Rain Caps and Horizontal Stacks

The latest version of the AERMOD Implementation Guide[1] indicates that the procedures for modeling capped/vertically obstructed and horizontal stack discharges are incorporated into AERMOD, beginning with version 16216, as POINTCAP and POINTHOR source types.

Stacks with a horizontal discharge should be modeled using the POINTHOR source type in AERMOD. Stacks with an obstructing rain cap on the top of the stack should be modeled using the POINTCAP source type in AERMOD. Care should be exercised when modeling horizontal point sources to ensure that downwash is included. Model stacks with a downward discharge with an exhaust gas exit velocity of 0.001 m/s and the actual stack tip diameter.

For capped/vertically obstructed and horizontal stack discharges that ***are not*** subject to building downwash, these options are consistent with the approach that was approved by the Model Clearinghouse. [2] AERMOD sets the exit velocity equal to a small value, 0.001 m/sec, in order to suppress vertical momentum of the plume but still enable the determination whether the plume is dominated by momentum or buoyancy and thus computing plume rise accordingly.[3]

For capped/vertically obstructed and horizontal sources that ***are*** subject to building downwash, the options have been adapted to better account for the PRIME algorithm.

For capped or vertically obstructed stack discharges that ***are*** subject to building downwash, the POINTCAP source type is used. For this option, AERMOD assigns the initial diameter of the plume to be 2 times the actual stack diameter to account for initial spread of the plume associated with the cap; the initial horizontal velocity of the plume is set equal to 25% of the total exit velocity; the initial vertical velocity is set at 0.001 m/sec.[1] If the stack includes an unobstructing rain guard (hinged stacks, hexagonal stacks and stack-in-a-stack), then model the stack as a point source with no obstruction. For "stack-in-a-stack" discharge styles, the stack diameter and stack height are based on the opening size and height of the outer stack.

For horizontal stack discharges that ***are*** subject to building downwash, the POINTHOR source type is used. For this option, AERMOD assigns the initial plume trajectory angle to be horizontal and emitted in the downwind direction; the initial horizontal velocity of the plume is set equal to the total exit velocity; the initial vertical velocity is set at 0.001 m/sec.[1]

For downward directed stack discharges, whether or not there is downwash, the point source type should be used with a vertical velocity of 0.001 m/sec and with the actual stack tip diameter.

In rare cases, there may be a tilted stack. If it is unobstructed, model as a point source, but use only the vertical component of total stack exit velocity: multiply the total exit velocity by the cosine of the angle between the stack and the vertical. If the stack is obstructed, model as a POINTCAP source type. Adjust the exit velocity by multiplying the total stack exit velocity by the cosine of the angle between the stack and the vertical. The stack height is, as usual, the distance between the stack tip and the ground.

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[1]Section 3.2.2.3 of the User's Guide for the AMS/EPA Regulatory Model (AERMOD), EPA-454/B-16-011, December, 2016; also Section 6.1 of the AERMOD Implementation Guide, EPA-454/B-16-013, December 2016.

[2] EPA Model Clearinghouse Memorandum, dated July 9, 1993, *"Proposal for Calculating Plume Rise for Stacks with Horizontal Releases or Rain Caps for Cookson Pigment, Newark, New Jersey."* This memo appears in Appendix D of the Addendum to the User's Guide for the AMS/EPA Regulatory Model – AERMOD, EPA-454/B-03-001, September 2004.

[3] If the stack gas temperature is greater than or equal to the ambient temperature, then it must be determined if buoyancy or momentum dominate. A crossover temperature (ΔT_c) is computed. If the stack gas temperature minus the ambient temperature exceeds or is equal to ΔT_c, the plume rise is assumed to be buoyancy dominated. Buoyant plume rise and crossover temperature are proportional to v_s raised to a positive power. If v_s is set equal to zero, no analysis can be done and thus there is no additional plume rise due to buoyancy. A small value for v_s doesn't add any measurable momentum but allows for a buoyancy-dominated plume to exist a portion of the time, depending on the stack and (varying) ambient temperatures, thus resulting in a plume rise due to buoyancy. (ISC User's Guide, Volume II, section 1.1.4.)