more vapor-like matter, even though the same basic theories govern both classes.

Dust or gas may be captured by enclosure or by open hoods with positive inward air movement. With some classes of machinery it is not feasible to hood the machines closely, and in these cases open hoods over or adjacent to the machines are provided to collect as much as possible of the dust and fumes. Examples of these classes include such machines or operations as pickling tanks, melting furnaces, arc welding, and monument finishing operations.

Open hoods should be placed as close to the source of dust or fumes as possible, with due regard to the movements of the operator. In no instance should the operator be located between the source of dispersion and the exhaust hood or enclosure. When the hood must be placed at some distance above the machine, it should be large enough to cover a large area, as dispersion (considering dust) is usually quite rapid.

Some consideration should be given to the natural movement of the contaminant. In many cases there are convection currents and other atmospheric disturbances in the work room. These disturbances diminish the tendency of dust and fumes to settle from the room air.

In some classes of operation, the main objective is to prevent the escape of dust into the surrounding atmosphere, and the removal of some dust from the machine or enclosure may be merely incidental. The dust-creating apparatus is enclosed within a housing which is made as tight as practicable, and sufficient suction is applied to the enclosure to maintain an inward air flow through all cracks and openings, thus preventing escape of the dust. While the exhaust system is required to handle only the air which enters through the crevices and openings in the enclosure, in many installations leakages are very high, and great care is required to reduce such leakages to a minimum.

Certain dust and fume producing operations are best carried on by isolating the process in a separate compartment or room, and then applying general ventilation to this space.

HOOD DESIGN PRINCIPLES[2, 3, 4, 5, 6, 7]

The first and most important steps in the design of a local exhaust system are to determine the number and shape of hoods or enclosures, and the size of the branch connections. No general rules, however, can be given since hood and duct designs are determined by the characteristics of the operations to which they are applied. When a tentative decision regarding the set-up has been made, it is next necessary to obtain the suction and air velocities required to effect control. At this point, the designer must rely upon the prevailing practice, and on such physical data relating to hoods, duct systems, and collectors as are available.

In general, the most important requirements[3] of an efficient local exhaust system are:

1. Hoods, ducts, fans, motors and collectors should be of adequate size and type.
2. The air velocities should be sufficient to control and convey the materials collected.
3. The hoods and ducts should be placed so as not to interfere with the operation of a machine or any working part.
4. The system should do the required work with a minimum power consumption.
5. When flammable contaminants are conveyed, the piping should be provided with an automatic damper in passing through a fire-wall (Refer to *Pamphlet* No. 91, *National Board of Fire Underwriters*).[9]
6. Ducts and all metal parts should be grounded to reduce the danger of dust explosions by static electricity. Motor and starting equipment should conform to Article 500—Hazardous Locations—of the National Electrical Code.[10]
7. The exhaust system should be readily accessible for inspection and maintenance.

CAPTURE VELOCITY AND HOOD SUCTION

The removal of dust or contaminant by means of an exhaust hood requires a movement of air, at the point of origin, sufficient to carry it into the exhaust system. The air velocity necessary to accomplish this depends upon the physical properties of the material to be controlled, and the direction and speed with which it is dispersed. If the dust to be removed is already in motion, as is the case with high-speed grinding wheels, the hood must be installed in the path of the particles so that a minimum air volume may be used effectively. It is always desirable to design and locate a hood so that the volume of air necessary to produce results is as small as possible. This will reduce the size of equipment, the power required by the system, and also the heating load requirements in winter.

TABLE 1. MINIMUM AIR VELOCITIES REQUIRED AT POINT OF ORIGIN TO CAPTURE CONTAMINANT EFFECTIVELY

CONDITION OF GENERATION OF CONTAMINANT	MINIMUM CAPTURE VELOCITY, FPM	PROCESS
Released without noticeable movement	50–100	Evaporation of vapors, exhaust from pickling, washing, degreasing, plating, welding, etc.
Released with low velocity	100–200	Paint spraying in booth; inspection, sorting, weighing, packaging, low speed conveyor transfer points, rotating mixtures, barrel filling.
Active generation	200–500	Foundry shakeout, high speed conveyor transfer points, crushers, screens.
Released with great force	500–2000	Grinding, tumbling mills, abrasive cleaning.

Capture Velocities

Data for the selection of *capture velocities* of many operations are not available, but it is safe to assume that for most dusty operations velocities should not be less than 200 fpm at the point of origin. Recommended minimum capture velocities for various processes are given in Table 1.

The method for determining, approximately, the quantity of air that must be exhausted to produce these capture velocities at the point of origin, is given in Equation 1:

$$Q = V(10X^2 + A) \qquad (1)$$

where

Q = quantity of air exhausted, cubic feet per minute.
V = air velocity in feet per minute at X distance in feet from the hood and on the centerline of the hood.
X = distance in feet, along the hood centerline, from the face of the hood to the point where the air velocity is V feet per minute.
A = area in square feet of the hood opening.