | 1.006.750,39     | 1.814.963,65     | 1.814.963,65     |
|                                                   | sea-going vessel      | 117.224       | 409.515       | 256.924         | 323.622          | 311.822          | 311.822          |
| <b>natural sands, gravel and stones</b>           | inland vessel         | 40.518.020    | 31.927.501    | 33.178.046      | 36.072.381       | 35.475.138,6     | 35.475.138,6     |
|                                                   | railways              | 56.517.180    | 43.958.000    | 43.837.499      | 39.960.787       | 41.345.431       | 41.345.431       |
|                                                   | heavy-duty vehicle    | 1.655.747.400 | 1.853.177.400 | 1.669.958.848,9 | 1.672.131.248,33 | 1.838.142.737,04 | 1.838.142.737,04 |
|                                                   | sea-going vessel      | 8.739.096     | 9.739.769     | 10.353.589      | 13.515.063       | 12.463.686       | 12.463.686       |
| <b>non-iron ores</b>                              | inland vessel         | 1.512.246     | 2.964.925     | 2.827.648       | 3.199.797        | 3.043.061,9      | 3.043.061,9      |
|                                                   | railways              | 29.742        | 8.000         | 6.642           | 16.877           | 61.486           | 61.486           |
|                                                   | heavy-duty vehicle    | 705.600       | NE            | 0               | 827.676,19       | 512.050,57       | 512.050,57       |
|                                                   | sea-going vessel      | 2.687.815     | 2.850.350     | 3.870.273       | 4.368.429        | 4.621.799        | 4.621.799        |
| <b>raw coals</b>                                  | inland vessel         | 36.652.759    | 0             | 0               | 0                | 19.571           | 19.571           |
|                                                   | railways              | 58.433.815    | 67.749.000    | 61.034.978      | 51.142.196       | 48.277.288       | 48.277.288       |
|                                                   | heavy-duty vehicle    | 10.561.400    | 13.275.800    | 11.858.051,12   | 16.057.484,06    | 12.593.015,33    | 12.593.015,33    |
|                                                   | sea-going vessel      | 13.299.295    | 16.476.145    | 14.401.269      | 15.919.606       | 16.187.881       | 16.187.881       |
| <b>secondary raw materials</b>                    | inland vessel         | 15.691.876    | 11.521.886    | 11.212.165      | 12.089.358       | 15.101.718,2     | 15.101.718,2     |
|                                                   | railways              | 25.614.264    | 22.113.000    | 21.261.312      | 22.147.649       | 20.565.387       | 20.565.387       |
|                                                   | heavy-duty vehicle    | 422.570.000   | 490.299.000   | 161.493.436,36  | 171.462.234,65   | 502.448.809,36   | 502.448.809,36   |
|                                                   | sea-going vessel      | 5.047.097     | 5.810.444     | 5.057.435       | 4.173.386        | 3.427.249        | 3.427.249        |
| <b>rock &amp; saline salt</b>                     | inland vessel         | 2.769.356     | 3.939.437     | 3.651.498       | 4.115.651        | 3.977.617,5      | 3.977.617,5      |
|                                                   | railways              | 3.067.187     | 2.575.000     | 2.362.886       | 2.603.115        | 3.017.352        | 3.017.352        |
|                                                   | heavy-duty vehicle    | 21.579.000    | 7.887.600     | 7.238.776,07    | 10.591.976,8     | 11.820.822,05    | 11.820.822,05    |
|                                                   | sea-going vessel      | 567.059       | 919.251       | 888.593         | 812.124          | 1.116.411        | 1.116.411        |

|                                   | <b>transport mode</b> | <b>2010</b> | <b>2015</b> | <b>2016</b>   | <b>2017</b>   | <b>2018</b>   | <b>2019</b>   |
|-----------------------------------|-----------------------|-------------|-------------|---------------|---------------|---------------|---------------|
| <b>nitrogen fertilisers</b>       | inland vessel         | 5.737.386   | 5.104.076   | 4.930.755     | 4.742.988     | 4.466.441,8   | 4.466.441,8   |
|                                   | railways              | 15.708.472  | 14.091.000  | 13.614.102    | 14.066.445    | 12.318.493    | 12.318.493    |
|                                   | heavy-duty vehicle    | 37.454.600  | 71.366.600  | 28.434.988,59 | 30.619.530,39 | 68.151.043,89 | 68.151.043,89 |
|                                   | sea-going vessel      | 5.309.443   | 6.509.499   | 7.011.855     | 7.392.865     | 7.239.705     | 7.239.705     |
| <b>white cement, lime, cement</b> | inland vessel         | 3.273.975   | 2.479.720   | 2.532.347     | 2.776.593     | 2.978.725,6   | 2.978.725,6   |
|                                   | railways              | 17.849.146  | 21.867.000  | 19.270.679    | 18.928.775    | 18.679.111    | 18.679.111    |
|                                   | heavy-duty vehicle    | 69.407.200  | 86.441.400  | 76.251.684,33 | 77.289.168,89 | 99.899.784,63 | 99.899.784,63 |
|                                   | sea-going vessel      | 1.544.488   | 2.757.516   | 2.470.814     | 2.552.567     | 2.172.344     | 2.172.344     |
| <b>sugar beet</b>                 | inland vessel         | 0           | 6.366.439   | 6.426.328     | 6.396.070     | 5.912.658,8   | 5.912.658,8   |
|                                   | railways              | 123.598     | 24.000      | 64.094        | 37.555        | 0             | 0             |
|                                   | heavy-duty vehicle    | 26.946.200  | 36.601.000  | 22.159.059,85 | 32.853.553,74 | 31.023.481,64 | 31.023.481,64 |
|                                   | sea-going vessel      | 17          | 2.872       | 3.125         | 9.676         | 3.277         | 3.277         |

sources: annual data deliveries DESTATIS & KBA (for heavy-duty vehicles) to the inventory compiler

### Emission factors

Emission factors are based on the methodology according VDI guidelines 3790. The values used here originate from a research project by (Müller-BBM, 2011) <sup>5)</sup> taking into account information of an expert panel of industry and administration. For details see the [[\\*https://www.umweltbundesamt.de/publikationen/konsistenzpruefung-verbesserungspotenzial](https://www.umweltbundesamt.de/publikationen/konsistenzpruefung-verbesserungspotenzial) project report] (German version only).

Within the study, PM emission factors are estimated for each material or good that might be transported as dry and unpacked bulk. These very specific EF are then assigned to the classes of materials/goods available from the different different statistics (NST/R, NST-2007) to form implied EF for these class of bulk material.

As NST/R provided a wide variety of goods and materials, whereas NST-2007 provides only a very condensed list of classes of goods, the very specific EF derived during the study and the joint expert workshop have been aggregated in order to match the classes of goods following NST-2007.

Table 2: specific EF for PM emissions from NST/R crop products, in [kg/t], as used for 2009 estimates

|                           | <b>TSP</b> | <b>PM10</b> | <b>PM2.5</b> |
|---------------------------|------------|-------------|--------------|
| for barley                |            |             |              |
| <b>inland ship</b>        | 0.038      | 0.019       | 0.004        |
| <b>railway</b>            | 0.038      | 0.019       | 0.004        |
| <b>maritime ship</b>      | 0.038      | 0.019       | 0.0038       |
| <b>heavy-duty vehicle</b> | 0.038      | 0.019       | 0.004        |
| for oats                  |            |             |              |
| <b>inland ship</b>        | 0.018      | 0.009       | 0.002        |
| <b>railway</b>            | 0.018      | 0.009       | 0.002        |
| <b>maritime ship</b>      | 0.018      | 0.009       | 0.00179      |
| <b>heavy-duty vehicle</b> | 0.018      | 0.009       | 0.002        |
| for corn                  |            |             |              |
| <b>inland ship</b>        | 0.029      | 0.014       | 0.003        |
| <b>railway</b>            | 0.029      | 0.014       | 0.003        |
| <b>maritime ship</b>      | 0.029      | 0.014       | 0.00287      |
| <b>heavy-duty vehicle</b> | 0.029      | 0.014       | 0.003        |

|                           | <b>TSP</b> | <b>PM10</b> | <b>PM2.5</b> |
|---------------------------|------------|-------------|--------------|
| for rice                  |            |             |              |
| <b>inland ship</b>        | 0.015      | 0.008       | 0.002        |
| <b>railway</b>            | 0.015      | 0.008       | 0.002        |
| <b>maritime ship</b>      | 0.015      | 0.008       | 0.00151      |
| <b>heavy-duty vehicle</b> | 0.015      | 0.008       | 0.002        |
| for rye                   |            |             |              |
| <b>inland ship</b>        | 0.038      | 0.019       | 0.004        |
| <b>railway</b>            | 0.038      | 0.019       | 0.004        |
| <b>maritime ship</b>      | 0.038      | 0.019       | 0.0038       |
| <b>heavy-duty vehicle</b> | 0.038      | 0.019       | 0.004        |
| for wheat                 |            |             |              |
| <b>inland ship</b>        | 0.038      | 0.019       | 0.004        |
| <b>railway</b>            | 0.038      | 0.019       | 0.004        |
| <b>maritime ship</b>      | 0.038      | 0.019       | 0.0038       |
| <b>heavy-duty vehicle</b> | 0.038      | 0.019       | 0.004        |

Here, in order to match the new NST-2007 classes for goods and materials, the very specific emission factors used in former submissions were converted to aggregated implied emission factors.

Table 3: IEFs used for emission estimates as of 2010, in [kg/t]

|                                                  | <b>Heavy-duty vehicles</b> |          |          | <b>Railways</b> |          |          | <b>Inland vessels</b> |          |          | <b>Sea vessels</b> |          |          |
|--------------------------------------------------|----------------------------|----------|----------|-----------------|----------|----------|-----------------------|----------|----------|--------------------|----------|----------|
|                                                  | TSP                        | PM10     | PM2.5    | TSP             | PM10     | PM2.5    | TSP                   | PM10     | PM2.5    | TSP                | PM10     | PM2.5    |
| <b>Other herbal products</b>                     | 0.032000                   | 0.016000 | 0.003200 | 0.024000        | 0.012000 | 0.002400 | 0.022000              | 0.011000 | 0.002200 | 0.028000           | 0.014000 | 0.002800 |
| <b>Chemische Grundstoffe, mineralisch</b>        | 0.041000                   | 0.020500 | 0.004100 | 0.031000        | 0.015500 | 0.003100 | 0.029000              | 0.014500 | 0.002900 | 0.036000           | 0.018000 | 0.003600 |
| <b>Raw organic chemicals</b>                     | 0.024000                   | 0.012000 | 0.002400 | 0.018000        | 0.009000 | 0.001800 | 0.017000              | 0.008500 | 0.001700 | 0.021000           | 0.010500 | 0.002100 |
| <b>Iron ore</b>                                  | 0.057000                   | 0.028500 | 0.005700 | 0.042000        | 0.021000 | 0.004200 | 0.040000              | 0.020000 | 0.004000 | 0.050000           | 0.025000 | 0.005000 |
| <b>Crops</b>                                     | 0.045000                   | 0.022500 | 0.004500 | 0.034000        | 0.017000 | 0.003400 | 0.031000              | 0.015500 | 0.003100 | 0.039000           | 0.019500 | 0.003900 |
| <b>Potatoes</b>                                  | 0.007000                   | 0.003500 | 0.000700 | 0.005000        | 0.002500 | 0.000500 | 0.005000              | 0.002500 | 0.000500 | 0.006000           | 0.003000 | 0.000600 |
| <b>Coal products</b>                             | 0.019000                   | 0.009500 | 0.001900 | 0.014000        | 0.007000 | 0.001400 | 0.013000              | 0.006500 | 0.001300 | 0.017000           | 0.008500 | 0.001700 |
| <b>Products from grinding and shelling mills</b> | 0.003000                   | 0.001500 | 0.000300 | 0.003000        | 0.001500 | 0.000300 | 0.003000              | 0.001500 | 0.000300 | 0.003000           | 0.001500 | 0.000300 |
| <b>Mineral fertilisers</b>                       | 0.024000                   | 0.012000 | 0.002400 | 0.018000        | 0.009000 | 0.001800 | 0.017000              | 0.008500 | 0.001700 | 0.021000           | 0.010500 | 0.002100 |
| <b>Natural sands, gravel, and stones</b>         | 0.027000                   | 0.013500 | 0.002700 | 0.020000        | 0.010000 | 0.002000 | 0.019000              | 0.009500 | 0.001900 | 0.023000           | 0.011500 | 0.002300 |
| <b>Non-iron ores</b>                             | 0.066000                   | 0.033000 | 0.006600 | 0.049000        | 0.024500 | 0.004900 | 0.046000              | 0.023000 | 0.004600 | 0.058000           | 0.029000 | 0.005800 |
| <b>Raw coals</b>                                 | 0.016000                   | 0.008000 | 0.001600 | 0.016000        | 0.008000 | 0.001600 | 0.020000              | 0.010000 | 0.002000 | 0.028000           | 0.014000 | 0.002800 |
| <b>Secondary raw materials</b>                   | 0.027000                   | 0.013500 | 0.002700 | 0.020000        | 0.010000 | 0.002000 | 0.019000              | 0.009500 | 0.001900 | 0.023000           | 0.011500 | 0.002300 |
| <b>Rock &amp; saline salt</b>                    | 0.068000                   | 0.034000 | 0.006800 | 0.051000        | 0.025500 | 0.005100 | 0.047000              | 0.023500 | 0.004700 | 0.059000           | 0.029500 | 0.005900 |
| <b>Nitrogen fertilisers</b>                      | 0.024000                   | 0.012000 | 0.002400 | 0.018000        | 0.009000 | 0.001800 | 0.017000              | 0.008500 | 0.001700 | 0.021000           | 0.010500 | 0.002100 |
| <b>White cement, lime, cement</b>                | 0.005000                   | 0.002500 | 0.000500 | 0.004000        | 0.002000 | 0.000400 | 0.003000              | 0.001500 | 0.000300 | 0.004000           | 0.002000 | 0.000400 |
| <b>Sugar beet</b>                                | 0.000240                   | 0.000120 | 0.000024 | 0.000180        | 0.000090 | 0.000018 | 0.000170              | 0.000085 | 0.000017 | 0.000210           | 0.000105 | 0.000021 |

**Ratio TSP : PM<sub>10</sub> : PM<sub>2.5</sub>**

The shares of PM<sub>10</sub> and PM<sub>2.5</sub> of the entire amounts of emitted TSP have been set to fixed values used for the entire time series.

Assumptions:

1. TSP = 100%,
2. 50% of TSP are  $\leq 10 \mu\text{m}$ . Therefore, the EF(PM<sub>10</sub>) are assumed as 1/2 of the corresponding EF(TSP), and
3. 10% of TSP are  $\leq 2.5 \mu\text{m}$ . Therefore, the EF(PM<sub>2.5</sub>) are assumed as 1/10 of the corresponding EF(TSP).

The ratios of TSP, PM<sub>10</sub>, and PM<sub>2.5</sub> were also discussed in the research project mentioned above, but without generating any new data. Nonetheless, the ratios might be too low at the moment and will be checked furthermore.

**Recalculations**

With both **activity data** and **emission factors** remaining unrevised, no recalculations have been carried out.

**Planned improvements**

Although no specific improvement is planned, additional effort will be necessary to further minimise the inconsistencies in the activity data time series resulting from the different approaches applied.

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