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Background Chapter	4
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AB2588 EMISSION ESTIMATION TECHNIQUES FOR PETROLEUM REFINERIES AND BULK TERMINALS

FINAL REPORT

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8.0 COOLING TOWERS

Emissions of interest from cooling towers can include:

- Chlorine;
- Chloroform;
- Hexavalent chromium;
- Manganese;
- Nickel; and
- Trichloroethylene.

Emissions of chlorine from cooling towers may be estimated by determining the chlorine concentration in the cooling water and the cooling tower drift. The quantity of chlorine released to the atmosphere would be equivalent to the chlorine fraction of the drift.

Chloroform emissions from cooling towers are typically quite small, on the order of 1 lb/yr per 200 gallons per minute (gpm) cooling tower throughput. These emissions can only be measured indirectly by sampling the cooling water in the risers and in the basin and comparing results. Furthermore, the emission rate varies during the day, being at a maximum in the hour after chlorination of the system. Therefore, we recommend an emission factor approach. Radian has developed chloroform emission estimates based on data presented by Smith and DaRos (1983).

The data developed by Smith and DaRos (1983) are used to estimate the chloroform concentration of the cooling water based on the chlorine treatment. Chloroform emissions are calculated by estimating the chloroform in the cooling tower drift plus the evaporative loss (stripping) in the cooling tower. Based on data provided by Smith and DaRos (1983) evaporative losses of 30 percent are expected.

Smith and DaRos (1983) also measured the concentration of trichloroethylene in the cooling tower water. This AB2588 listed substance is expected

to behave in a manner similar to chloroform. It's measured concentration was found to be 0.045 times that of chloroform. Therefore, once the chloroform emissions have been estimated, the trichloroethylene emissions are calculated by multiplying the chloroform emissions by .045. An example of the chloroform and trichloroethylene emission estimating method is included in Appendix D.

Hexavalent chromium is emitted from towers if chromium-based corrosion inhibiting additives are used. Cooling tower hexavalent chromium emissions are estimated using the method outlined by the Air Resources Board (1988). This calculation method is outlined in Table 8-1. The ARB method requires knowledge of the chromate mixing ratio. For calculating hexavalent chromium emissions when the chromate mixing ratio was not known, ARB estimated a value of 10 ppm by weight (ARB, 1988).

Manganese and nickel may be emitted from cooling towers if manganese and nickel based corrosion inhibiting agents and biocides are used. Manganese and nickel emission factors have been developed for electric utility cooling towers (Radian, 1984). The emission factors are based on the generating capacity of the electric utility.

An engineering calculation, similar to the hexavalent chromium calculation procedure, could be used to estimate manganese and nickel emissions. This procedure would require data describing the manganese and nickel concentration in the cooling tower water.

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TABLE 8-1. COOLING TOWER HEXAVALENT CHROMIUM EMISSION ESTIMATION METHOD

Equation:

Hexavalent Chromium Emissions (lb/yr)=

Drift Fraction (gpm/gpm) x Circulation Rate (gpm) x

[Chromate Mixing Ratio (ppm by wt)/10^6 lb H_2O] x

[52 lb Hexavalent Chromium/116 lb Chromate] x

525960 min/yr x Operation Fraction (yr/yr).

Variables:

Drift Fraction - Fraction of Circulation Water Emitted from the Cooling Tower

Circulation Rate - Cooling Tower Water Flow Rate (gal/min)

Chromate Mixing Ratio - Desired Concentration of Chromate in Cooling Tower Water (parts per million by weight)

Operation Fraction - Fraction of year during which the cooling tower is in operation.

Source: ARB, 1988.