

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, 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

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

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

Buoyancy Parameter:

$$F' = g L W_m w (T_s - T_a) / T_a$$

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 oftakes)
 - 2) Fugitive Emissions (charging, door leaks, topside leaks, 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)