INDIANA DEPARTMENT OF LABOR

Brad Freeman, CIH, CSP Gary Hulbert, CHMM, CSP

Spray Finishing

Objectives

- Definitions
- OSHA and NFPA regulations that apply to spray finishing
- Types of spray booths
- Components of a spray booth
- Determining proper equipment setup in a spray booth
- Personal Protective Equipment
- General Safety Principles

Definitions

- **Spray-finishing operation:** The employment of methods wherein organic or inorganic materials are utilized in dispersed form for deposit on surfaces to be coated, treated, or cleaned.
  - Spray finishing can be conducted in a spray booth, spray room, or spray area.

Definitions

- **Spray room:** A spray room is a room in which spray-finishing operations not conducted in a spray booth are performed separately from other areas. ***1910.94(c)(1)(iii)***
- **Spray booth:** A power-ventilated structure provided to enclose or accommodate a spraying operation to confine and limit the escape of spray, vapor, and residue, and to safely conduct or direct them to an exhaust system. ***1910.94(c)(1)(ii)***

Definitions

- **Spraying area:** Any area in which dangerous quantities of flammable vapors or mists, or combustible residues, dusts, or deposits are present due to the operation of spraying processes.

  1910.107(a)(2)

- **Exhaust ventilation system:** A system for removing contaminated air from a space, comprising two or more of the following elements (a) enclosure or hood, (b) duct work, (c) dust collecting equipment, (d) exhauster, and (e) discharge stack.

Difference Between Spray Booth and Spray Room

- From the definitions provided and the wide range of spray booth sizes, a spray booth and a spray room could be treated as same under certain conditions; for example, in most cases where the employee could enter the face of the booth.
- Spray room, spray booth, interior of exhaust plenum or duct, and areas is direct path of spray are spray areas.

Hazards of Spray Finishing

- Fire and explosions from using flammable and combustible liquids.
- Employee potential exposures to toxic chemicals.

Standards That Apply to Spray Finishing

- 1910.94(c) – Ventilation (based on ANSI Z9.3-1970)
- 1910.107 – Spray Finishing Using Flammable and Combustible Materials
- NFPA 33-1969)
- 1910.307 – Hazardous (Classified) Electrical Locations
- NFPA 33- 2007 – Spray Application Using Flammable and Combustible Materials
- NFPA 70-1990 2005 – National Electrical Code (NEC)
- ANSI/AIHA Z9.3-1994 – Spray Finishing Operations – Safety Code for Design, Construction, and Ventilation

NFPA 33

- Standard is intended to provide requirements for fire safety. Only fire and explosion hazards are addressed, not toxicity.
- NFPA covers 18 chapters of standards applicable to spray finishing as well as appendices A-E.
- According to a federal OSHA interpretation:
  - If a state or local public safety agency or official, such as a fire marshal, enforces the NFPA 33 requirements for electrical safety, ventilation, and fire protection, your client would have to comply with them if they were equivalent to, or more protective than 1910.107.

Vehicle Undercoating and Body Lining

- According to NFPA 33 14.1:
  - These processes are exempt from requirements if:
    - Adequate natural or mechanical ventilation;
    - Undercoating materials not more hazardous than kerosene;
    - Materials use solvents with flash point over 100 degrees F;
    - No open flames or ovens within 20 feet.
    - 1910.107(k) pertains to automobile undercoating in garages.

1910.94 Ventilation

- The standard for ventilation of spray finishing operations, 29 CFR 1910.94(c), was derived from ANSI Z9.3-1964, Design, Construction, and Ventilation of Spray Finishing Operations.
- Therefore, 29 CFR §1910.94 and its source standard, ANSI Z9.3, have the purpose of protecting employees from health hazards associated with spray finishing operations, whereas 29 CFR §1910.107 and its source standard, NFPA 33, address the explosion and flammability hazards of these operations.
- As a result, if there are health hazards associated with vehicle body lining operations, such as exposure to di-isocyanates, then it is possible that, even though a spray booth or room would not be required because of an employer's compliance with NFPA 33-2003, the presence of the health hazard would still necessitate a spray booth or room as required by 29 CFR §1910.94(c).

Do I Need a Spray Booth or Room

- **Scenario:**
  - Spraying water-based coating that has some toxic properties
  - Air monitoring indicates no overexposures to employees
  - Use approximately 18 gallons of coating per week

Question:

Should the determination whether to perform the spray operation in a booth be based on the employee's level of exposure to the hazardous chemicals in the paint or the mere presence of a hazardous chemical in the paint?

Do I Need a Spray Booth or Room

- **Answer:**
  - According to 1910.94(c) – Scope: Spray booths or spray finishing rooms are to be used to enclose or confine all spray finishing operations covered by this paragraph.
  - The source of the spray finishing portion of the ventilation standard is ANSI Z9.3-1971.
  - ANSI Z9.3-1971 states: This standard is intended to protect the health of personnel from injurious effects of *contact* with gases, vapors, mists, dusts, or solvents used in, created, released, or disseminated by spray finishing operations.
  - So the answer is that it is the presence of a toxic chemical which creates the possibility of injurious effects.

OSHA Interpretation dated March 28, 2008

1910.107 and NFPA 33 General Requirements

- Spraying areas posted with a conspicuous sign reading "No Smoking“. [1910.107(g)(7)] [NFPA 33 10.11]
- An adequate supply of portable fire extinguishers near all spraying areas. [1910.107(f)(4)]
- Clothing contaminated with spray material, kept off premises overnight or stored in metal lockers. [NFPA 33 10.6]
- Approved metal waste cans with self-closing lids provided wherever rags or waste are impregnated with finishing material. All such rags or waste deposited there immediately after use. [NFPA 33 10.5.1] [OSHA 1910.107(g)(3)]

1910.107 and NFPA 33 General Requirements

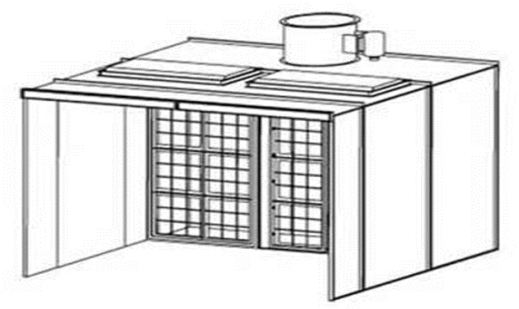
- Operator training documented. [NFPA 18.1.4]
- All personnel involved in spray operations trained in the following:
  - Potential safety and health hazards
  - Operational, maintenance, and emergency procedures
  - Importance of operator awareness [NFPA 33 18.1]
- Spray booths substantially constructed with securely and rigidly supported non-combustible material or covered with non-combustible material. [1910.107(b)(1)] [NFPA 33 5.1]
- The floor constructed of or covered with noncombustible material. [1910.94(c)(3)(iii)] [NFPA 33 5.1.2]

1910.107 and NFPA 33 General Requirements

- Spray booth interiors smooth and continuous, without edges, and designed to prevent accumulation of residues. [1910.107(b)(2)] [NFPA 33 5.1]
- Spraying operations and booths separated from other operations by at least three feet or a partition or wall to reduce the hazard. [1910.107(b)(8)] [NFPA 33 5.3]
- Spray booths installed so that all portions are readily accessible for cleaning. [NFPA 33 5.3.1]
- Portable light units restricted from use in the spray area. [1910.107(b)(10)] [NFPA 33 6.9]
- All motors, wiring, and lighting fixtures that are not separated by a partition and located within 20 feet from spray finishing operations explosion proof. [1910.94(c)(3) and 1910.107(c)(6)] [NFPA 33 6.2.6]

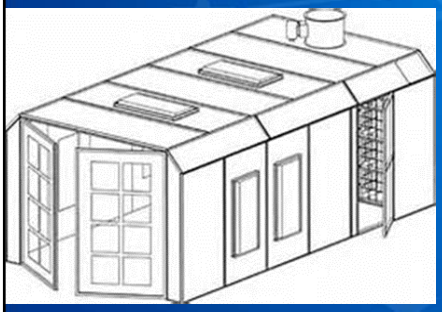
Types of Spray Booths

- Spray booths are defined by the type of airflow they use to collect overspray.
- **Open front booths:** Open front booths are not fully enclosed. Three walls and a ceiling contain the overspray and fumes, and a fan in the back wall draws room air past the work area and out through an exhaust filter.



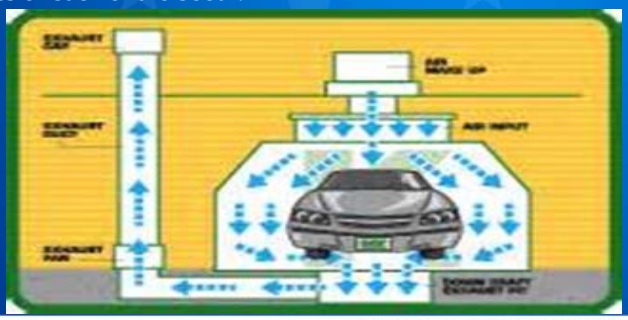
Types of Spray Booths

- **Crossflow booths:** Fully enclosed booths use a horizontal stream of air to collect fumes and particles. An intake filter on one side cleans incoming air, and an exhaust filter cleans it again before it's vented outside the booth.



Types of Spray Booths

- **Downdraft booths:** Downdraft booths are fully enclosed just like crossflow booths. However, incoming air is drawn through ceiling-mounted filters. There are several variations on the downdraft design: some use pits below the floor to draw air straight down, while others use "semi-downdraft" or "side downdraft" designs that pull incoming air down and to the sides or back of the booth.



Components of a Spray Booth

- Exhaust working chamber
- Intake
- Make-up air
- Accessories

Components of a Spray Booth

Exhaust working chamber

The Exhaust Fan

- The exhaust fan is the heart of any spray booth.

Exhaust Ducts

Inlet Fan

Components of a Spray Booth

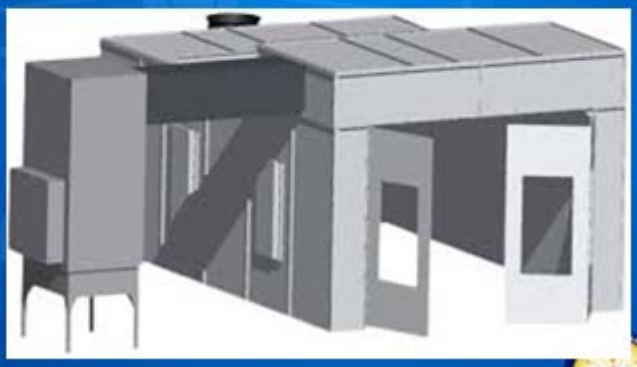
- Intake filters

Components of a Spray Booth

- Make up Air

Air Make Up Continued

- Temperature
- Volume of air
- Filtered air



Spray Booth Accessories

Accessories:
Turntables
Draft gauges
Spray booth scrapers
Conveyor systems
Spray gun rack and shelf
Interlocks

Other Accessories

Turntable

Other Accessories

Lighting

- When it comes to lighting, regulatory agencies require that booth light fixtures be approved for Class I, Division II, Groups A-D.

Maintenance/Cleaning

- Cleanliness is important
- Filter overspray
- Baffle booths
- Fan and V belt

Paint Residue

Sprinklers

Maintenance/Cleaning

OSHA Injury Report

On July 5, 2010, two subcontractors were critically injured due to a flash fire while cleaning an enclosed paint booth. One worker received burns to over 80% of her body. She was taken to Vanderbilt University Medical Center where she had to undergo many surgeries and skin grafts. The second employee received third degree burns to the arms and face.

Why Monitor Spray Booth Filters Using a Manometer

- The manometer allows you to use the filters to the maximum rating of the filters' loads.
- The manometer indicates the pressure difference across the filters.
- If there are no filters in the filter bank, there will be no pressure difference between the front of and behind the filter bank.
- Not monitoring your filter loading can mean you are changing your filters too often or damaging other parts of your spray booth by improper exhaust of solvents, excessive strain on the exhaust fan and motor, or possible spontaneous combustion from the build up of heat from the drying paint

Monometers

Calibrating a Manometer

- Fill the manometer with the fluid (often red) that comes with the tool.
- With the spray booth off, adjust the manometer to read zero by turning the knob on the side of the manometer.
- Start the ventilation with clean filters and observe the rise of the manometer reading. This reading should be marked with a green arrow. It represents that there is no resistance to the air flow through the spray booth filters.
- Add .30 to .50 to this reading (depending on the spray booth filter manufacturer's recommendation) and mark this reading with a red arrow. This reading represents when the spray booth filters are dirty or loaded and need replacing. When you reach the red arrow, it's time to replace the filters.

How to Size Exhaust Fan for Spray Booth

- Multiply the width times the height of the spray booth to get the booth face area.
- Multiply the booth face area by the velocity desired (never less than 100 feet per minute (FPM), generally 125 to 200 FPM).
- NFPA 33, 1995 edition, Spray Application Using Flammable or Combustible Materials, paragraph 5-2, which requires that "each spray area be provided with mechanical ventilation that is capable of confining and removing vapors and mists to a safe location and is capable of confining and controlling velocity.

How to Size Exhaust Fan for Spray Booth

- Combustible residues, dusts, and deposits. The concentration of vapors and mists in the exhaust stream of the ventilation system shall not exceed 25% of the lower flammable limit.“
- Air Velocity (Feet per Minute – FPM)
- Air Volume (Cubic feet per Minute – CFM)
- CFM = Booth Face Area in square feet multiplied by the required flow (typically 100 FPM)
- For example, and 8 X 10 filter bank (80 square feet) would require an exhaust of 8000 CFM (100 X 80) to achieve the required 100 FPM

How to Determine Air Flow

- 1910.94(c)(6)(ii)
- 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.
- Example: To determine the lower explosive limits of the most common solvents used in spray finishing, see Table G-11. Column 1 gives the number of cubic feet of vapor per gallon of solvent and column 2 gives the lower explosive limit (LEL) in percentage by volume of air. Note that the quantity of solvent will be diminished by the quantity of solids and nonflammables contained in the finish.
- To determine the volume of air in cubic feet necessary to dilute the vapor from 1 gallon of solvent to 25 percent of the lower explosive limit, apply the following formula: Dilution volume required per gallon of solvent = 4 (100 - LEL) (cubic feet of vapor per gallon) divided by LEL .

Respiratory Protection

- A written statement of company policy, including assignment of individual responsibility, accountability, and authority for required activities of the respiratory protection program.
- Written standard operating procedures governing the selection and use of respirators.
- Respirator selection (from NIOSH/MSHA approved and certified models) on the basis of hazards to which the worker is exposed.
- Medical evaluation to determine if employees are medically able to wear respirators.

Respiratory Protection

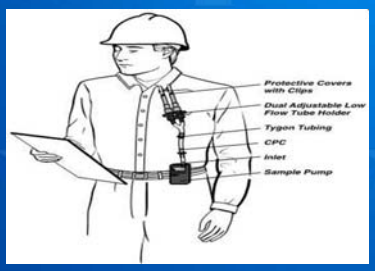
- Employee training in the proper use and limitations of respirators (as well as a way to evaluate the skill and knowledge obtained by the worker through training).
- Respirator fit testing.
- Regular cleaning and disinfecting of respirators.
- Routine inspection of respirators during cleaning, and at least once a month and after each use for those respirators designated for emergency use

Respiratory Protection

- Storage of respirators in convenient, clean, and sanitary locations.
- Surveillance of work area conditions and degree of employee exposure (e.g., through air monitoring).
- Regular inspection and evaluation of the continued effectiveness of the program

Types of Air Monitoring for Solvents

- Personal air-sampling pumps are a little difficult to use. They consist of a small pump that pulls a constant amount of air (usually in liters per minute), a charcoal tube or filter cassette, and a clip for attaching the collection media near the worker's breathing zone.
- Sampling media for solvents: 100/50 Charcoal tube with a flow rate of 0.2 l/min and a maximum volume of 10 liters.



General Safety Principles

- Spray booth interiors will be kept clean with 3 feet on all sides of the booth clear of storage and combustible materials
- Spray booths will be illuminated by approved protective lighting devices
- All spraying areas will be equipped with mechanical ventilation adequate to remove flammable vapors, mists, or powders to a safe location
- Respirators are required for any spray finishing other than very minor touch-up procedures
- Storage of flammables and combustibles will comply with 1910.106, Flammable and Combustible Liquids
- All cleaning solvents will be restricted to those having flashpoints of not less than 100 degrees (F)

Conclusion

- Discussed :
  - Applicable definitions
  - OSHA and NFPA regulations that apply to spray finishing
  - Types of spray booths
  - Components of a spray booth
  - Determining proper equipment setup in a spray booth
  - Personal Protective Equipment

INSafe Consultation Service

Indiana Department of Labor
402 West Washington Street, Room W195
Indianapolis, Indiana 46204
(317) 232-2655

insafe@dol.in.gov

INSafe
Indiana's Worker Safety Initiative