N.C. Department of Labor OSHA 125 Course

- Industrial Ventilation

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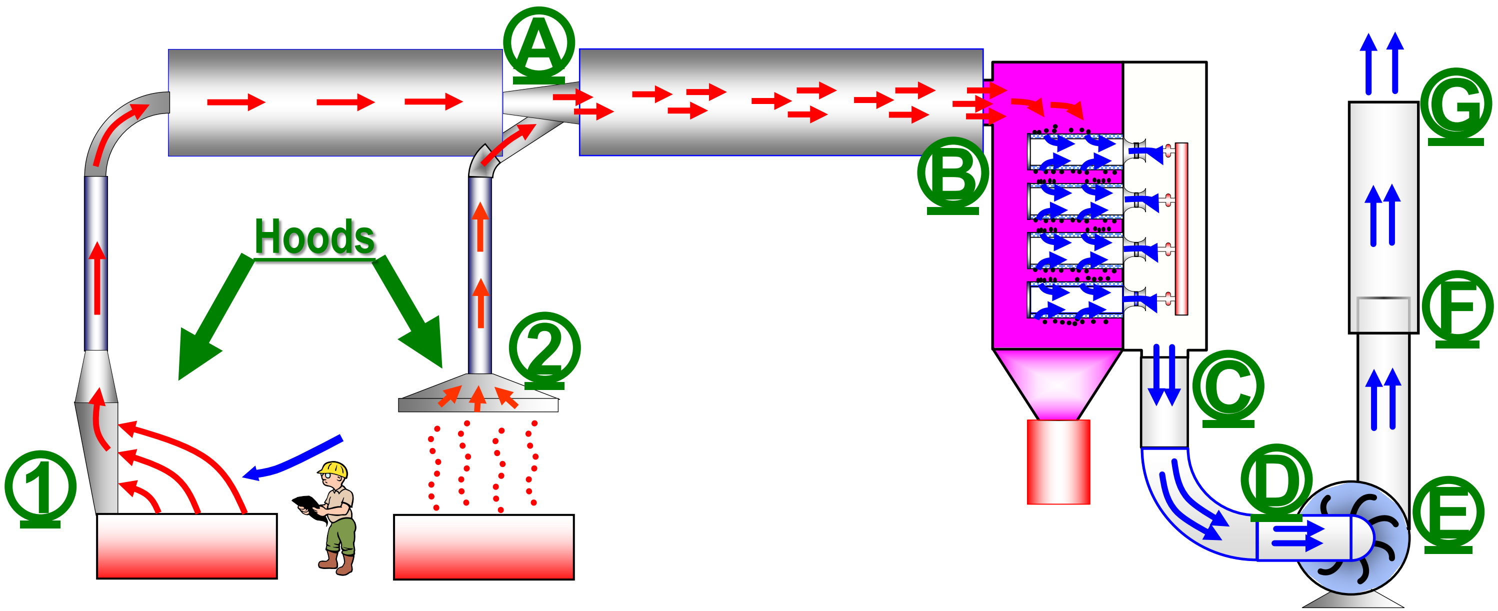
Ventilation Objectives

- Understand the basics of industrial (local exhaust) ventilation
- Discuss applicable standards and how ventilation is typically cited by CSHOs

Example Local Exhaust Ventilation System



Introduction to Hoods

Hoods are the single most important component in the establishment of a system's flow requirement (Q) and control of the emission source.

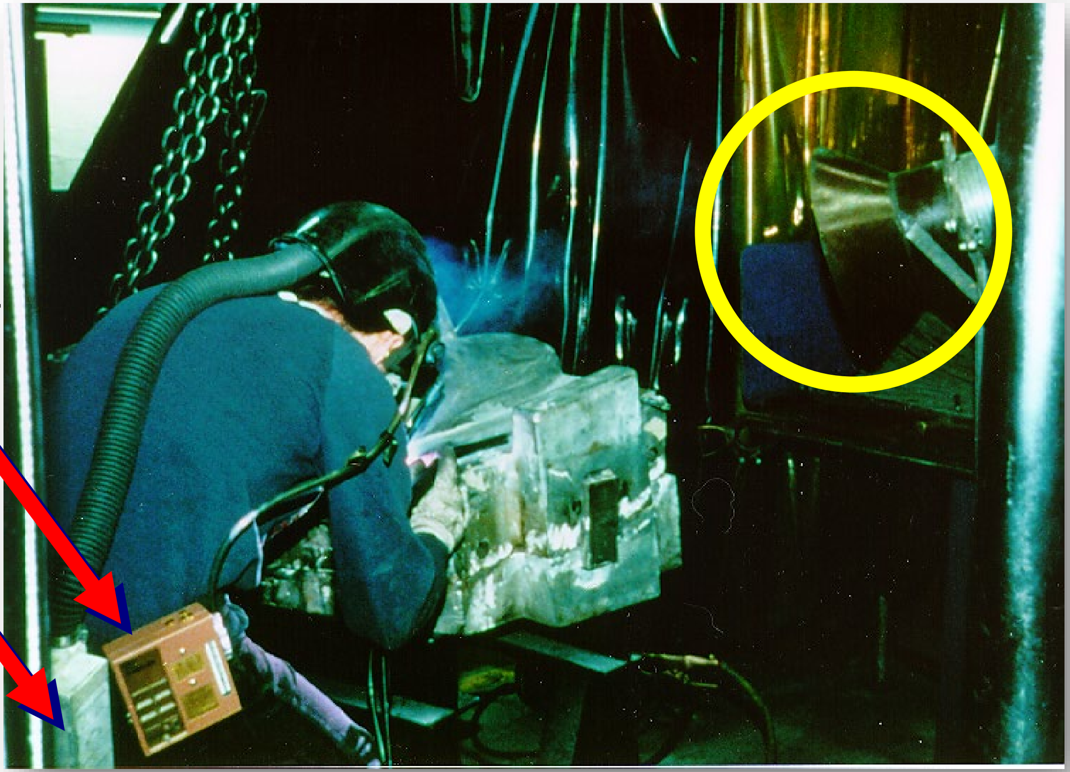
Toner Cartridge Blowout Hoods

There are numerous examples of poor hood design…

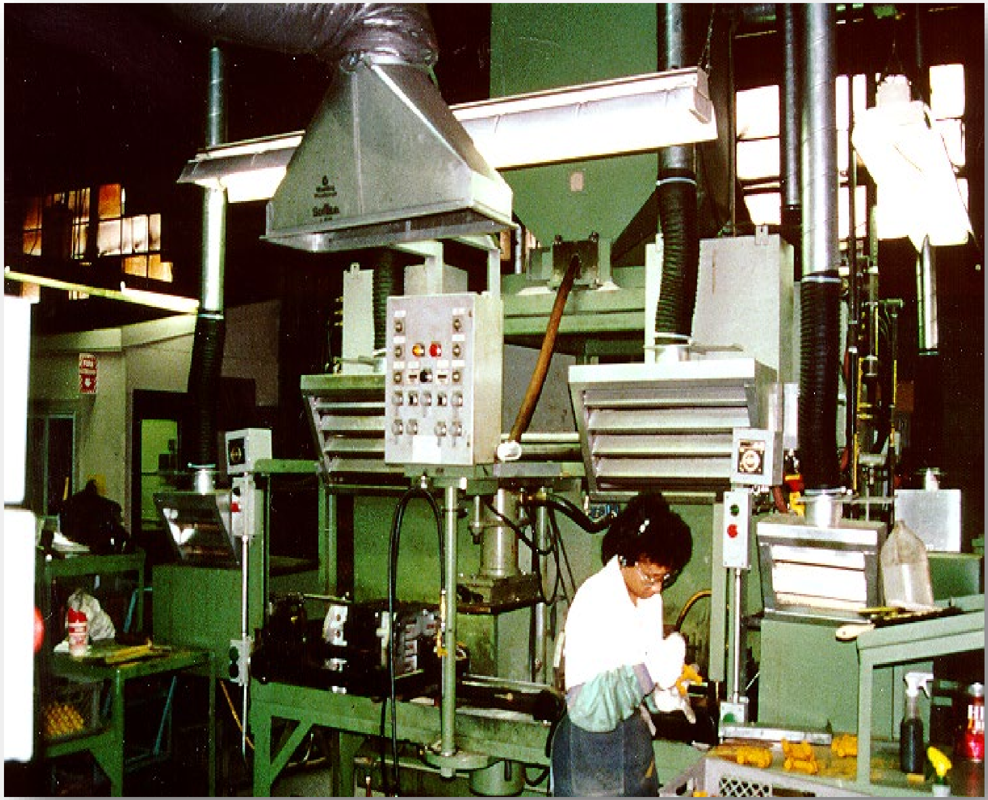
…poor due to hood location…

Air Monitoring

PAPR



…poor due to air currents…



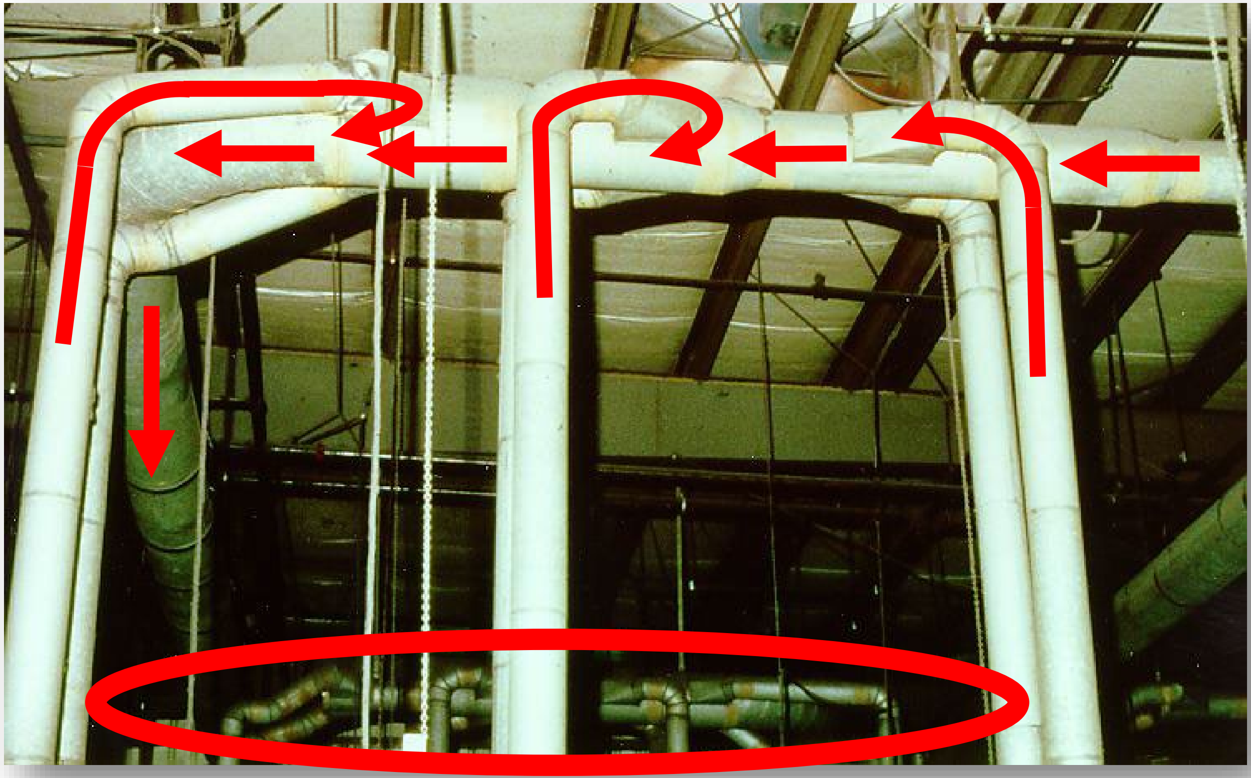
…poor due to lack of knowledge of design principles…

…poor due to use of personnel fans…

…poor due to materials of construction…

…poor due to improper work practices…

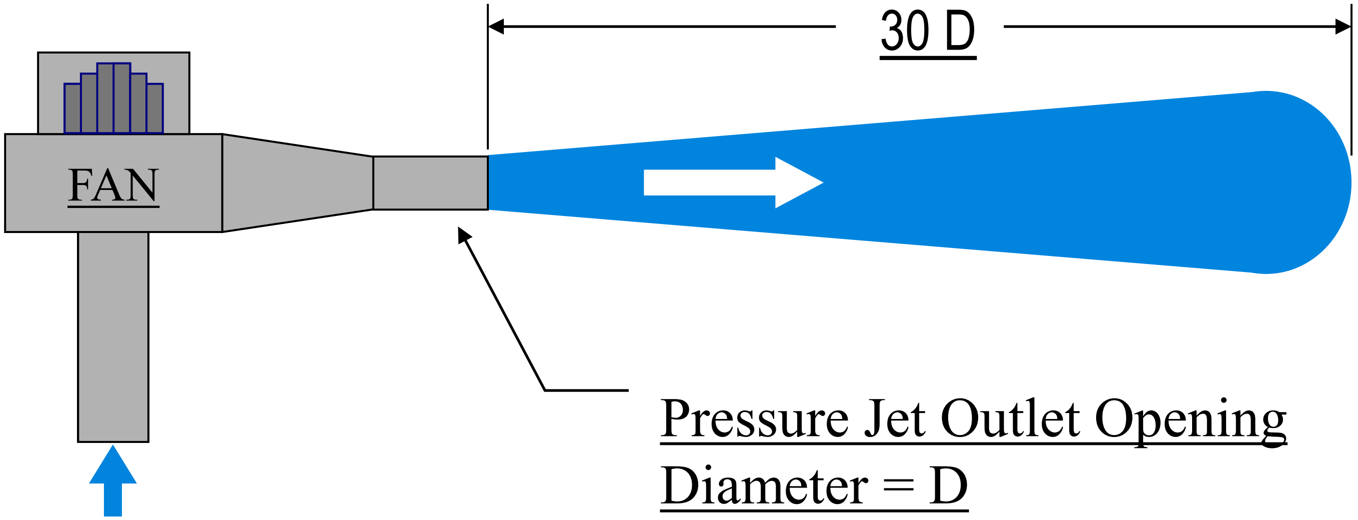
…and pretty…but just plain poor.



Definition: "Hood"

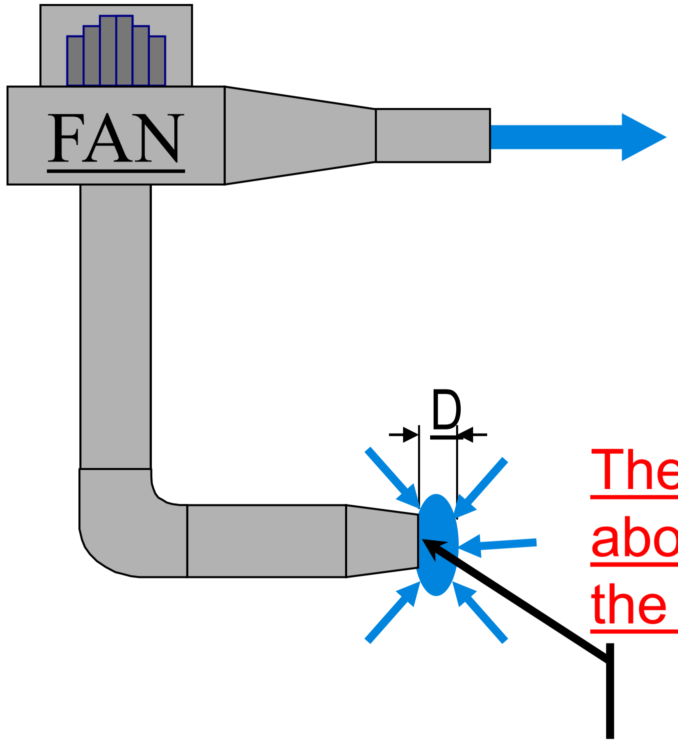
A shaped inlet designed to **capture** contaminated air **and conduct away from the worker's breathing zone** and into the duct system.

Remember this fact regarding blowing air…



The face velocity decreases to about 10% at 30 diameters (D) from the pressure jet opening.

…and this fact regarding exhausting air…



Key Fundamental

Local exhaust hoods must be placed close to the source of generation to effectively capture the air contaminant and direct it into the ductwork system

The capture velocity decreases to about 10% at **one** diameter (D) from the pressure jet opening.

Hood Classifications

Enclosing Hoods

- Contaminant to be controlled is generated within the hood.
- Build a box around the source
- Most efficient hood type
- Access for workers could pose problems

Capturing Hoods

- Contaminant to be controlled is generated outside the hood.
- Located adjacent to the source; does not enclose the source
- Work practices and air currents are critical to the successful operation of this hood type

Push-Pull Hoods

- Used when source is located about four feet or more from hood face (large, open-surface vessels)
- Combines pushing and receiving of air to control the emission source

Hood Classification Examples

Enclosing Hood

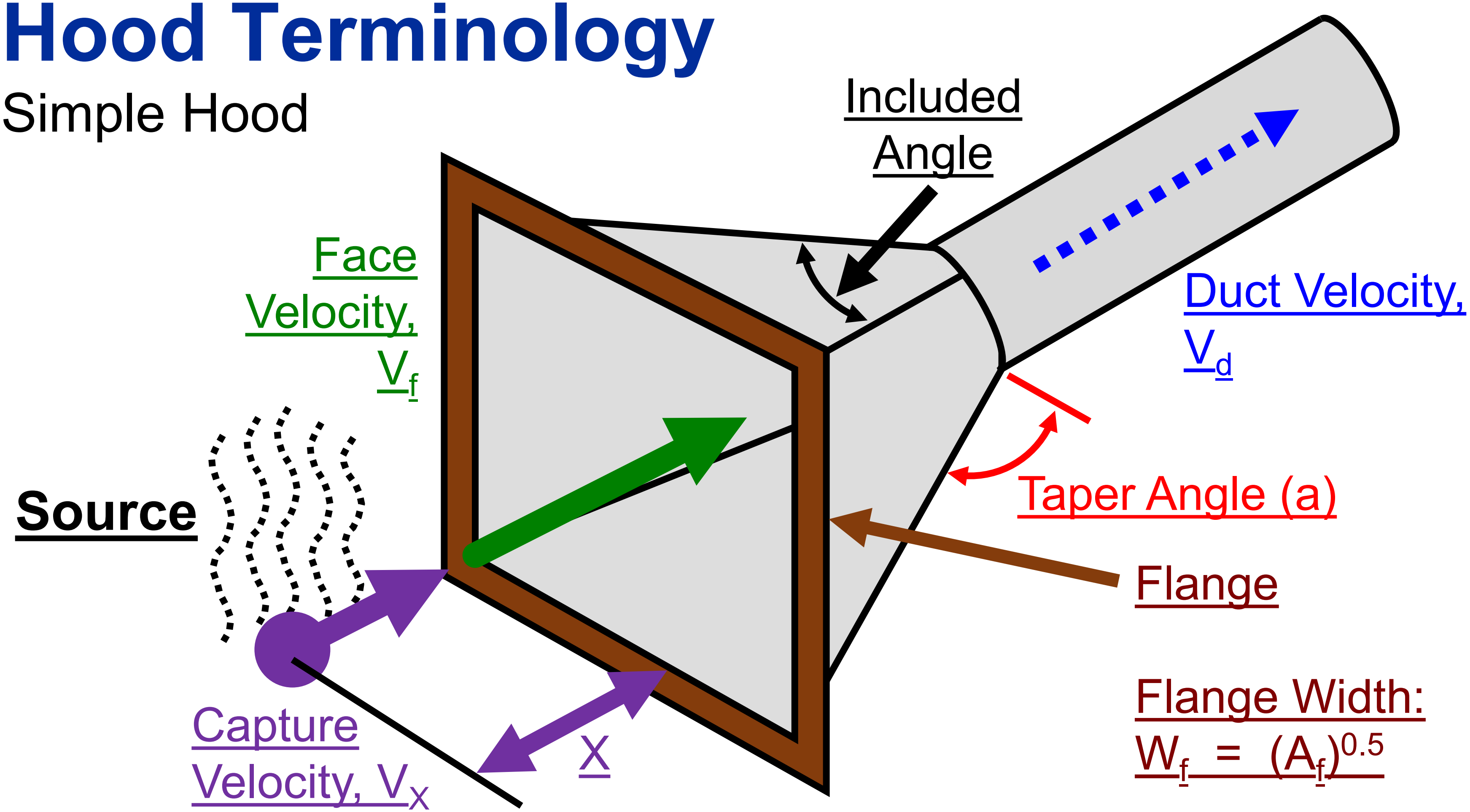
Capturing Hood

Push-Pull Hood

Remember: Q = VA

Hood Terminology

Simple Hood



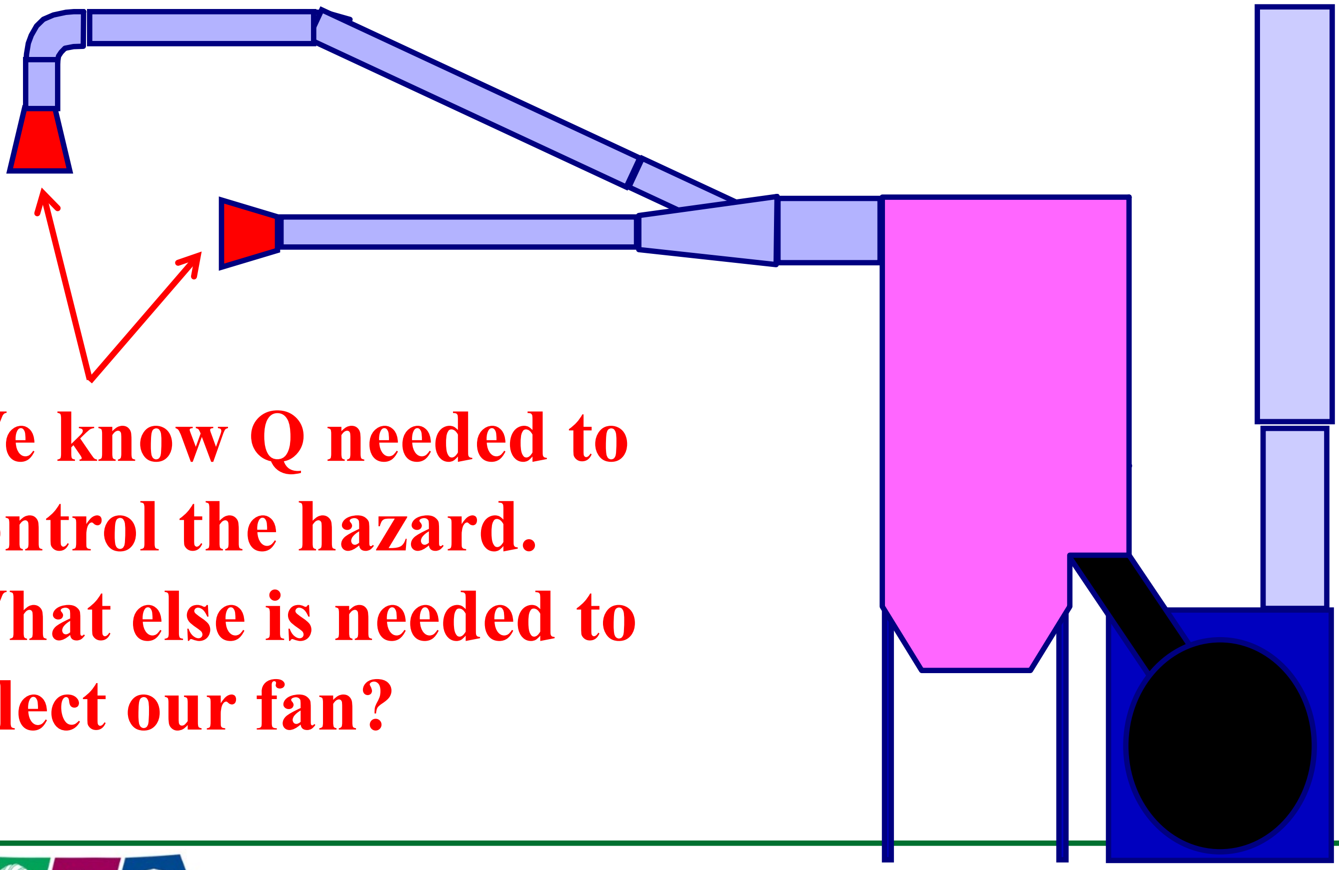
Flange Width: $W_f = (A_f)^{0.5}$

System Design

- What values are needed to size your fan?
  - Total air volume per minute (Q).
  - System Static Pressure – a measure of the total static pressure "losses" throughout the ventilation system.

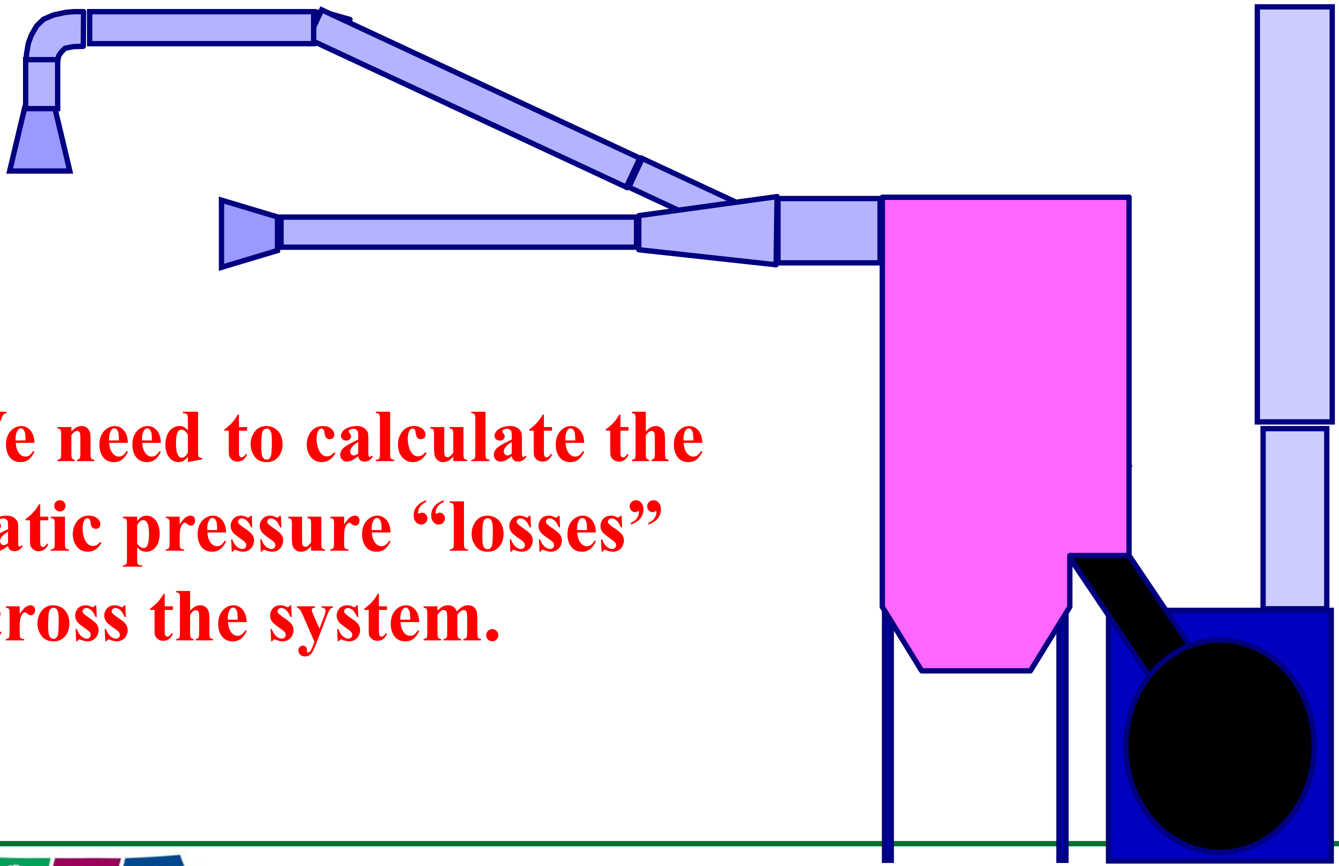
- Your goal is to minimize losses while providing enough air volume to control the hazard (i.e. maintaining the required capture velocity at each hood).

Local Exhaust Components



We know Q needed to control the hazard. What else is needed to select our fan?

Local Exhaust Components

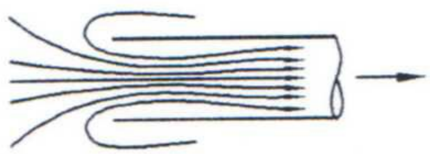


We need to calculate the static pressure "losses" across the system.

Hood Static Pressure

- If we know shape of the hood and the amount of flow required, we can then determine the energy required to overcome the resistance to flow into the hood.
- It is a function of the hood entry coefficient and the air velocity in the duct.
- $SP_h = F_h VP_d + VP_d$

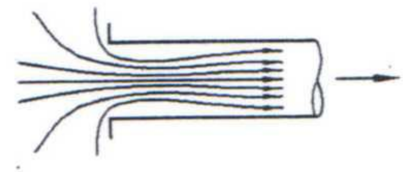
Hood Static Pressure



$h_e = 0.93\ VP_d$

$C_e = 0.72$

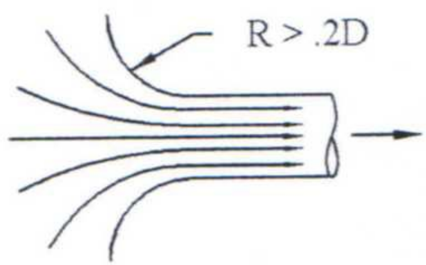
PLAIN DUCT END



$h_e = 0.49\ VP_d$

$C_e = 0.82$

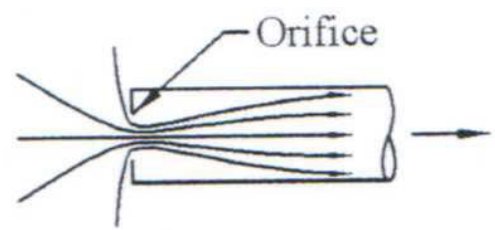
FLANGED DUCT END



$h_e = 0.04\ VP_d$

$C_e = 0.96$

BELLMOUTH ENTRY



$h_e = 1.78\ VP_{Orifice}$

$C_e = 0.35$

SHARP-EDGED ORIFICE

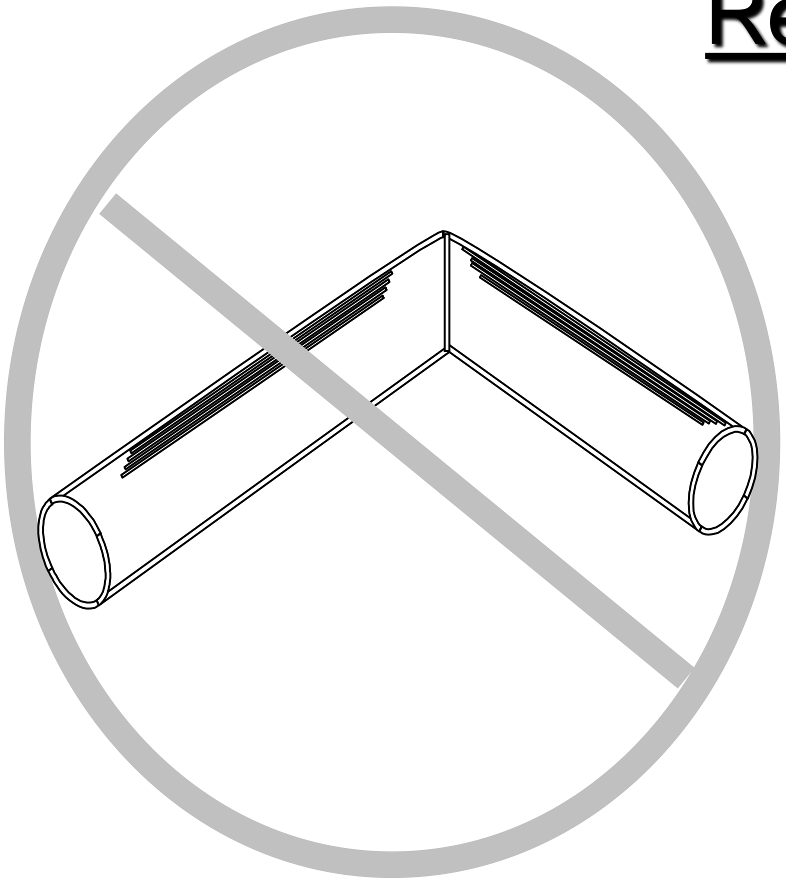
Minimum Duct Velocity

Vapors, Gasses, Smoke	1000 - 1200 fpm
Fumes, Metal Smokes	2000 - 2500 fpm
Dry Dust and Powder	3000 - 3500 fpm
Average Industrial Dust	3500 – 4000 fpm
Heavy Dust	4000 - 4500 fpm
Heavy and/or Moist Dusts	4500 fpm +

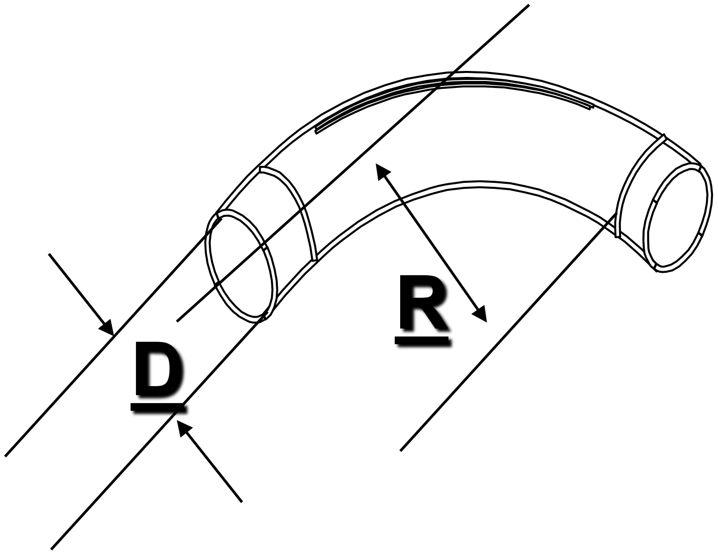
Straight Duct $F_{duct} = (F_d)(L)$

- Losses are a function of:
  - Length of duct
  - Diameter of duct (smaller duct has more friction)
  - Speed of air through the duct

Elbow Design



Recommended: R/D ≥ 2

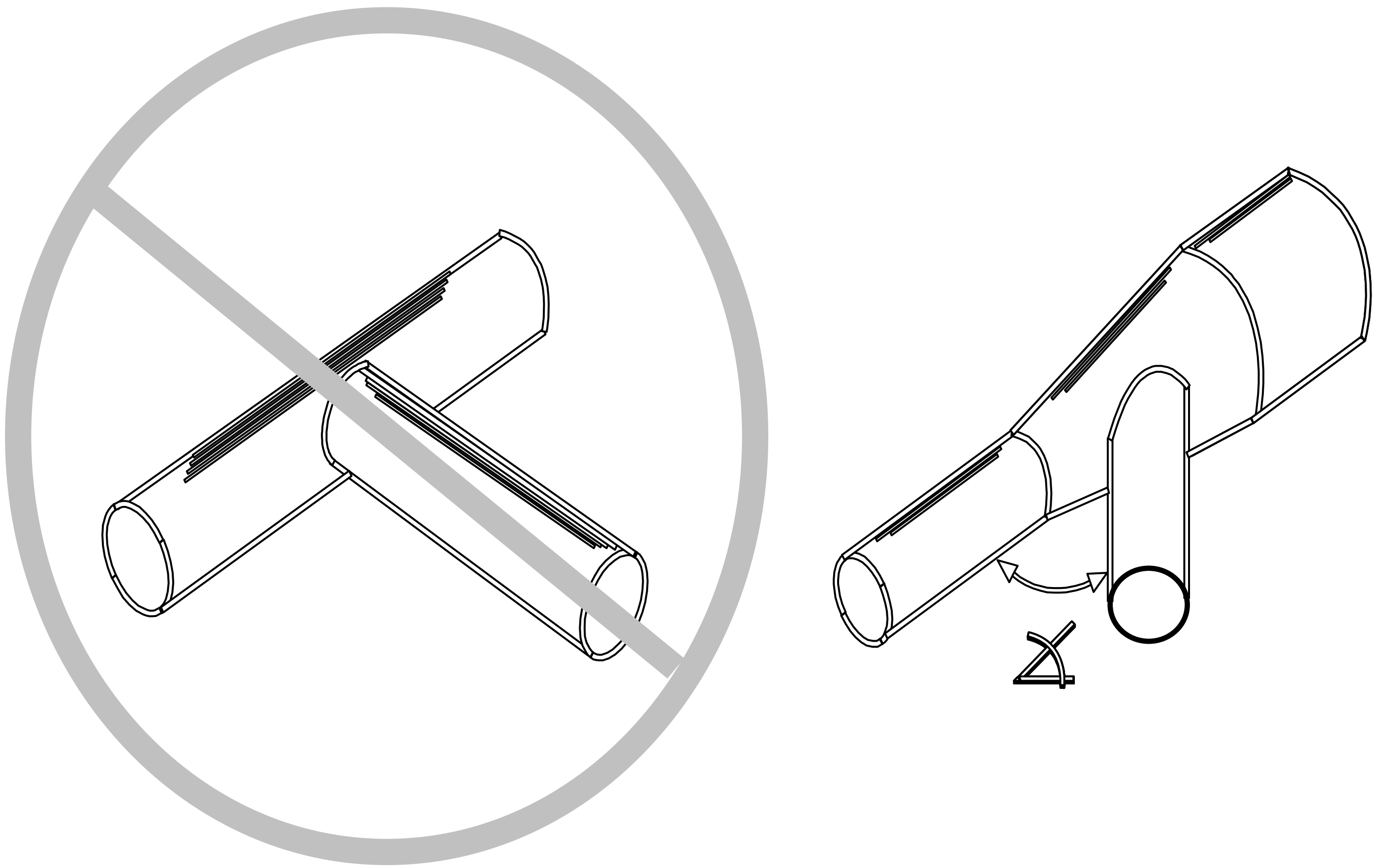


Branch Entries

F_{en} is a function of Angle of Entry

30° and 45° are most common

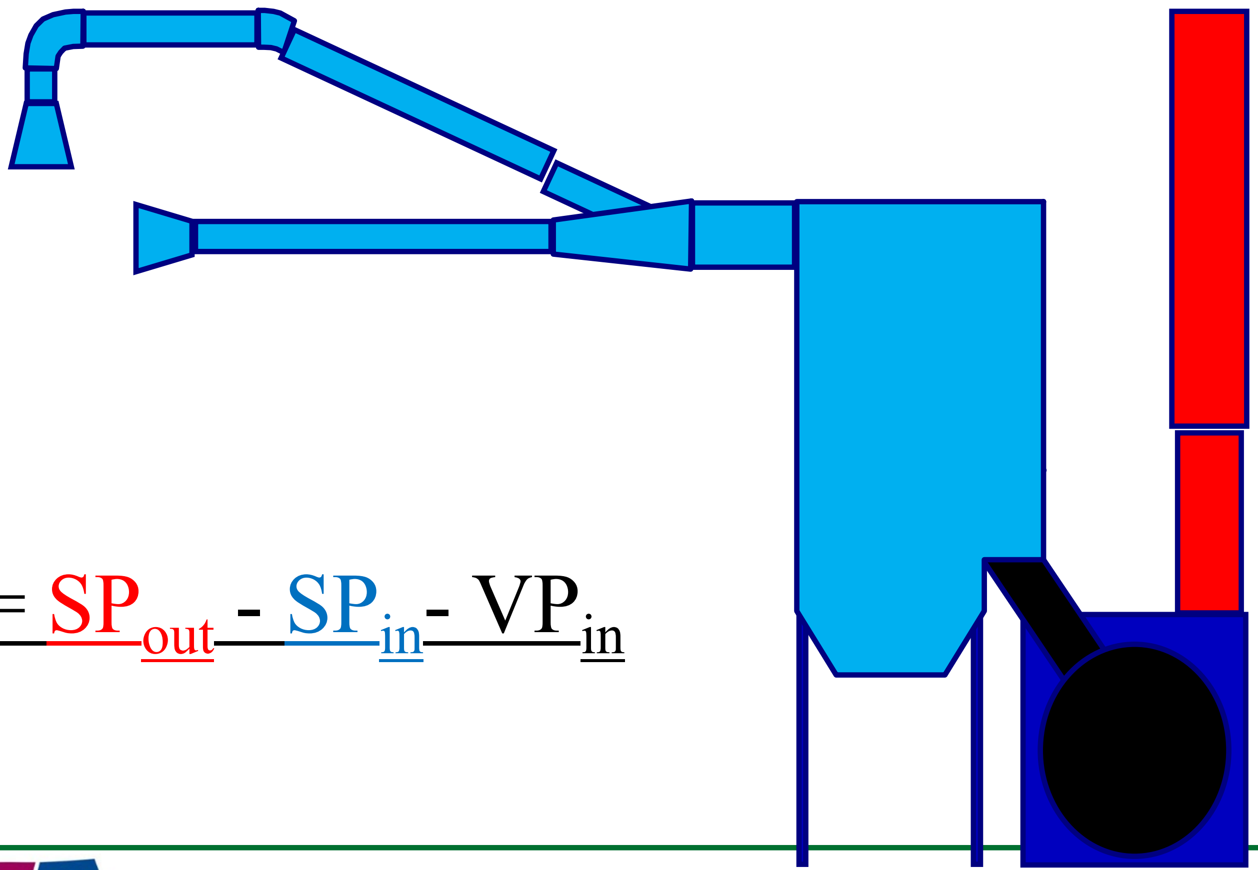
Branch Entry Design ‘F_{en}’



System Losses

- How do we use these static pressure loss calculations?
- System Static Pressure (SP_{sys}).
  - Provides the fan SP for fan selection.

System Static Pressure



$$SP_{sys} = SP_{out} - SP_{in} - VP_{in}$$

Ventilation Standards

- Most CSHO dealings with ventilation are related to the PELs
  - 1910.1000
  - 1926.55
  - Expanded health standards

- Subparts G (Occupational Health and Environmental Controls) and H (Hazardous Materials) also have ventilation-related standards

PEL Compliance

- Employers must achieve compliance with PELs by using engineering or administrative controls:
  - Elimination/substitution
  - Local exhaust ventilation
  - General exhaust ventilation
  - Work practice controls, job rotation, or other administrative controls

PEL Compliance

- Typically enforced through:
  - 29 CFR 1910.1000(e)
    - General industry (most chemicals)
  - 29 CFR 1910.1xxx
    - Expanded health standards
  - 29 CFR 1926.55(b)
    - Construction industry
  - 29 CFR 1926.1xxx
    - Expanded health standards

Ventilation

29 CFR 1910.94

- An eight-page standard that deals with three specific operations:
  - (a) Abrasive blasting
  - (b) Grinding, polishing, and buffing operations
  - (c) Spray finishing operations

Abrasive Blasting

1910.94(a)(3)(i)

- Blast-cleaning enclosures shall be exhaust ventilated in such a way that a continuous inward flow of air will be maintained at all openings in the enclosure during the blasting operation.

Abrasive Blasting

1910.94(a)(5)(ii)(a) – (c)

- Abrasive-blasting respirators shall be worn by all abrasive-blasting operators:
  - When working inside of blast-cleaning rooms, ***or***
  - When using silica sand in manual blasting operations where the nozzle and blast are not physically separated from the operator in an exhaust ventilated enclosure, ***or***
  - Where concentrations of toxic dust dispersed by the abrasive blasting may exceed the limits set in 1910.1000 and the nozzle and blast are not physically separated from the operator in an exhaust-ventilated enclosure.

Grinding, Polishing, and Buffing Operations

1910.94(b)(2)

- **"Application"**
  - Wherever dry grinding, dry polishing or buffing is performed, and employee exposure, without regard to the use of respirators, exceeds the permissible exposure limits prescribed in 1910.1000 or other sections of this part, a local exhaust ventilation system shall be provided and used to maintain employee exposures within the prescribed limits.

Spray Finishing Operations

1910.94(c)(3)(i)

- Spray booths shall be designed and constructed in accordance with 1910.107(b)(1) through (4) and (6) through (10).
  - **(a)** Lights, motors, electrical equipment, and other sources of ignition shall conform to the requirements of 1910.107 (b)(10) and (c).

Spray Finishing Operations 1910.94(c)(6)(i) –(ii)

- Except where a spray booth has an adequate air replacement system, the velocity of air into all openings of a spray booth shall be not less than that specified in Table G-10 for the operating conditions specified.

- In addition to the requirements in paragraph (c)(6)(i) of this section, the total air volume exhausted through a spray booth shall be such as to dilute solvent vapor to at least 25 percent of the lower explosive limit of the solvent being sprayed.

Ventilation Requirements

- What other OSHA standards have ventilation requirements?

Flammable and Combustible Liquids

1910.94(d)(4)(iv)

- **"Ventilation"**
  - Every inside storage room shall be provided with either a gravity or a mechanical exhaust ventilation system. Such system shall be designed to provide for a complete change of air within the room at least six times per hour. If a mechanical exhaust system is used, it shall be controlled by a switch located outside of the door.

Spray Finishing

1910.94(b)(5)(i)

- The spraying operations except electrostatic spraying operations shall be so designed, installed and maintained that the average air velocity over the open face of the booth (or booth cross section during spraying operations) shall be not less than 100 linear feet per minute.

- Electrostatic spraying operations may be conducted with an air velocity over the open face of the booth of not less than 60 linear feet per minute, or more, depending on the volume of the finishing material being applied and its flammability and explosion characteristics. Visible gauges or audible alarm or pressure activated devices shall be installed to indicate or insure that the required air velocity is maintained.

Spray Finishing

1910.107(d)(2)

- **"General"**
  - All spraying areas shall be provided with mechanical ventilation adequate to remove flammable vapors, mists, or powders to a safe location and to confine and control combustible residues so that life is not endangered. Mechanical ventilation shall be kept in operation at all times while spraying operations are being conducted and for a sufficient time thereafter to allow vapors from drying coated articles and drying finishing material residue to be exhausted.

Permit Required Confined Spaces

1910.146(c)(5)(ii)(E)

- **Alternate procedures**
  - An employee may not enter the space until the forced air ventilation has eliminated any hazardous atmosphere;
  - The forced air ventilation shall be so directed as to ventilate the immediate areas where an employee is or will be present within the space and shall continue until all employees have left the space;
  - The air supply for the forced air ventilation shall be from a clean source and may not increase the hazards in the space.

Cotton Dust

1910.1043(e)(4)

- **Mechanical ventilation**
  - When mechanical ventilation is used to control exposure, measurements which demonstrate the effectiveness of the system to control exposure, such as **capture velocity, duct velocity, or static pressure** shall be made at reasonable intervals.

Lead

1910.1025(e)(4)(i)

- **Mechanical ventilation**
  - When ventilation is used to control exposure, measurements which demonstrate the effectiveness of the system in controlling exposure, such as **capture velocity, duct velocity, or static pressure** shall be made at least every 3 months.
  - Measurements of the system's effectiveness in controlling exposure shall be made within 5 days of any change in production, process, or control which might result in a change in employee exposure to lead.

Summary

- Discussed applicable standards and how ventilation is typically cited by CSHOs
- Covered the basics of industrial (local exhaust) ventilation
- Overview of information required to work through some ventilation calculations and design problems

Thank You For Attending!

Final Questions?

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