

HOW TO DESIGN THE PERFECT SPRAY BOOTH

WHILE AVOIDING CODE VIOLATIONS

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INTRODUCTION

Today, manufacturers, or part finishers, must discover ways to avoid costly mistakes and design the perfect spray booth that fits their paint finishing requirements. Too many times companies assume a design of their booth for their finishing application and move too quickly into ordering rather than designing – this is costly, in time and money, from installation to operations. And the proper *design* for the booth must take into account all the applicable booth code requirements that affect operator and plant safety – and there are many.

THE “PERFECT” SPRAY BOOTH MUST ADDRESS THE THREE ESSENTIALS OF A SPRAY BOOTH SOLUTION...

1. Protecting employees and facilities at all times from a hazardous environment
2. Providing a spray environment in which to obtain the highest quality finish
3. Realizing and sustaining measurable cost reductions and optimizations from spray booth operations.

In this 3-Part presentation, titled ***“How to design the perfect spray booth while avoiding code violations”***, we reinforce the ultimate spray booth design objectives listed above, and then apply the codes that might affect optimal booth designs. The booth designer must protect the best design choice when codes are considered; the designer’s job is to not only engineer the optimal booth environment for the best possible finish, but also ensure that all building and safety codes are followed. Codes cannot be underestimated – compliance is mandatory, from NFPA33, OSHA, IFC and building codes, and violations can be very costly. We’ll explore what aspects of booth design create the biggest risk and what happens if I violate.

01

Part 1:

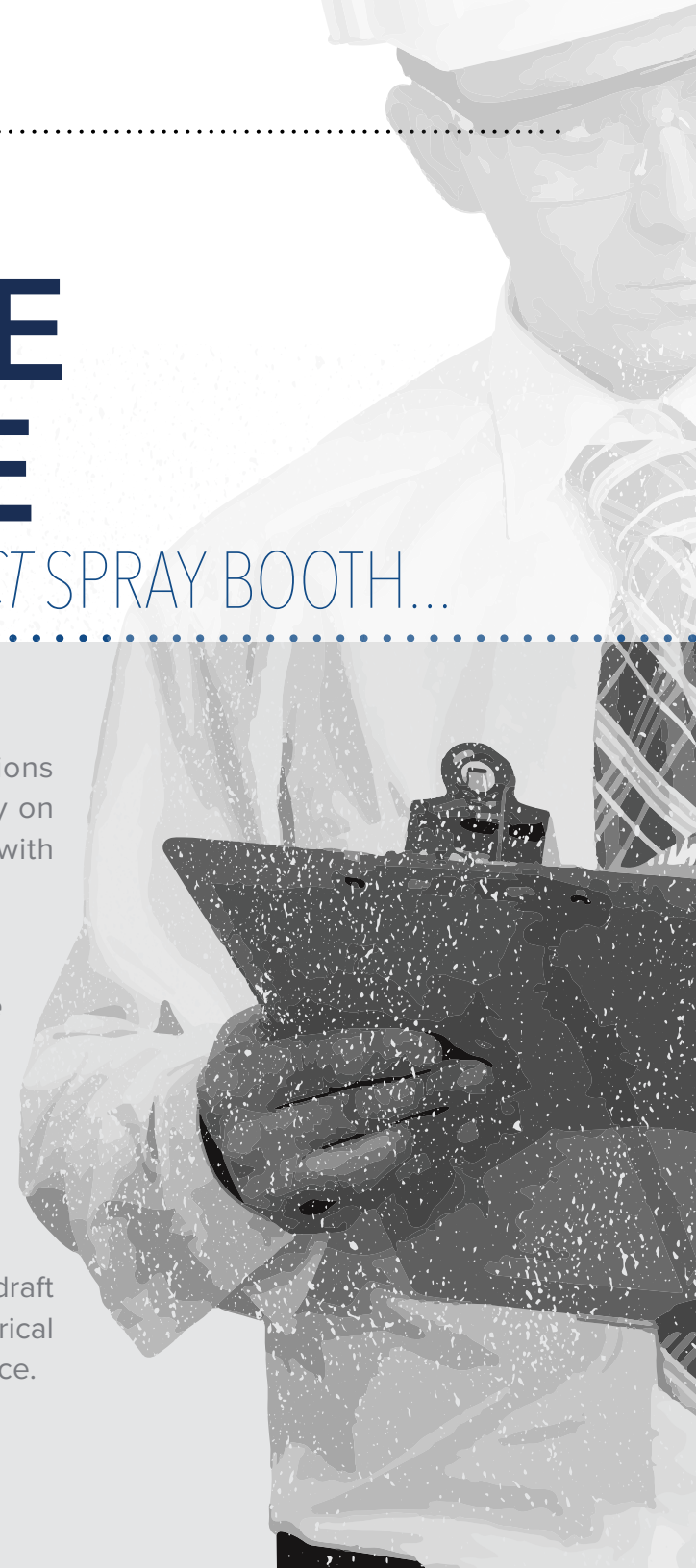
CODES HAVE THEIR PLACE

IN DESIGNING YOUR *PERFECT* SPRAY BOOTH...

Booths are highly regulated by many different agencies, as well as any other regulations that the Finisher requires within their plant – the spray environment impacts directly on operator health, personnel and plant safety, productivity, potential fire hazard, along with an overall environmental impact. Because of these important aspects, spray booths are highly scrutinized by the applicable governing agencies.

The assumption that we've heard many of our customers make too many times...*"I've got the building inspector all over me...I'm sure my booth designer will meet all required regulations."* If you don't ask the right code questions, upfront, you're assuming, dangerously.

A typical spray booth installation is much like a mini-building construction project. Not only is there the mechanical installation of the booth, but also the building interface and utility connections to the booth. Whether a small bench booth, large equipment down draft booth, or powder booth, they all require utility connections, such as wet sprinkler lines, electrical connection to building electrical sources and compressed air from a compressed air source.



NFPA (FIRE PROTECTION STANDARDS)

Plant and property safety is governed by national and local Fire Department regulations. Finisher's need to protect product inventory and the cost to replace, as well as equipment downtime due to damage, or citations issued by these regulatory agencies.

We at Spray Systems understand that the design and implementation of your spray booth can be an extremely challenging and confusing process. It is our goal to provide you with important information to help that process go as smoothly as possible. Although designing the perfect spray booth is very important, designing the booth AND complying with all the federal and local safety codes are the most important steps in ensuring the long and continued success, productivity and efficiency of your spray application. We believe that keeping all these codes in mind during the design phase is the only way to prevent any complications down the road. For this reason, we have provided a summary of important safety code sections of NFPA 33 so that you can better understand the regulatory impact of designing the perfect spray booth for you

- **NFPA 33 Spraying of Flammable Material** – 5 key chapters that effect booth design
- **NFPA 68 Explosion Protection Venting** – especially important for powder booth operations
- **NFPA 654 Handling of Combustible Particulate Solids** – especially important for powder booth operations
- **NFPA 70 National Electrical Code** – important electrical requirements for installing spray booths
- **NFPA 86 Standards for Ovens & Furnaces** – critical requirements for curing or baking parts

OSHA (OCCUPATIONAL SAFETY AND HEALTH STANDARDS)

- **Standards - 29 CFR: OSHA Regulation 1910.107** – spray finishing using flammable and combustible materials

BUILDING CODES

- **International Fire Code (IFC)** – where NFPA standards are confirmed in international code
- **International Mechanical Code (IMC)** – where local mechanical standards are confirmed in international code
- **International Building Codes (IBC)** – where local building standards are confirmed in international code

LOCAL CITY CODES

- **Authority Having Jurisdiction (AHJ)** – local inspectors having authority to assess and apply code to installation
- **UL or ETL Rated and Approved Installations (Certified in Field)** – post-installation evaluation and certification
- **NESHAP** – filter requirements ensure meeting all air pollution limits
- **State and local VOC emission limitations and regulations (BACT)** – as applied to spray booth installations

INSURANCE STANDARDS

- **FM Global** – achieving the “FM Approved” mark for meeting safety standards

02

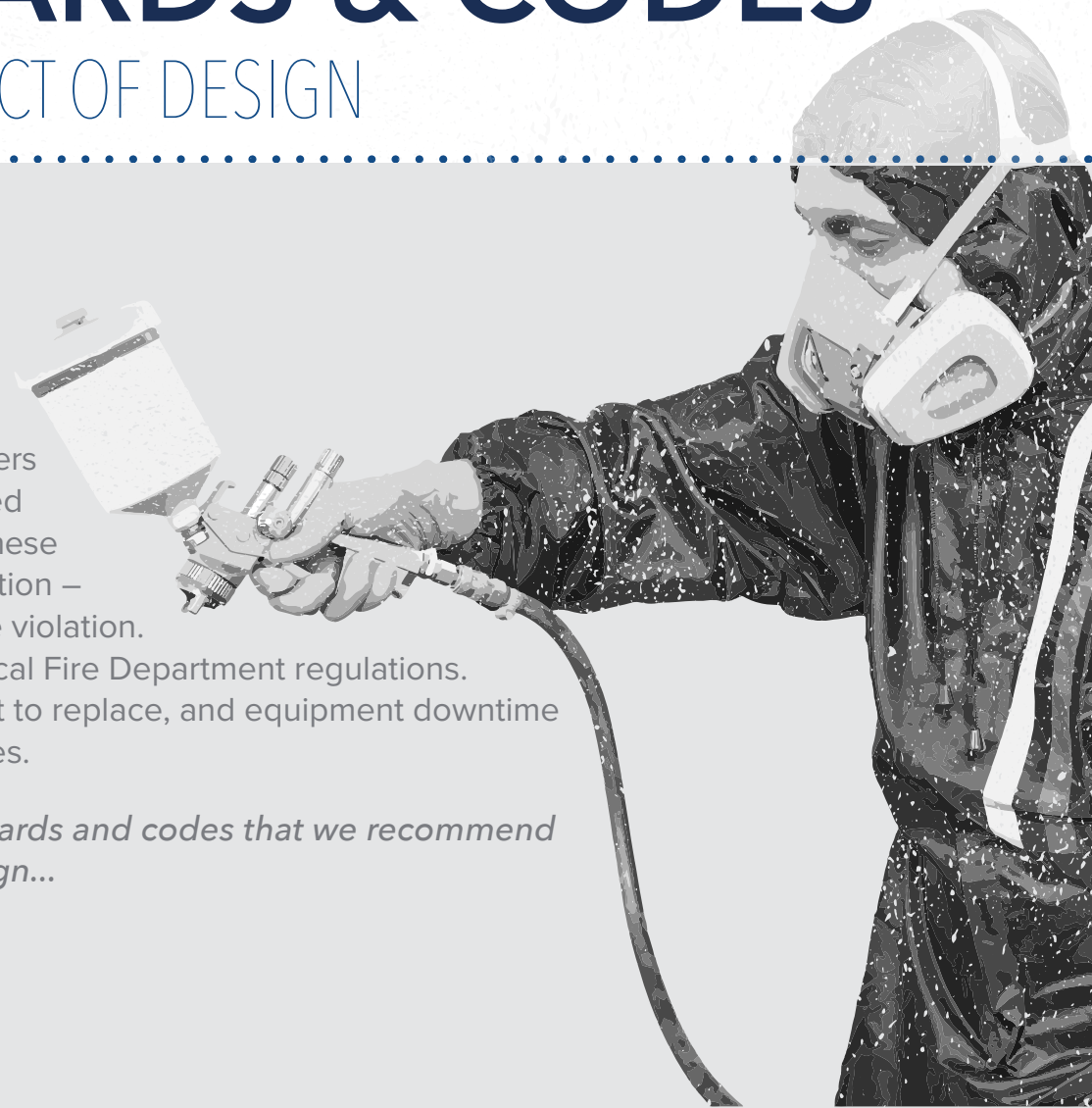
Part 2:

COMPLYING WITH ALL STANDARDS & CODES

IN EACH ASPECT OF DESIGN

The liability to your business for violation can be far-reaching. The Fabricator can't be too cavalier about these codes and standards. Too often, any code or standard violation can bring on lawsuits, whether they're initiated by agencies or employees, especially where workers compensation claims get involved. These can be avoided if the booth designer understands and appreciates how these codes can be satisfied while protecting your design solution – preventing is certainly less expensive than curing a code violation. Plant and property safety is governed by national and local Fire Department regulations. Finisher's need to protect product inventory and the cost to replace, and equipment downtime due to damage, or citations issued by regulatory agencies.

To start, here are some key highlights of agency standards and codes that we recommend you understand and apply early on in your booth design...



NFPA 33 (STANDARD FOR SPRAY APPLICATION USING FLAMMABLE OF COMBUSTIBLE MATERIALS)

(Figures and Sections reproduced with permission from NFPA 33-2018, Standard for Spray Application Using Flammable of Combustible Materials, Copyright © 2017, National Fire Protection Association, Quincy, MA 02169. This reprinted material is not the complete and official position of the NFPA on the referenced subject, which is represented only by the standard in its entirety which can be obtained through the NFPA web site at www.nfpa.org

Here are (5) key chapters from NFPA that you should know as they pertain to spray booth design and installation and are further discussed below...

- **Chapter 5:** Construction and Design of Spray Areas, Spray Rooms, and Spray Booths
- **Chapter 6:** Electrical and Other Sources of Ignition
- **Chapter 7:** Ventilation
- **Chapter 8:** Storage, Handling, and Distribution of Flammable and Combustible Liquids
- **Chapter 13:** Spray Booths and Rooms Used for Drying at Elevated Temperatures
- **Chapter 15:** Powder Coating

QUICK LOOK AT THE ESSENTIALS OF NFPA 33

CHAPTER 5: CONSTRUCTION AND DESIGN OF SPRAY AREAS, SPRAY ROOMS, AND SPRAY BOOTHS

Chapter 5 of the NFPA 33 document covers the basics of design and construction requirements of a spray paint operation. This section outlines the materials that are permitted in the construction of a spray booth with specific examples and exemptions given the location and purpose of a spray booth component. In addition to spray booth construction requirements, this section also provides guidelines for spray booth location in relation to other working operations in the same building. These requirements are paramount for the safe operation of a spray booth as well as for the ease of maintenance and filter replacement. Finally, this section

covers the allowable construction materials for illumination, observation panels, and ventilation systems.

Here are some important examples about booth construction and separation you should know:

Section 5.1.1: Walls, doors, and ceilings that intersect or enclose a spray area shall be constructed of noncombustible or limited combustible materials or assemblies and shall be securely and rigidly mounted or fastened. The interior surfaces of the spray area shall be smooth, designed and installed to prevent pockets that can trap residues, and designed to facilitate ventilation and cleaning.

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installed to prevent pockets that can trap residues, and designed to facilitate ventilation and cleaning.

Section 5.5: Separation from Other Operations. Spray booths shall be separated from other operations by a minimum distance of 915 mm (3 ft) or by a partition, wall, or floor/ceiling assembly having a minimum fire resistance rating of 1 hour; multiple connected spray booths shall not be considered as “other operations” except as provided for in Section 13.3.

The following are other sections in Chapter Five that address the Construction and Design of Spray Areas and Spray Booths. You can review these fully from our website at: spraysystems.com

- Outlines materials allowed/not allowed in spray booth construction.
 - Provides specific exemptions.
- Requirements for conveyor openings.
- Requirements for booths using nitrocellulose.
- Required distances between spray operations.
 - Clear areas around spray booths and other operations.
- Outlines requirements for glass covering lighting and observation windows.
- General filter requirements.
- Restrictions on filters being used for multiple materials that are highly combustible.

CHAPTER 6: ELECTRICAL AND OTHER SOURCES OF IGNITION

Chapter 6 of NFPA 33 lists the requirements and restrictions for electrical wiring and spark-producing materials that are allowed within a spray paint booth area. The first section defines the applicable zoning system as well as class/division determination. This section is very important in spray booth electrical design as it provides an in-depth description of electrical area classification. Similar to Chapter 5, this chapter covers restrictions on the electrical equipment that is permitted to be within certain areas surrounding a spray booth. Figures (or sketches) are provided that show specific areas where electrical equipment can/cannot be located.

Here are examples of some important electrical requirements you should know:

6.2.5: Open flames, spark-producing equipment or processes, and equipment whose exposed surfaces exceed the autoignition temperature of the material being sprayed shall not be located in a spray area or in any surrounding area that is classified as Division 2, Zone 2, or Zone 22.

6.2.6: Any utilization equipment or apparatus that is capable of producing sparks or particles of hot metal and that is located above or adjacent to either the spray area or the surrounding Division 2, Zone 2, or Zone 22 areas shall be of the totally enclosed type or shall be constructed to prevent the escape of sparks or particles of hot metal.

6.5.2: Electrical area classification NFPA-33, confirms that if spray application operations are conducted within a closed-top, open-face or open-front booth or room, as shown in Figure 6.5.2, any electrical wiring or utilization equipment located outside the booth or room but within 915mm (3 ft) of

QUICK LOOK AT THE ESSENTIALS OF NFPA 33

any opening shall be suitable for Class I, Division 2; Class I, Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable.

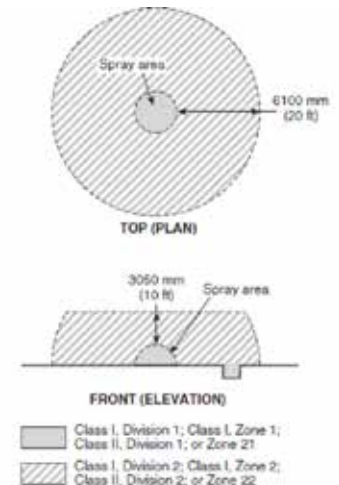
6.6.1: Luminaires, like that shown in Figure 6.6.1, that are attached to the walls or ceiling of a spray area but that are outside any classified area and are separated from the spray area by glass panels that meet the requirements of Section 5.6 shall be suitable for use in unclassified locations. Such fixtures shall be serviced from outside the spray area.

Also covered in this chapter is the requirement to ground all electrically conductive objects in a spray area.

- Zoning system is described and restrictions on class/division location are provided.
- Restrictions on spark producing equipment and/or processes.
- In depth description of electrical area classification.
- Electrical wiring and equipment allowed/not allowed within a spray booth setting.
- Electrical wiring and equipment allowed/not allowed in areas adjacent to a spray booth setting.
- Drawings provided to show areas within/adjacent to a spray booth where electrical restrictions apply.
- Guidelines for luminaires located within a spray booth.
- Guidelines for grounding all electrically conductive objects in a spray area.

CHAPTER 7: VENTILATION

Chapter 7 of NFPA 33 outlines the most important requirements of spray booth ventilation. The three main topics covered in this section are powder coating systems, make-up air, and recirculated air. For each of these, the minimum performance requirements are listed as well as general information on when each of these is required in spray booth design. The routing requirements of all exhaust ducts are another important section of this code. Penetrations and discharge restrictions are discussed and exact measurements are provided for reference. Exhaust duct support is another important code listed in this section. The code outlines the structural requirements of any component that is meant to hold exhaust duct in place. These requirements are meant to ensure that the duct is securely fastened to the building and need to be able to support any fire protection systems that are added. The final section of this code outlines the allowable construction materials of exhaust fans and drives as well as restrictions on where exhaust fan components can be located within a spraying operation.



Here are examples of some important ventilation requirements you should know:

7.2.3 Mechanical Ventilation. Mechanical ventilation shall be kept in operation at all times while spray operations are being conducted and for a sufficient time thereafter to allow the vapors from drying coated objects or material and residues to be exhausted. Where spray operations are conducted

QUICK LOOK AT THE ESSENTIALS OF NFPA 33

automatically without an attendant constantly on duty, the operating controls of the spray apparatus shall be arranged so that the spray apparatus cannot function unless the exhaust fans are operating.

7.5 Recirculation of Exhaust. Air exhausted from spray areas shall not be recirculated unless all of the following requirements are met...

- (1) Recirculation particulate filters as defined in this standard shall be used to remove particulates from the recirculated air.
- (2) The concentration of vapors in the exhaust airstream shall not exceed 25 percent of the lower flammable limit.
- (3) Listed equipment shall be used to monitor the concentration of vapors in all exhaust airstreams.
- (4) The equipment specified in 7.5(3) shall initiate a local alarm and shall automatically shut down the spray operation if the concentration of any vapor in the exhaust airstream exceeds 25 percent of the lower flammable limit.
- (5) All equipment installed to process and remove contaminants from the air exhausted from spray operations shall be approved by the authority having jurisdiction.
- (6) For occupied spray areas where a portion of the exhaust air is recirculated within the spray area, toxicity and worker exposures shall be addressed.

Other Performance requirements under NFPA Chapter 7 you can research are...

- Powder coating systems
- Make-up air systems
- Exhaust ducts
- Exhaust recirculation
- Heating of recirculated air
- Allowable materials of construction given the spray booth application.
- Requirements of exhaust duct support structure.
- Restrictions for construction and location of exhaust fans and drives.
- Ventilation requirements of drying rooms and enclosures.

CHAPTER 8: STORAGE, HANDLING, AND DISTRIBUTION OF FLAMMABLE AND COMBUSTIBLE LIQUIDS

Chapter 8 of NFPA 33 is very important if the medium that is being sprayed within a spray booth is flammable or combustible. This chapter is meant to ensure the safety of all personnel during the storage, mixing, and distribution phases of spraying. The general requirements for mixing paints and ventilation within a mix room are outlined. It is very important to be familiar with this code as it explains the restrictions on the amount of liquid that is permitted per day given certain circumstances. Diagrams have been provided to demonstrate the relationship between the proximity of a mix room to a paint booth and the amount of liquid that can be used during a 1-day period. Finally, this chapter covers the general rules for paint distribution and piping mechanisms. This section of NFPA 33 references other parts of the NFPA code and it is important to be familiar with all applicable codes in order to ensure a successful spraying operation.

QUICK LOOK AT THE ESSENTIALS OF NFPA 33

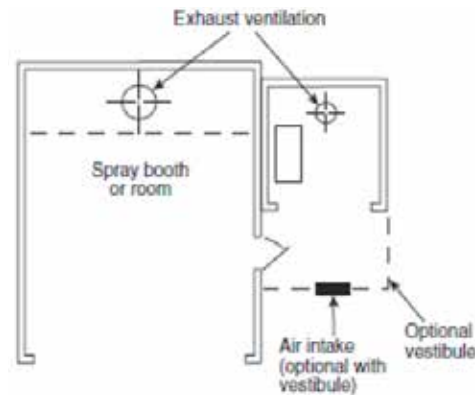
Here are examples of some important paint storage requirements you should know:

8.3.2 Where the quantities of liquids required or the floor area necessary to provide a suitable mixing room exceeds the limits specified in 8.3.3 through 8.3.6, the mixing room shall meet all applicable requirements of NFPA 30.

8.3.3 Mixing rooms shall meet all of the following requirements

- (1) Mixing rooms shall meet the construction requirement of Section 5.1.
- (2) The area of a mixing room shall not exceed 14 m (150 ft²).
- (3) If more than one mixing room is installed, the total quantity of liquids shall not exceed the limits in 8.3.5 or 8.3.6.
- (4) Mixing rooms shall be designed to contain a spill of the contents in the room.
- (5) Mixing rooms where dispensing, handling, or transferring of Class I, Class II, or Class III liquids at temperatures at or above their flash point occurs shall be provided with mechanical ventilation capable of providing air movement not less than 0.3 m³/min/m² (1 ft³/min/ft²) of floor area or 4 m³/min (150 ft³/min), whichever is greater.

8.3.5 Where a separate mixing room is provided and the mixing room is located adjacent to or within 1830 mm (6 ft) of an adjacent spray area or areas, as shown in Figure 8.3.5(a) and Figure 8.3.5(b), the combined quantities of liquids located in the spray areas and the mixing room shall not exceed 454 L (120 gal).



Maximum volumes of liquid allowed:
 Spray area, 227 L (60 gal)
 Spray area and mix room, 454 L (120 gal)

FIGURE 8.3.5(a) Mixing Room Within 1830 mm (6 ft) of Spray Area, Including Maximum Volume of Liquid Allowed.

8.3.6 Where a separate mixing room is provided, and the mixing room is located more than 1830 mm (6 ft) from an adjacent spray area or areas, the quantity of liquid permitted in the mixing room shall not exceed 80 L/m² (2 gal/ft²), up to a maximum of 1135 L (300 gal), as

shown in Figure 8.3.6. The amount of liquid in the spray area shall not exceed 227 L (60 gal).

Other Performance requirements under NFPA Chapter 8 you can research are...

- Guidelines for mixing room distribution systems.
- Piping
- General
- Maximum allowable quantities of flammable and combustible liquids allowed to be stored in each control area.
- Table provided
- Guidelines for mixing or transferring liquids.

QUICK LOOK AT THE ESSENTIALS OF NFPA 33

CHAPTER 13: SPRAY BOOTHS AND ROOMS USED FOR DRYING AT ELEVATED TEMPERATURES

Chapter 13 of NFPA 33 is all about the use of heating systems for the purpose of paint drying and curing. This is one of the most important sections to be familiar with if your spray applications involve drying at elevated temperatures. The first part of this code outlines safety requirements and fail-safes that need to be present whenever heating elements are used. There are specific requirements for flash-off areas that are present in a spraying application. This section mentions several other NFPA codes that also need to be referenced when dealing with flash-off areas. The final sections of NFPA 33 cover interconnecting doors and high temperature limit switches that automatically shut off the drying apparatus at a specified temperature. This code also references specific warning signs that need to be in place to indicate when a drying process is taking place and that can restrict access when high temperatures are involved.

Here are examples of some important drying or curing requirements you should know:

13.2 Spray Booths and Spray Rooms Used for Ambient Air Drying. If a spray booth or spray room is also used for air-drying, curing, or fusing operations and the air temperature therein is not elevated above ambient conditions, the ventilation system shall maintain the concentration of any vapors in the exhaust stream below 25 percent of the lower flammable limit. If the temperature in the spray area is elevated for the purpose of accelerating the drying or curing process, then the requirements of Section 13.3 shall apply.

13.3* Spray Booths and Spray Rooms Used for Drying at Elevated Temperatures.

13.3.1 Spray booths or spray rooms used for batch-

type spray application operations, including automobile refinishing operations, shall be permitted to be used alternately for drying, curing, or fusing operations, provided they meet all applicable requirements of this standard and the requirements of NFPA 86 as well as the requirements of 13.3.1.1 through 13.3.1.8.

Other Performance requirements under NFPA Chapter 13 you can research are...

- Guidelines for ambient air drying.
- Guidelines for spray booths and rooms used for drying at elevated temperatures.
- Requirements for Flash-Off Areas.
- Requirements for spray operations connected to or adjacent to drying, curing, or fusing operations.
- Fusion apparatus ventilation guidelines.
- Requirements for drying, curing, and fusion warning signs.

CHAPTER 15: POWDER COATING

Chapter 15 of NFPA 33 covers the general requirements for powder coating applications. Diagrams have been provided to that show the restrictions on where powder coating booths can be located in relation to other spraying applications and general working operations. Powder coating applications require specific safety protections systems. These are introduced in this section with references to other codes that give more specific instruction on these requirements. For powder coating booths that include automation, this section covers the requirements for emergency shutdown protocols, ventilation systems, automatic sprinkler systems, and the need for portable fire extinguishers. Electrical wiring, dust collection, and explosion protection requirements

QUICK LOOK AT THE ESSENTIALS OF NFPA 33

are covered. In addition to operation guidelines, this section also elaborates on paint booth maintenance. This includes, powder unloading, bag dumping stations, and spill cleanup.

Here are examples of some important powder coating ventilation requirements you should know:

15.6 Enclosures. Powder shall be confined by conducting coating operations within one of the following:

- (1) A completely enclosed, ventilated room of noncombustible or limited-combustible construction with smooth surfaces designed to prevent accumulation of powder and to facilitate cleaning
- (2) A ventilated spray booth meeting the requirements of Section 5.1 through Section 5.7, and having enclosed, ventilated containers (tanks, bins, etc.)

15.8.2 Air Exhausted. Air exhausted from the recovery system of a powder operation shall not be recirculated unless the concentration of particulate matter in the exhaust air has been reduced to a level that is considered safe for personnel occupational exposure and equipment continuously monitors the filtration system to signal the operator and to automatically shut down the operation in the event the filtration system fails to maintain the air in this condition. You should know that you can recirculate your powder booth back into the plant, which makes powder applications so efficient – no make-up air.

Other Performance requirements under NFPA 33 Chapter 15 you can research are...

- Restrictions on powder coating booth locations.
- General safety and protection requirements.

- Description of required safety protection systems.
- Guidelines for automated spray operation.
 - Emergency shutdown
 - Ventilation systems
 - Automatic sprinkler systems
 - Need for portable fire extinguishers
- Protection guidelines for automated powder application equipment.
- Guidelines for electrical wiring and other sources of ignition within a powder coating enclosure.
- Guidelines for ventilation, dust collection, and explosion protection.
- Operation and maintenance requirements.
- Automated/handheld electrostatic powder spraying equipment.
 - Hot flocking
 - Fluid bed coating
- Requirements for powder coating delivery and circulation.
- Requirements for powder unloading, bag dumping stations, and pneumatic conveying systems.
- Storage and handling guidelines.
- Housekeeping guidelines.
 - Spill clean up

Here are some other NFPA codes and standards that apply to spray booths. Please refer to the complete edition for specific standards as they apply to your booth design...

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NFPA 68 Standard on Explosion Protection by Deflagration Venting. This standard applies to the design, location, installation, maintenance, and use of devices and systems that vent the combustion gases and pressures resulting from a deflagration within an enclosure so that structural and mechanical damage is minimized.

NFPA 70®: National Electrical Code®. Broadly covers the workplace in this 800+ page code. Safety requirements for Special Equipment can be found in Chapter 3. NFPA-70 also outlines a documented system of electrical safety principles and procedures that directs activities for the risk associated with electrical hazards. Article 105 address the application of safety-related work practices and procedures and Article 120 addresses establishing an electrically safe work condition.

NFPA 86: Standards for Ovens and Furnaces. This standard shall apply to Class A, Class B, Class C, and Class D ovens,

dryers, and furnaces; thermal oxidizers; and any other heated enclosure used for processing of materials and related equipment...Class A ovens and furnaces (specifically for spray booths) are heat utilization equipment operating at approximately atmospheric pressure, wherein there is a potential explosion or fire hazard that could be occasioned by the presence of flammable volatiles or combustible materials processed or heated in the furnace. Such flammable volatiles or combustible materials can originate from any of the following...paints, powders, inks, and adhesives from finishing processes, such as dipped, coated, sprayed, and impregnated materials.

Note: NFPA 70® and National Electrical Code® are registered trademarks of the National Fire Protection Association, Quincy, MA

OSHA (29 CFR: OSHA REGULATION 1910.107) SPRAY FINISHING USING FLAMMABLE AND COMBUSTIBLE MATERIALS

Employee safety is addressed by OSHA under section CFR-1910. These OSHA requirements not only cover personnel and operator safety but also address special guidelines for the operator which directly affect the design of the spray booth. Items such as emergency egress, proper airflow, storage of paint, minimum clearances are all items addressed in this code.

Here are examples of 29 CFR requirements you should know...

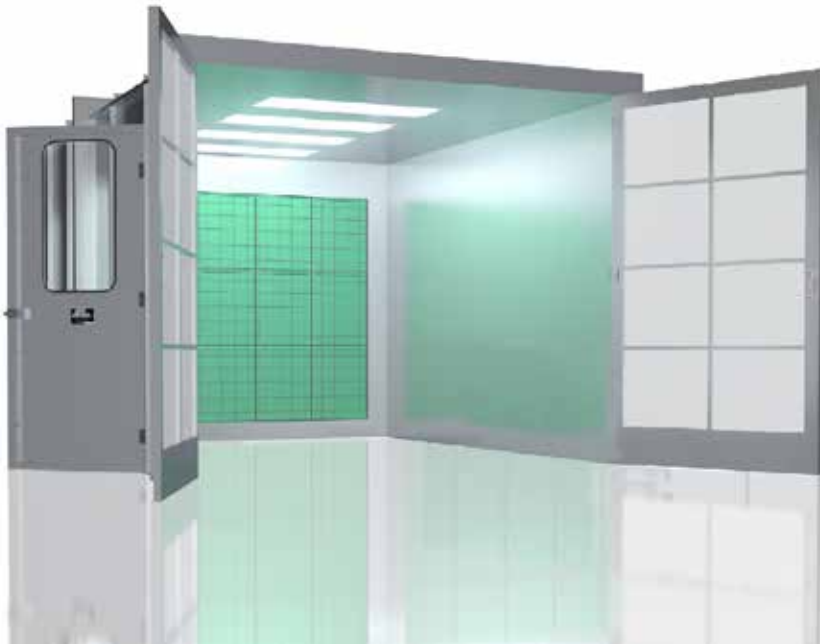
- **Spray Booth Construction, 1910.107(b)(1).** This states that spray booths shall be substantially constructed of steel, securely and rigidly supported, or of concrete or masonry except that aluminum or other substantial noncombustible material may be used for intermittent or low volume spraying. Spray booths shall be designed to sweep air currents toward the exhaust outlet.
- **Fan Noise Level, 1910.95a.** This requires that protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table G-16 when measured on the A scale of a standard sound level meter at slow response...

TABLE G-16 - PERMISSIBLE NOISE EXPOSURES (1)

Duration per day, hours Sound level dBA slow response			
8.....	90	1 1/2	102
6.....	92	1.....	105
4.....	95	1/2	110
3.....	97	1/4 or less.....	115
2.....	100		

LOCAL BUILDING CODES

Utility and building interface necessities will require building permits from the local city or municipality. In addition to utility connections from building sources to the booth, there are mechanical interfaces with the building – roof openings, roof curbs, grounding requirements – and sometimes will cover building space and distance minimums, depending on booth location. Specifically, International Fire Code (IFC) Chapter 24 provides requirements that govern operations where flammable or combustible finishes are applied by spraying, dipping, powder coating or flow-coating processes. As with all operations involving flammable or combustible liquids and combustible dust or vapors, controlling ignition sources and methods of reducing or controlling flammable vapors or combustible dust at or near these operations are emphasized.



Here are examples of IFC Section 2403 requirements you should know...

- **Spray Finishing, IFC-2404.3.3.5.** Spray booths shall be installed so that all parts of the booth are able to be accessed for cleaning. A clear space of not less than 3' shall be maintained on all sides of the spray booth. This clear space shall be kept free of any storage or combustible construction.
- **Protection of Operations, IFC-2403.2.1.1.** This mandates that all electrical wiring and equipment in flammable vapor areas shall be on an explosion proof type approved for use in such hazardous locations. Such areas shall be considered to be Class I, Division 1 or Class II, Division 1 hazardous locations in accordance with NFPA 70.

LOCAL CITY CODES

Sometimes third-party certification such as UL or ETL approvals are required to meet local codes. This requirement is based solely on local City and State requirements and codes. Due to the nature of a spray booth installation, a local testing agency such as ETL or UL (third party nationally recognized testing agency) can inspect the booth's equipment components and installation to acquire this certification. There is a charge to have the agency review the booth's documentation and installation. Lastly, state and local requirements will require an air pollution permit based on the VOC emissions for your particular booth installation. Each state and geographical region has certain VOC emission restrictions in order to meet federal EPA guidelines and requirements. Check with you state and local air pollution authority for the emission requirement that will affect your booth installation.

INSURANCE CODES

Manufacturers must address the specific requirements within their own insurance liability coverages. Many insurance companies follow the same guidelines and regulations required by local and federal agencies; but sometimes they add "best practice requirements" to ensure the proper safety in the operation of the spray booth and use of booth components.

For example, FM Global can certify a product and label with a "FM Approved" certification mark. This ensures that the product meets the highest property loss prevention product testing and certification standards. Relative to spray booths, Air Make-up Units as well as the overall booth installation can receive this FM approval that helps to meet the insurance requirement of the company.

OTHER CLASSIFICATION AND CODE DEFINITIONS TO BE AWARE OF..

- **Authority Having Jurisdiction (AHJ)** – local inspectors having authority to assess and apply code to booth installation
- **UL or ETL Rated and Approved Installations (Certified in Field)** – these agencies will perform a post-installation evaluation and certification
- **NESHAP** – National Emissions Standards of Hazardous Air Pollutants – requires a 3-Stage exhaust filter system which meets EPA Rule Test Method 319 for paint materials with hexavalent chrome.
- **State and local VOC emission limitations and regulations, which is oftentimes referred to as “Best Available Control Technology” (BACT)** – covering spray booth installations which require more stringent VOC emission reductions.
- **International Mechanical Code (IMC)** – within this IMC, there are a number of specific code requirements pertaining to mechanical installations of a spray booth.
- **International Building Codes (IBC)** – within IBC, there are also a number of specific code requirements pertaining to the larger booth structures, and therefore, qualify under the IBC (e.g., seismic requirements, structural analysis, outdoor booth designs...).

03

Part 3:

AVOID THESE COSTLY PENALTIES

Effective booth design can be achieved while you're protecting your workers and your environment.

Here are true examples of violations and how it could have been avoided in the design and operation of the spray booth...



VIOLATION DUE TO INSUFFICIENT SPACE AROUND BOOTH

- **Company type and location?**

- Illinois manufacturer of silk screen printing equipment, and graphic and textile screen printing machines

- **What is the code requirement relating to this example?**

- NFPA Chapter 5.5 requires spray booths to be separated from other operations by a minimum distance of 915 mm (3 ft)

- **How did the Company violate this code?**

- Manufacturer didn't ensure a 3' clearance around the booth due to storage that obstructed the 3' pathway around the booth (including used rags, chemical containers...); NFPA deemed this a serious violation – required that the manufacturer immediately remove all garbage and storage, file an abatement certificate, and provide photographic evidence of the abatement

- **What was the penalty and costs to the Company?**

- Pay \$4,900 in fines; plus cover the cost of the abatement; plus raised insurance liability to person or property in case of emergency; plus a strike on company's record with NFPA where their next violation may be seen as a willful violation bringing greater fines and penalties

- **How could it have been avoided in the design of the booth?**

- Booth was engineered and installed with adequate outside dimensions to meet this code requirement, but this manufacturer ignored the code by obstructing the space with garbage and storage – the need to maintain clear and accessible pathways around the booth is critical for compliance and mitigation of liability.

VIOLATION DUE TO EXCESSIVE SOUND OPERATING LEVELS

- **Company type and location?**

- Metal fabricating plant located in Illinois

- **What is the code requirement relating to this example?**

- OSHA Fan Noise Level, 1910 requires that protection against the effects of noise exposure shall be provided when the sound levels go above action level of 85dBA

- **How did the Company violate this code?**

- After receiving a complaint of unsafe working conditions, inspectors with OSHA allegedly discovered that employees at the Company were over-exposed to noise and dust hazards within their powder booths. OSHA deemed this a serious violation. Among the several violations that the Agency found, they did not administer an effective hearing conservation program; did not use gages or alarms to monitor air velocity on the paint booth; did not operate the exhaust fans within the spray booth to reduce hazards; did not properly ground electrical equipment.... Because this noise violation opened up the further examination of the work environment by OSHA, OSHA inspectors allegedly found more than 26 violations, with 15 deemed serious.

- **What was the penalty and costs to the Company?**

- Company was fined \$76,000 for all violations, which the Company contested and is negotiating with OSHA; plus the cost cover the cost of correction; plus raised insurance liability to person or property in case of injury; plus a strike on Company's record with OSHA where their next violation may be seen as a willful violation bringing greater fines and penalties

- **How could it have been avoided in the design of the booth?**

- A properly designed spray booth takes into account not only the proper air flow requirements, but how the exhaust ventilation equipment must meet the OSHA sound level requirements. This also includes the installation and operation of alarms and gages that monitor air flow velocity in the booth.

VIOLATION DUE TO INSUFFICIENT FILTER MAINTENANCE

- **Company type and location?**

- Illinois manufacturer of silk screen printing equipment, and graphic and textile screen printing machines

- **What is the code requirement relating to this example?**

- 29 CFR OSHA 1910.107(b)(5)(i) and IFC 2018 Code 2404.7.3.1, requires company's spray booth to maintain the average air velocity over the open face of the booth during spraying operations of not less than 100FPM

- **How did the Company violate this code?**

- Paint arrester filter pads were not inspected to ensure proper replacement of filter media, nor was there a visible gage or audible alarm to indicate or ensure that the required air velocity was maintained, and OSHA deemed this a serious violation.

- **What was the penalty and costs to the Company?**

- Pay \$4,900 in fines; plus cover the cost of compliance; plus raised insurance liability to person or property in case of emergency; plus a strike on Company's record with OSHA where their next violation may be seen as a willful violation bringing greater fines and penalties.

- **How could it have been avoided in the design of the booth?**

- Spray booths are designed with filter cells that allow for replacement of these filters. Ensuring that you maintain the correct airflow for the optimum finishing environment requires that you have a visible gage (e.g., manometer) in good, operating condition at all times to indicate to the operator that filters must be replaced.

VIOLATION DUE TO SPRAYING CONDUCTED OUTSIDE OF PREDETERMINED SPRAYING AREAS

- **Company type and location?**
 - Illinois manufacturer of silk screen printing equipment, and graphic and textile screen printing machines
- **What is the code requirement relating to this example?**
 - 29 CFR OSHA 1910.107(g)(1) requires that spraying shall not be conducted outside of a predetermined spraying area.
- **How did the Company violate this code?**
 - Company’s painters did not ensure that the spray painting of parts and equipment was conducted inside of the spraying area, but rather spraying activities were conducted outside the protected spray area, including the hanging of painted parts from an overhead bar at the entrance of the dry type paint spray booth. In addition, adjacent to the spray booth, activities included spark and heat producing processes, such as sanding. OSHA deemed this a serious violation.
- **What was the penalty and costs to the Company?**
 - Pay \$4,900 in fines; plus cover the cost of compliance; plus raised insurance liability to person or property in case of emergency; plus a strike on Company’s record with OSHA where their next violation may be seen as a willful violation bringing greater fines and penalties.
- **How could it have been avoided in the design of the booth?**
 - Spray booths are specifically designed to accommodate particular spraying and production requirements based upon the manufactured part. From the current part size, to future parts sizes and plans for a spraying operations, all must be considered. *Current part size* (from all dimensions) must be evaluated and discussed to help arrive at the effective size of the booth needed. Although small parts deserve smaller booth dimensions (and larger parts deserve larger) consideration must be given to the access needed around the part, spray clearances, door clearances, and more. *Future part size* of production parts could influence the size and dimension of the spray booth as the Finishers consider the initial booth design. Finisher must also anticipate plans for future parts that may be manufactured and coated within the proposed spray booth. Not only from a size perspective, but also anticipating any changes in production rates as well. By anticipating future part needs, the Finisher can extend the life of their booth. *Configuration of the part* will determine how the spray booth operates to facilitate the Finisher’s spraying operation: Vertical vs horizontal orientation will determine proper height, width and length of the booth to ensure ample room for spray operations; one-sided vs 2-sided part orientation determines the need for proper width and depth of the booth to accommodate spraying equipment; and single sprayer vs. multiple sprayer operation will determine the width and height of the booth for air quality and safety; this is especially true for powder applications when multiple operators or gun stations are employed.

OFTEN SEEN VIOLATION DUE TO INSUFFICIENT EMERGENCY EGRESS

- **What is the code requirement relating to this example?**

- NFPA 33 Chapter 5.1.4 requires enclosed spray areas shall be provided with means of egress that meet applicable requirements of NFPA 101, Chapter 40, which is entitled *Industrial Occupancies*.

- **How does a Company violate this code?**

- It is typical for spray booths to be designed without the proper consideration for emergency egress for the operators. For example, the booth could be designed with doors that either exceed the maximum width of 48”, or not meet the minimum of 36”. Or, that the spray booth door is located outside a 25’ reach – in case of a major event, there must be emergency egress available not farther than 25’ from the painter’s area of operation.

- **How could a Company avoid these violations in the design of the booth?**

- Design of a modified downdraft booth must take into account the spray operation and these safety requirements. Side plenums in this type of booth can sometimes interfere with the proper location of the door in order to comply with these Standards. Another constraint is a booth located adjacent to a building wall without the proper aisleway to allow for emergency exit from the spray area. All design specifications regarding emergency egress must be challenged by the booth engineer before any booth fabrication can take place.

BOTTOM-LINE

The safer the work environment, the more productive the workforce becomes, and the more you reduce your risk – sustainable productivity improvement is key. As you can see, it can be very costly and disruptive to underestimate these standard and code compliances in the final spray booth solution.

It's the Part Finisher's job to provide the right information about their part, the right information about their facility, the right information about their production requirements and expectations, and make no assumptions, all along the guidelines outlined in this Presentation. And it's the spray booth designer's job to take that information, give feedback on design options, and optimize its spray booth solution in both its mechanical design and technical sophistication, as well as meeting all applicable standards and codes.





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Bob Hauck, Vice President for Spray Systems, Inc., with over 40 years of technical experience in the finishing industry. Starting as engineer for Binks-Sames Corporation, he helped design large finishing systems for such OEMs as General Motors and Ford. Then promoted to West Coast Regional Manager for Binks, directing 3 west coast branches, with a business development force of over 20, advising customers, engineers and plant managers on designing effective finishing systems. Now with Spray Systems as Vice President, Bob leads the national business development team to design critical spray booth solutions for manufacturers in the aerospace and large equipment industries.

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