A Procedure for Modeling Buoyant Line Sources with AERMOD

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Applications

- Complex sources such as roof monitors and positive pressure baghouses in the metals industry (e.g., electric arc furnaces, basic oxygen furnaces, aluminum reduction plants, etc.)
- Coke batteries
- NAAQS attainment demonstrations, PSD/NSR, NATA, residual risk assessment modeling, etc.

Limitations of AERMOD

- AERMOD does not treat buoyant line sources
- Previous modeling approaches (e.g., 2005 RTR for Subpart L - Coke Ovens) have used a hybrid modeling scheme involving: a) plume rise estimation using a buoyant line source algorithm (e.g., EPA BLP Model) and b) point source dispersion calculations in an EPA regulatory default dispersion model (ISCST3)

Relevant Features of the BLP Model

- Enhanced plume rise of buoyant line sources compared to point sources (less entrainment of ambient air)
- Plume enhancement due to multiple line sources
- Line source rise dependency on wind direction, line length, the number of parallel lines, and their spacing
- Effect of vertical wind shear on plume rise
- Incorporation of building downwash in both plume rise and dispersion calculations
- *Drawback: BLP does not treat complex terrain*

BLP Line Source Plume Rise

$$z' = [F'/2ßLU_s^3]^{0.5}x' \text{ (neutral atmosphere)}$$

Note: linear x' dependence of line source plume rise vs. $x^{2/3}$ dependence for point source

Buoyancy Parameter:

$$F' = gLW_m w(T_s - T_a)/T_a$$

Example: Buoyancy Parameter for Coke Batteries

- Two Components:

  1) Convective Heat Transfer – convective heating of ambient air surrounding hot coke oven surfaces (doors, oven tops, buckstays, and offtakes)

  2) Fugitive Emissions (charging, door leaks, topside leaks, soaking, pushing fugitives, quench car travel, and decarbonization)

Proposed Modeling Procedure

- Two-step hybrid modeling scheme:

  1) Apply BLP to estimate hourly line source final plume rise, based on line source buoyancy parameter(s), physical dimensions, and source orientation

  2) Apply the BLP-predicted final plume heights in AERMOD and model as *volume* sources using hourly source height adjustment factors

Summary

- Until EPA develops a buoyant line source algorithm in AERMOD, a two-step hybrid modeling scheme has been proposed involving the application of two Guideline dispersion models (BLP and AERMOD)
- This procedure can treat enhanced plume rise from multiple buoyant line sources
- Hybrid modeling approach is more time- and resource-intensive (e.g., requires two meteorological data preprocessors – RAMMET for BLP and AERMET for AERMOD)