CALCULATION OF PLUME TEMPERATURE AND HUMIDITY

CERC

In this document 'ADMS' refers to ADMS 5.2.

In some circumstances plumes contain live micro-organisms, such as Legionella, which may pose a risk to the public. These micro-organisms can be sensitive to the conditions within the plume, for example, they may only survive if the temperature and/or humidity levels are above certain threshold values. It is therefore of interest to be able to calculate the temperature and humidity at any point taking into account the conditions within the plume.

ADMS includes the calculation of

- the temperature, relative humidity and specific humidity at any point, taking into account mixing between the plume and the ambient air,

- the number of exceedences of threshold values of temperature, relative humidity and specific humidity, where the threshold values are defined by the user, and

- the number of times a temperature threshold and a relative (or specific) humidity threshold are simultaneously exceeded, where the threshold values are defined by the user.

The temperature, T (°C), and specific humidity, H (kg/kg), at the plume centreline are calculated as part of the plume rise calculations (please see the ADMS Technical Specification papers P11/02 and P26/01 for further details). The ambient temperature and specific humidity are also known (see P09/01).

The temperature and specific humidity at an arbitrary point are calculated by assuming that the vertical and horizontal profiles are the same as that of the concentration. So if the concentration $C(x, y, z)$ is given by

$$C(x, y, z) = C_p \times F(y) \times G(z)$$

where C_p is the plume centreline concentration, then the temperature $T(x, y, z)$ is given by

$$T(x, y, z) = T_a(z) + \left(T_p - T_a(z_p)\right) \times F(y) \times G(z)$$

where $T_a(z)$ is the ambient temperature at the height, z, of the output point, and $T_a(z_p)$ is the ambient temperature at the plume centreline height z_p. The same profile is used for specific humidity $H(x, y, z)$:

$$H(x, y, z) = H_a(z) + \left(H_p - H_a(z_p)\right) \times F(y) \times G(z)$$

The relative humidity RH is then calculated from T and H, using

$$RH = 100 \frac{R}{R_{sat}}$$

where R is the mixing ratio (kg/kg), obtained from

$$H = \frac{R}{1 + R}$$

and R_{sat} is the saturated mixing ratio, which depends on T (as described in P26/01).

Note that at temperatures above 100°C, relative humidity is not defined, hence no relative humidity output is given.