

SUBJECT: Spray Finishing Operations

Purpose: To provide guidance in enforcement of 1910.94(c) and 1910.107. This directive takes into consideration changes made in NFPA 33 since 1969.

Scope: Whenever materials are used for spray applications, the following OSHA and consensus standards are to be used in determining compliance:

References:

- a. 1910.94(c) – Ventilation (based on ANSI Z9.3-1970)
- b. 1910.107 – Spray Finishing Using Flammable and Combustible Materials (based on NFPA 33-1969)
- c. 1910.307 – Hazardous (Classified) Electrical Locations
- d. NFPA 33-2016 – Spray Application Using Flammable and Combustible Materials
- e. NFPA 70-2014 – National Electrical Code (NEC)
- f. ANSI/AIHA Z9.3-2007 – Spray Finishing Operations – Safety Code for Design, Construction, and Ventilation
- g. Federal Instruction STD 1-5.10 Clarification of 29 CFR 1910.107(b)(5)(i) Average Air Velocity of Spray Booths.
- h. MNOSHA Instruction STD 1-4.1 Citation Guidelines for Air Contaminant Overexposures
- i. Federal OSHA standard interpretation dated July 9, 1991 to Richard F. Andree
- j. Federal OSHA standard interpretation dated April 8, 1997 to Elsie L. Munsell
- k. Federal OSHA standard interpretation dated October 22, 2001 to Wade R. Abnett
- l. Federal OSHA standard interpretation dated March 28, 2008 to Dee Woodhull
- m. Federal OSHA standard interpretation dated July 14, 2009 to John M. Hermanson

Cancellation: This directive cancels STD 1-5.3, Spray Finishing Operations, dated February 25, 2010.

Application: This directive covers the application of flammable or combustible materials by spray atomization, including compressed air, airless, hydraulic and other methods. These application techniques may or may not include the use of electrostatic technology. Water-borne, water-based and water-reducible coatings are also included, providing that they contain flammable or combustible liquids, or produce combustible products or residues. It does not include outdoor operations or the occasional use of small portable equipment or aerosol spray cans.

Spray booths or spray rooms are to be used to enclose or confine all spray finishing operations according to 1910.94(c). This is primarily intended to protect the health of employees from contact with gases, vapors, mists, dusts, or solvents used in, created, released, or disseminated by spray finishing operations.

1910.107 applies to fire or explosion hazards from flammable or combustible materials when applied as a spray by compressed air, "airless" or "hydraulic atomization", by steam or electrostatic methods, or by other means in continuous or intermittent processes. It also covers the application of combustible powders when applied by powder spray guns, electrostatic powder spray guns, fluidized beds, or electrostatic fluidized beds. To cite appropriate paragraphs of 1910.107, it must be proven that the spray material is flammable or combustible.

Action:

A. GENERAL REQUIREMENTS

1. 1910.94(c)(2) requires that spray booths or spray rooms be used to enclose or confine all spraying operations. This requirement was modified by later editions of NFPA, which allow spray application in spray booths, spray rooms, and spray areas. **Citations will not be issued if the workplace area meets all the construction, ventilation, electrical, and fixed fire suppression requirements for the type of area in accordance with the most recent edition of NFPA 33.**
2. 1910.94(c)(2) further requires that spray application operations are to be located as provided in sections 201-206 of NFPA 33-1969 so as to minimize damage to life and property. Spray application in an educational, institutional, assembly, or residential occupancy is limited to rooms having an approved automatic sprinkler system and two-hour fire resistant construction.
3. If the workplace area does not meet the construction, ventilation, electrical, and fixed fire suppression requirements outlined in the following sections, the OSHI should cite 1910.94(c)(2), using the SAVE, which references the abatement guidelines for proper design and construction of spray booths, spray rooms, and designated spray areas. Other sections of 1910.94 and 1910.107 should be cited as appropriate for the type of area.

B. SPRAY BOOTH REQUIREMENTS

1. Construction requirements referenced under 1910.94(c)(3) may be found in 1910.107(b)(1)-(4) and (7)-(10). Due to changes in NFPA 33, as noted by a federal letter of interpretation dated 7/9/91, the requirement for a metal deflector or curtain under 1910.107(b)(6) will not be cited and the employer will not have to take corrective action.
2. Ventilation requirements may be found in 1910.94(c)(6) and (7) and in 1910.107(b)(5)(i). Face velocity ranges for various operations are listed in 1910.94(c)(6)(i) Table G-10; however, the OSHI must demonstrate that either a health or fire hazard exists in order to issue a citation (see 10/22/2001 letter of interpretation). Air sampling must be performed to document that the hazard does exist.

Citations for exposure to hazardous substances over the PEL will be issued under the appropriate health standards (see MNOSHA Instruction STD 1-4.1). Engineering controls will be cited under 1910.1000(e) or the applicable vertical standard, rather than 1910.94(c)(6)(i) (see 10/22/2001 federal letter of interpretation).

1910.94(c)(6)(ii) may be cited if the concentration of flammable vapors inside the spray booth exceeds 25% of the lower explosive limit (LEL).
1910.107(b)(5)(i) may only be cited for spraying flammable or combustible materials in a dry filter spray booth where the concentration exceeds 25% of the LEL.

3. Electrical and other sources of ignition are addressed in 1910.107(b)(10) and (c). The following standards also address electrical equipment located in hazardous locations: 1910.307 and NEC Articles 500, 501, and 502.
4. Fixed fire suppression equipment requirements may be found in 1910.107(b)(5)(iv).

C. SPRAY ROOM REQUIREMENTS

1. Construction requirements may be found in 1910.94(c)(4).
2. Ventilation requirements may be found in 1910.94(c)(4)(iii), and (c)(7).
3. Electrical and other sources of ignition are addressed in 1910.107(c). The following standards also address electrical equipment located in hazardous locations: 1910.307 and NEC Articles 500, 501, and 502.

D. DESIGNATED SPRAY AREA (DSA) REQUIREMENTS

1. Construction requirements may be found in Chapter 5 of NFPA 33-2016. Deficiencies should be cited under 1910.94(c)(2).
2. Ventilation requirements may be found in 1910.107(d) and Chapters 5 and 7 of NFPA 33-2016. Deficiencies should be cited under 1910.107(d)(2).
3. Electrical and other sources of ignition are addressed in 1910.107(c) and Chapter 6 of NFPA 33-2016. The following standards also address electrical equipment located in hazardous locations: 1910.307 and NEC Articles 500, 501, and 502.
4. Fixed fire suppression equipment is addressed in Chapter 9 of NFPA 33-2016. Concerns should be addressed with a referral to the fire marshal.

E. EVALUATION OF VENTILATION SYSTEMS

1. Spray Booths
 - a. Use a smoke tube to check the direction of airflow. Airflow throughout the booth should be toward the exhaust ventilation system duct opening. Direct the smoke across, or perpendicular to the expected flow direction.

- b. Airflow measurements should be taken across the face of the booth using a velometer. Divide the opening into a one foot by one foot grid pattern. Take velometer readings at the center of each grid section and determine the average velocity.
- c. Use an intrinsically safe photoionization detector or combustible gas meter to determine what percent of the LEL is present inside the booth.
- d. Detector tubes and pumps may be used as a screening tool to help determine whether further sampling of employee exposure to air contaminants is warranted.
- e. Provided that a documented safety or health hazard exists, failure to meet the minimum ventilation requirement of 100 fpm for conventional dry type spray booths, overspray dry filters or filter rolls shall be cited under 1910.107(b)(5)(i). Failure to meet the minimum requirement of 60 fpm for electrostatic spraying operations shall also be cited under 1910.107(b)(5)(i).

2. Spray Rooms and Spray Areas

- a. Evaluate the spray room or area for possible employee chemical overexposure or inadequate dilution of the vapor to at least 25% LEL by using detector tubes, velometer, direct sampling equipment, etc. Conduct sampling if there are indications of inadequate ventilation following appropriate protocol and STD 1-4.1.
- b. Exhaust Ventilation – General: The minimum volume of air that must be exhausted from the spray area can be determined from the following two pieces of information which the OSHI should obtain during the inspection:

1) The type of solvent in the sprayed material. The exhaust ventilation needed to dilute some commonly used solvents is listed in Appendix A of this directive.

2) The quantity of material that is sprayed over a given period of time. This may be expressed, for instance, as "one gallon in 30 minutes" or "55 gallons in an 8-hour shift", etc., and converted to an application rate in gallons per minute (gpm). For the above examples:

$$\text{Application rate (gpm)} = 1 \text{ gallon}/30 \text{ minutes} = 0.03 \text{ gpm}$$

$$\text{Application rate (gpm)} = 55 \text{ gallons}/480 \text{ minutes} = 0.11 \text{ gpm}$$

- c. Determining Minimum Required Exhaust Ventilation [Ref. 1910.94(c)(6)(ii) and ANSI/AIHA Z9.3-2007]:

1) NFPA 33 has traditionally recommended a ventilation rate of at least 10,000 cubic feet of air per gallon of solvent sprayed at the equipment's maximum flow rate. This figure can be found in

Annex B, paragraph B.1 of NFPA 33-2016, and represents a safety factor of 4 to 1. This can be converted to cubic feet per minute (cfm) for the particular spray area using the following equation:

$$10,000 \text{ ft}^3/\text{gal} \times \text{application rate (gpm)} = \text{recommended cfm}$$

2) If less than 10,000 cubic feet of air is being exhausted for each gallon of solvent, then use the following equation to determine the minimum required ventilation [Note: the dilution volumes required per gallon of common solvents is contained in Appendix A of this directive.]:

$$\text{Dilution volume recommended (ft}^3/\text{gal.)} \times \text{application rate (gpm)} = \text{cfm ventilation needed.}$$

EXAMPLE: Spray room using one 55-gallon drum of toluene-based paint over an 8-hour work shift:

$$8564 \text{ ft}^3/\text{gal.} \times 0.11 \text{ gpm} = 942 \text{ cfm ventilation needed}$$

d. Determining Actual Ventilation

- 1) Using a velometer, the OSHI should measure the velocity of the air at the ventilation duct opening. The velometer reads in linear feet per minute (fpm).
- 2) The OSHI should measure the dimensions of the duct opening and compute the area in square feet.
- 3) To determine the volume of air exhausted (ventilation in cfm), use the following equation:

$$(\text{cfm}) = \text{velocity (fpm)} \times \text{duct area (sq. ft.)}$$

- 4) The OSHI should use a smoke tube to check for vapor capture in the spray area. When smoke is released in the spray area, the smoke should drift toward the exhaust ventilation duct.
- 5) Determine adequacy of make-up air either by measuring the volume of make-up air directly, using the same method as above, or taking exhaust ventilation measurements with all doors and windows closed. The latter method indicates whether there is enough building leakage to provide adequate make-up air.

e. Ventilation Citations

- 1) If the measured ventilation rate for the spray area is less than the minimum required, or if the solvent concentration exceeds 25% of the LEL, then a violation of 1910.107(d)(2) will be cited.

- 2) Similarly, a citation of 1910.107(d)(2) may be issued if the mechanical ventilation is not capturing and exhausting flammable or combustible vapors, mists, or powders.
- 3) Other ventilation deficiencies covered by 1910.107(d) shall be cited accordingly.
- 4) Violations of make-up air requirements may be cited using 1910.94(c)(7) when an overexposure is cited under 1910.1000.

F. RESPIRATORY PROTECTION

1. If respirators are worn, but elements of a suitable respiratory protection program are missing, then follow CPL 2-2.120.
2. If respirators are not being worn, the Safety OSHI should discuss the exposure conditions with a Health OSHI. A decision can then be made whether to submit a referral for sampling to be done by a Health OSHI.

James Krueger, Director MNOSHA Compliance
For the MNOSHA Management Team

Distribution: OSHA Compliance and WSC Director

Attachments: Appendix A - Dilution Volume Required per Gallon of Common Solvents

NOTICE: Minnesota OSHA Directives are used exclusively by MNOSHA personnel to assist in the administration of the OSHA program and in the proper interpretation and application of the occupational safety and health statutes, regulations, and standards. They are not legally binding declarations, and they are subject to revision or deletion at any time without notice.

APPENDIX A

DILUTION VOLUME REQUIRED PER GALLON OF COMMON SOLVENTS

<u>SOLVENT</u>	<u>DILUTION REQUIRED (CU.FT./GAL.)</u>
Acetone	6,592
Amyl Acetate (iso)	8,553
Amyl Alcohol (n)	9,748
Amyl Alcohol (iso)	9,748
Benzene	10,367
Butyl Acetate (n)	5,736
Butyl Alcohol (n)	9,916
Butyl Cellosolve	8,919
Cellosolve	7,332
Cellosolve Acetate	5,366
Cyclohexanone	11,221
1,1 Dichloroethylene	2,859
1,2 Dichloroethylene	1,579
Ethyl Acetate	5,117
Ethyl Alcohol	4,914
Ethyl Lactate	7,355
Methyl Acetate	5,001
Methyl Alcohol	4,104
Methyl Cellosolve	6,365
Methyl Ethyl Ketone	7,856
Methyl n-Propyl Ketone	7,985
Naphtha (VM&P) (76° F.P. Naphtha)	9,866
Propyl Acetate (n)	5,331
Propyl Acetate (iso)	6,110
Propyl Alcohol (n)	8,354
Propyl Alcohol (iso)	8,624
Stoddard Solvent (100° F.P. Naphtha)	8,344
Toluene	8,564
Turpentine	10,317
Xylene (o)	10,454