ROAD SOURCES

CERC

In this document 'ADMS' refers to ADMS-Roads 4.1, ADMS-Urban 4.1 and ADMS-Airport 4.1. Where information refers to a subset of the listed models, the model name is given in full.

1. INTRODUCTION

In ADMS, roads are modelled as line sources, with modifications to account for:

- traffic-produced turbulence, and
- street canyons (optional).

Details of the way road sources are represented are given in Section 2. A description of traffic-produced turbulence is given in Section 3. The specification for the street canyon module within ADMS is given in the Technical Specification documents P28/01 and P28/02.

2. ROAD SOURCE REPRESENTATION

Road sources are represented as line sources with no plume rise. The concentration C from a finite crosswind line source of length L_s is given by

$$C(x,y,z) = \frac{Q_s}{2\sqrt{2\pi}\sigma_z(x)U}\exp\left(-\frac{(z-z_p)^2}{2\sigma_z^2}\right)\times \left[\operatorname{erf}\left(\frac{y+L_s/2}{\sqrt{2}\sigma_y}\right)-\operatorname{erf}\left(\frac{y-L_s/2}{\sqrt{2}\sigma_y}\right)\right] + \text{reflection terms}$$

where Q_s is the source strength (g/m/s), z is the height above the ground (m), y is the lateral distance from the plume centreline (m), z_p is the height of the plume above the ground (m), U is the wind speed at the plume height (m/s), σ_y is the horizontal plume spread (m) and σ_z is the vertical plume spread (m).

For a road, the height of the plume above the ground is set to be $z_p = z_{s\_road}$ where

$$z_{s\_road} = z_s + h_0.$$

Here, h_0 is usually referred to as the initial mixing height, and is set to 1m, and z_s is the road height as entered by the user.

If chemistry is modelled, the source-receptor travel time used in the calculation of the reaction time (see P18/03 for further details) is adjusted for road sources to account for the time taken for the pollution to become well mixed within the road. This is done by adding an 'initial mixing time', given by

$$\frac{h_0}{\sigma_w(h_0)}$$

where σ_w is the vertical component of turbulence.

3. TRAFFIC-PRODUCED TURBULENCE

For busy roads, extra turbulence will be induced by the traffic. To model the effect on the vertical turbulence, the vertical plume spread parameter, σ_{z_road}, is increased:

$$\sigma_{z\_road}^2 = \sigma_z^2 + h_0^2$$

To model the effect on the lateral turbulence, an extra component is included in the lateral plume spread parameter σ_y. (Note that this extra component is not included when modelling street canyons. The street canyon module includes a separate treatment of traffic-produced turbulence.) The formulation of this extra component, $\sigma_{y_{vehicle}}$, is as follows (formulation by D. J. Carruthers):

$$\sigma_{y_{vehicle}} = \sigma_{v_{vehicle}} t \left\{ 1 + \left(\frac{t}{t_d} \right)^2 \right\}^{-1/2}$$

where

$$\sigma_{v_{vehicle}} = b \cdot \left(\frac{\sum_i^{n_c} N_i U_i A_i}{W} \right)^{1/2}$$

and the turbulence decay time, t_d, is given by

$$t_d = \left(\frac{W}{\tau} \right) / \sigma_{v_{vehicle}}$$

In the above definitions,

- t = time to travel from source to this point(s)
- b = constant (0.3) [from OSPM street canyon model]
- τ = constant (0.1) [chosen by CERC after testing]

- n_c = number of vehicle categories
- N_i = number of vehicles per second for that vehicle category
- U_i = speed of vehicles (m/s) for that vehicle category
- A_i = area covered by a vehicle (m^2) for that vehicle category
- W = road width (m)

The formulation implies that $\sigma_{y_{vehicle}} / \sigma_{v_{vehicle}} \rightarrow 0$ as $t \rightarrow 0$ and $\sigma_{y_{vehicle}} / \sigma_{v_{vehicle}} \rightarrow t_d$ as $t \rightarrow \infty$.

If traffic counts are unknown, they are back-calculated by the model from the user-defined emission rate of NO_X, PM_{10} or VOC (in that order of preference). For this calculation, it is assumed that the speed of the traffic is 30 km/hr and that the traffic is 95% light goods vehicles, and 5% heavy goods vehicles; the vehicle split between light and heavy categories can be altered by the user. If no emissions are defined for any of these pollutants, no traffic-produced turbulence is modelled.