Loss Coefficients

The dimensionless coefficient C is used for fluid resistance because this coefficient has the same value in dynamically similar streams (i.e., streams with geometrically similar stretches, equal Reynolds numbers, and equal values of other criteria necessary for dynamic similarity). The fluid resistance coefficient represents the ratio of total pressure loss to the velocity pressure at a referenced cross section (Equation 1).

$$C = \frac{\Delta p_j}{p_v} = \frac{\Delta p_j}{\rho (V/1097)^2} \qquad 1\ (\text{IP})$$

$$C = \frac{\Delta p_j}{p_v} = \frac{\Delta p_j}{\rho V^2/2} \qquad 1\ (\text{SI})$$

where:

C	=	local loss coefficient
Δp_j	=	total pressure loss, in. water (Pa)
ρ	=	density, $lb_m/ft^3 (kg/m^3)$
V	=	velocity, fpm (m/s)
p_v	=	velocity pressure, in. of water (Pa)

Dynamic losses occur along a duct length and cannot be separated from friction losses. For ease of calculation, dynamic losses are assumed to be concentrated at a section (local) and exclude friction. Frictional losses must be considered only for relatively long fittings. Generally, fitting friction losses are accounted for by measuring duct lengths from the centerline of one fitting to that of the next fitting.

For fittings closely coupled (less than six diameters apart), the flow pattern entering subsequent fittings differs from the flow pattern used to determine loss coefficients. Adequate data for these situations are unavailable.

For all fittings, except junctions, the total pressure loss Δp_j is calculated by:

$$\Delta p_j = C_o \, p_{v,o} \qquad 2$$

where the subscript “c” is the cross section at which the velocity pressure is referenced. The dynamic loss is based on the actual velocity in the duct, not the velocity in an equivalent round duct. For unequal area fittings, the database for convenience provides the loss coefficient referenced to both the upstream and downstream velocity pressure (see Fittings SR3 and ER3 for examples). The pressure loss across the fitting is the same using either C_o or C_1.

For converging and diverging flow junctions, total pressure losses through the straight (main) section is calculated by

$$\Delta p_j = C_{c,s}\, p_{v,c} \qquad 3$$

or

$$\Delta p_j = C_s\, p_{v,s} \qquad 4$$

For total pressure losses through the branch section,

$$\Delta p_j = C_{c,b}\, p_{v,c} \qquad 5$$

or

$$\Delta p_j = C_b\, p_{v,b} \qquad 6$$

where:

(1) $p_{v,c}$ is the velocity pressure at the common section "c," and $C_{c,s}$ and $C_{c,b}$ are the local loss coefficients for the straight (main) and branch flow paths, respectively, each referenced to the velocity pressure at section "c."
(2) $p_{v,s}$ and $p_{v,c}$ is the velocity pressure at the main and branch cross sections and C_s and C_b are the local loss coefficients for the straight (main) and branch flow paths, respectively, referenced to the velocity pressure at sections "s" and "b," respectively.
(3) See Fittings SD5 and ED5 for examples.

Negative Loss Coefficients. The junction of two parallel streams moving at different velocities is characterized by turbulent mixing of the streams, accompanied by pressure losses. In the course of this mixing, an exchange of momentum takes palce between the particles moving at different velocities, finally resulting in the equalization of the velocity distributions in the common stream. The jet with higher velocity loses part of its kinetic energy by transmitting it to the slower moving jet. The loss in total pressure before and after mixing is always large and positive for the higher velocity jet and increases with an increase in the amount of energy transmitted to the lower velocity jet. Consequently, the local loss coefficient, defined by Equation 1, will always be positive. The energy stored in the lower jet increases as a result of the missing. The loss in total pressure and the local loss coefficient can, therefore, also have negative values for the lower velocity jet (Idelchik et al. 1994).

Duct Design. For HVAC duct design procedures and example problems, consult the "Duct Design" chapter in the *ASHRAE Handbook—Fundamentals* (latest edition).