
**PART L
ATMOSPHERES AND VENTILATION**

WAC

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WAC 296-62-11019 Spray-finishing operations.

(1) **Definitions.**

- (a) **“Spray-finishing operations”** means employment of methods wherein organic or inorganic materials are utilized in dispersed form from deposit on surfaces to be coated, treated or cleaned. Such methods of deposit may involve either automatic, manual, or electrostatic deposition but do not include metal spraying or metallizing, dipping, flow coating, roller coating, tumbling, centrifuging, or spray washing and degreasing as conducted in self-contained washing and degreasing machines or systems.
- (b) **“Spray booth”** spray booths are defined and described in WAC 296-24-370 through 296-24-37007. (See sections 103, 104, and 105 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969.)
- (c) **“Spray room”** means a room in which spray-finishing operations not conducted in a spray booth are performed separately from other areas.
- (d) **“Minimum maintained velocity”** means the velocity of air movement which must be maintained in order to meet minimum specified requirements for health and safety.

(2) **Location and application.** Spray booths or spray rooms are to be used to enclose or confine all operations. Spray-finishing operations shall be located as provided in sections 201 through 206 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969.

(3) **Design and construction of spray booths.**

- (a) Spray booths shall be designed and constructed in accordance with WAC 296-24-370 through 296-24-37007 (see sections 301-304 and 306-310 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969), for general construction specifications.

Note: For a more detailed discussion of fundamentals relating to this subject, see ANSI Z9.2-1960.

- (i) Lights, motors, electrical equipment and other sources of ignition shall conform to the requirements of WAC 296-24-370. (See section 310 and chapter 4 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969.)
- (ii) In no case shall combustible material be used in the construction of a spray booth and supply or exhaust duct connected to it.

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- (b) Unobstructed walkways shall not be less than 6 1/2 feet high and shall be maintained clear of obstruction from any work location in the booth to a booth exit or open booth front. In booths where the open front is the only exit, such exits shall be not less than 3 feet wide. In booths having multiple exits, such exits shall not be less than 2 feet wide, provided that the maximum distance from the work location to the exit is 25 feet or less. Where booth exits are provided with doors, such doors shall open outward from the booth.
 - (c) Baffles, distribution plates, and dry-type overspray collectors shall conform to the requirements of WAC 296-24-370. (See sections 304 and 305 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969.)
 - (i) Overspray filters shall be installed and maintained in accordance with the requirements of WAC 296-24-370, (See section 305 of the Standard for Spray Finishing Using Flammable and Combustible Materials, NFPA No. 33-1969), and shall only be in a location easily accessible for inspection, cleaning, or replacement.
 - (ii) Where effective means, independent of the overspray filters are installed which will result in design air distribution across the booth cross section, it is permissible to operate the booth without the filters in place.
 - (d)(i) For wet or water-wash spray booths, the water-chamber enclosure, within which intimate contact of contaminated air and cleaning water or other cleaning medium is maintained, if made of steel, shall be 18 gauge or heavier and adequately protected against corrosion.
 - (ii) Chambers may include scrubber spray nozzles, headers, troughs, or other devices. Chambers shall be provided with adequate means for creating and maintaining scrubbing action for removal of particulate matter from the exhaust air stream.
 - (e) Collecting tanks shall be of welded steel construction or other suitable noncombustible material. If pits are used as collecting tanks, they shall be concrete, masonry, or other material having similar properties.
 - (i) Tanks shall be provided with weirs, skimmer plates, or screens to prevent sludge and floating paint from entering the pump suction box. Means for automatically maintaining the proper water level shall also be provided. Fresh water inlets shall not be submerged. They shall terminate at least one pipe diameter above the safety overflow level of the tank.
 - (ii) Tanks shall be so constructed as to discourage accumulation of hazardous deposits.
 - (f) Pump manifolds, risers, and headers shall be adequately sized to insure sufficient water flow to provide efficient operation of the water chamber.
- (4) **Design and construction of spray rooms.**
- (a) Spray rooms, including floors, shall be constructed of masonry, concrete, or other noncombustible material.
 - (b) Spray rooms shall have noncombustible fire doors and shutters.
 - (c) Spray rooms shall be adequately ventilated so that the atmosphere in the breathing zone of the operator shall be maintained in accordance with the requirements of (6)(b) of this section.
 - (d) Spray rooms used for production spray-finishing operations shall conform to the requirements of spray booths.

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(5) Ventilation.

- (a) Ventilation shall be provided in accordance with provisions of WAC 296-24-370, (See chapter 5 of the Standard for Spray Finishing Using Flammable or Combustible Materials, NFPA No. 33-1969), and in accordance with the following:
 - (i) Where a fan plenum is used to equalize or control the distribution of exhaust air movement through the booth, it shall be of sufficient strength or rigidity to withstand the differential air pressure or other superficially imposed loads for which the equipment is designed and also to facilitate cleaning. Construction specifications shall be at least equivalent to those of (5)(c) of this section.
 - (ii) All fan ratings shall be in accordance with Air Moving and Conditioning Association Standard Test Code for Testing Air Moving Devices, Bulletin 210, April 1962.
- (b) Inlet or supply ductwork used to transport makeup air to spray booths or surrounding areas shall be constructed of noncombustible materials.
 - (i) If negative pressure exists within inlet ductwork, all seams and joints shall be sealed if there is a possibility of infiltration of harmful quantities of noxious gases, fumes, or mists from areas through which ductwork passes.
 - (ii) Inlet ductwork shall be sized in accordance with volume flow requirements and provide design air requirements at the spray booth.
 - (iii) Inlet ductwork shall be so supported throughout its length to sustain at least its own weight plus any negative pressure which is exerted upon it under normal operating conditions.
- (c) Ducts shall be so constructed as to provide structural strength and stability at least equivalent to sheet steel of not less than the following thickness:

DIAMETER OR GREATER DIMENSION	
	(U.S. gauge)
Up to 8 inches inclusive	No. 24
Over 8 inches to 18 inches inclusive	No. 22
Over 18 inches to 30 inches inclusive	No. 20
Over 30 inches	No. 18

- (i) Exhaust ductwork shall be adequately supported throughout its length to sustain its weight plus any normal accumulation in interior during normal operating conditions and any negative pressure exerted upon it.
- (ii) Exhaust ductwork shall be sized in accordance with good design practice which shall include consideration of fan capacity, length of duct, number of turns and elbows, variation in size, volume, and character of materials being exhausted. See American National Standard Z9.2-1960 for further details and explanation concerning elements of design.

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- (iii) Longitudinal joints in sheet steel ductwork shall be either lock-seamed, riveted, or welded. For other than steel construction, equivalent securing of joints shall be provided.
- (iv) Circumferential joints in ductwork shall be substantially fastened together and lapped in the direction of airflow. At least every fourth joint shall be provided with connecting flanges, bolted together or of equivalent fastening security.
- (v) Inspection or clean-out doors shall be provided for every 9 to 12 feet of running length for ducts up to 12 inches in diameter, but the distance between clean-out doors may be greater for larger pipes. (See 8.3.21 of American National Standard Z9.1-1960.) A clean-out door or doors shall be provided for servicing the fan, and where necessary, a drain shall be provided.
- (vi) Where ductwork passes through a combustible roof or wall, the roof or wall shall be protected at the point of penetration by open space or fire-resistive material between the duct and the roof or wall. When ducts pass through fire-walls, they shall be provided with automatic fire dampers on both sides of the wall, except that three-eighth-inch steel plates may be used in lieu of automatic fire dampers for ducts not exceeding 18 inches in diameter.
- (vii) Ductwork used for ventilating any process covered in this standard shall not be connected to ducts ventilating any other process or any chimney or flue used for conveying any products of combustion.

(6) Velocity and air flow requirements.

- (a) 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 14 for the operating conditions specified. An adequate air replacement system is one which introduces replacement air upstream or above the object being sprayed and is so designed that the velocity of air in the booth cross section is not less than that specified in Table 14 when measured upstream or above the object being sprayed.

Table 14			
Minimum Maintained Velocities into Spray Booths			
Operating Airflow conditions For object Completely inside booth	Crossdraft f.p.m.	Airflow Velocities f.p.m.	
		Design	Range
Electrostatic and automatic airless operation contained in booth without operator.	Negligible	50 large booth	50-75
		100 small booth	75-125
Air-operated guns, manual or automatic	Up to 50	100 large booth	75-125
		150 small booth	125-175
Air-operated guns, manual or automatic	Up to 100	150 large booth	125-175
		200 small booth	150-250

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Notes:

- (1) *Attention is invited to the fact that the effectiveness of the spray booth is dependent upon the relationship of the depth of the booth to its height and width.*
 - (2) *Crossdrafts can be eliminated through proper design and such design should be sought. Crossdrafts in excess of 100 fpm (feet per minute) should not be permitted.*
 - (3) *Excessive air pressures result in loss of both efficiency and material waste in addition to creating a backlash that may carry overspray and fumes into adjacent work areas.*
 - (4) *Booths should be designed with velocity shown in the column headed "Design." However, booths operating with velocities shown in the column headed "Range" are in compliance with this standard.*
- (b) In addition to the requirements in (6)(a) 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. An example of the method of calculating this volume is given below.

Example: To determine the lower explosive limits of the most common solvents used in spray finishing, see Table 15. 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 nonflammable 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:

$$\begin{array}{l} \text{Dilution volume} \\ \text{required per} \\ \text{gallon of solvent} \end{array} = \frac{4 (100 - \text{LEL}) (\text{cubic feet of vapor per gallon})}{\text{LEL}}$$

Using toluene as the solvent.

- (1) LEL of toluene from Table 15, column 2, is 1.4 percent.
- (2) Cubic feet of vapor per gallon from Table 15, column 1, is 30.4 cubic feet per gallon.
- (3) Dilution volume required =

$$\frac{4 (100 - 1.4) 30.4}{1.4} = 8,564 \text{ cubic feet.}$$

- (4) To convert to cubic feet per minute of required ventilation, multiply the dilution volume required per gallon of solvent by the number of gallons of solvent evaporated per minute.

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TABLE 15 LOWER EXPLOSIVE LIMIT OF SOME COMMONLY USED SOLVENTS		
Solvent	Cubic feet of vapor per gallon of liquid at 70°F.	Lower explosive limit in percent by volume of air at 70°F.
	Column 1	Column 2
Acetone	44.0	2.6
Amyl Acetate (iso)	21.6	1.0*
Amyl Alcohol (n)	29.6	1.2
Amyl Alcohol (iso)	29.6	1.2
Benzene	36.8	1.4*
Butyl Acetate (n)	24.8	1.7
Butyl Alcohol (n)	35.2	1.4
Butyl Cellosolve	24.8	1.1
Cellosolve	33.6	1.8
Cellosolve Acetate	23.2	1.7
Cyclohexanone	31.2	1.1*
1,1 Dichloroethylene	42.4	5.6
1,2 Dichloroethylene	42.4	9.7
Ethyl Acetate	32.8	2.5
Ethyl Alcohol	55.2	4.3
Ethyl Lactate	28.0	1.5*
Methyl Acetate	40.0	3.1
Methyl Alcohol	80.8	7.3
Methyl Cellosolve	40.8	2.5
Methyl Ethyl Ketone	36.0	1.8
Methyl n-Propyl Ketone	30.4	1.5
Naphtha (VM&P) (76° Naphtha)	22.4	0.9
Naphtha (100° Flash)		
Safety solvent-Stoddard Solvent	23.2	1.1
Propyl Acetate(n)	27.2	2.0
Propyl Acetate (iso)	28.0	1.8
Propyl Alcohol (n)	44.8	2.1
Propyl Alcohol (iso)	44.0	2.0
Toluene	30.4	1.4
Turpentine	20.8	0.8
Xylene (o)	26.4	1.0

* At 212°F

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- (c)(i) When an operator is in a booth downstream of the object being sprayed, an air-supplied respirator or other type of respirator certified by NIOSH under 42 CFR part 84 for the material being sprayed should be used by the operator.
 - (ii) Where downdraft booths are provided with doors, such doors shall be closed when spray painting.
- (7) **Make-up air.**
- (a) Clean fresh air, free of contamination from adjacent industrial exhaust systems, chimneys, stacks, or vents, shall be supplied to a spray booth or room in quantities equal to the volume of air exhausted through the spray booth.
 - (b) Where a spray booth or room receives make-up air through self-closing doors, dampers, or louvers, they shall be fully open at all times when the booth or room is in use for spraying. The velocity of air through such doors, dampers, or louvers shall not exceed 200 feet per minute. If the fan characteristics are such that the required air flow through the booth will be provided, higher velocities through the doors, dampers, or louvers may be used.
 - (c)(i) Where the air supply to a spray booth or room is filtered, the fan static pressure shall be calculated on the assumption that the filters are dirty to the extent that they require cleaning or replacement.
 - (ii) The rating of filters shall be governed by test data supplied by the manufacturer of the filter. A pressure gauge shall be installed to show the pressure drop across the filters. This gauge shall be marked to show the pressure drop at which the filters require cleaning or replacement. Filters shall be replaced or cleaned whenever the pressure drop across them becomes excessive or whenever the air flow through the face of the booth falls below that specified in Table 14.
 - (d)(i) Means of heating make-up air to any spray booth or room, before or at the time spraying is normally performed, shall be provided in all places where the outdoor temperature may be expected to remain below 55° F. for appreciable periods of time during the operation of the booth except where adequate and safe means of radiant heating for all operating personnel affected is provided. The replacement air during the heating seasons shall be maintained at not less than 65° F. at the point of entry into the spray booth or spray room. When otherwise unheated make-up air would be at a temperature of more than 10° F. below room temperature, its temperature shall be regulated as provided in section 3.6 of ANSI Z9.2-1960.
 - (ii) As an alternative to an air replacement system complying with the preceding section, general heating of the building in which the spray room or booth is located may be employed provided that all occupied parts of the building are maintained at not less than 65° F. when the exhaust system is in operation or the general heating system supplemented by other sources of heat may be employed to meet this requirement.
 - (iii) No means of heating make-up air shall be located in a spray booth.
 - (iv) Where make-up air is heated by coal or oil, the products of combustion shall not be allowed to mix with the make-up air, and the products of combustion shall be conducted outside the building through a flue terminating at a point remote from all points where make-up air enters the building.

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- (v) Where make-up air is heated by gas, and the products of combustion are not mixed with the make-up air but are conducted through an independent flue to a point outside the building remote from all points where make-up air enters the building, it is not necessary to comply with (7)(d)(vi) of this section.
- (vi) Where make-up air to any manually operated spray booth or room is heated by gas and the products of combustion are allowed to mix with the supply air, the following precautions must be taken:
 - (A) The gas must have a distinctive and strong enough odor to warn workmen in a spray booth or room of its presence if in an unburned state in the make-up air.
 - (B) The maximum rate of gas supply to the make-up air heater burners must not exceed that which would yield in excess of 200 p.p.m. (parts per million) of carbon monoxide or 2,000 p.p.m. of total combustible gases in the mixture if the unburned gas upon the occurrence of flame failure were mixed with all of the make-up air supplied.
 - (C) A fan must be provided to deliver the mixture of heated air and products of combustion from the plenum chamber housing the gas burners to the spray booth or room.
- (8) **Scope.** Spray booths or spray rooms are to be used to enclose or confine all spray finishing operations covered by this paragraph. This paragraph does not apply to the spraying of the exteriors of buildings, fixed tanks, or similar structures, nor to small portable spraying apparatus not used repeatedly in the same location.

[Statutory Authority: RCW 49.17.010, .040, .050. 99-10 (Order 98-10) § 296-62-11019, filed 05/04/99, effective 09/01/99.] Statutory Authority: RCW 49.17.040, 49.17.050, and 49.17.240. 81-16-015 (Order 81-20), 296-62-11019, filed 7/27/81; Order 73-3, 296-62-11019, filed 5/7/73.]

WAC 296-62-135 Oxygen deficient atmospheres.

- (1) **Definition.** A lack of sufficient oxygen is deemed to exist if the atmosphere at sea level has less than 19.5% oxygen by volume or has a partial pressure of oxygen of 148 millimeters of mercury (mm. Hg) or less. This may deviate when working at higher elevations and should be determined for an individual location. Factors such as acclimatization, physical conditions of the persons involved, etc., must be considered for such circumstances and conditions.
- (2) **Entering areas with possible oxygen deficient atmospheres.** Workers entering any area where a lack of sufficient oxygen is probable shall be supplied with and shall use approved equipment (for specific requirements see applicable provisions of chapter 296-62, 296-307 (Part U-3), 296-809 and 296-841 WAC) capable of providing safe respirable air, or prior to entry and at all times when workers are in such areas a sufficient supply of safe, respirable air shall be provided. All workers so exposed shall be under constant observation. If the oxygen content is unknown or may change during occupation, tests shall be required prior to and during occupation of questionable areas.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 07-23-072 (Order 07-35), § 296-62-135, filed 11/19/07, effective 01/02/08.]

WAC 296-62-136 Ventilation.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 07-23-072 (Order 07-35), § 296-62-136, filed 11/19/07, effective 01/02/08.]

WAC 296-62-13605 Definition. Ventilation shall mean the provision, circulation or exhausting of air into or from an area or space.

- (1) **“Local exhaust ventilation”** shall mean the mechanical removal of contaminated air from the point where the contaminant is being generated or liberated.
- (2) **“Dilution ventilation”** means inducing and mixing uncontaminated air with contaminated air in such quantities that the resultant mixture in the breathing zone will not exceed the permissible exposure limit (PEL) specified for any contaminant.
- (3) **“Exhaust ventilation”** means the general movement of air out of the area or permit-required confined space by mechanical or natural means.
- (4) **“Tempered make-up air”** means air which has been conditioned by changing its heat content to obtain a specific desired temperature.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 07-23-072 (Order 07-35), § 296-62-13605, filed 11/19/07, effective 01/02/08.]

WAC 296-62-13610 Ventilation guide. In addition to those mandatory controls as set forth in WAC 296-62-11019, chapter 296-818 WAC, Abrasive blasting, chapter 296-835 WAC, Dipping and coating operations (dip tanks), the *Industrial Ventilation Manual of Recommended Practices* as compiled and approved by the American Conference of Governmental Industrial Hygienists, applicable ANSI Standard or other National Consensus Standards recommended by the federal government, should be used as a guide for ventilation requirements.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 07-23-072 (Order 07-35), § 296-62-13610, filed 11/19/07, effective 01/02/08.]

WAC 296-62-13615 Adequate system. Adequate ventilation systems shall be installed as needed to control concentrations of airborne contaminants below applicable threshold limit values.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 07-23-072 (Order 07-35), § 296-62-13615, filed 11/19/07, effective 01/02/08.]

WAC 296-62-13620 Exhaust. Exhaust from ventilation systems shall discharge in such a manner that the contaminated air being exhausted will not present a health hazard to any workman or reenter buildings in harmful amounts.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 07-23-072 (Order 07-35), § 296-62-13620, filed 11/19/07, effective 01/02/08.]

WAC 296-62-13625 Make-up air quantity. Make-up air shall be of ample quantity to replace the exhausted air and shall be tempered when necessary.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 07-23-072 (Order 07-35), § 296-62-13625, filed 11/19/07, effective 01/02/08.]

WAC 296-62-13630 Design and operation. Ventilation systems shall be designed and operated in such a manner that employees will not be subjected to excessive air velocities.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 07-23-072 (Order 07-35), § 296-62-13630, filed 11/19/07, effective 01/02/08.]

WAC 296-62-13635 Compatibility of systems. Make-up air systems shall be designed and operated in such a manner that they will not interfere with the effectiveness of the exhaust air system.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 07-23-072 (Order 07-35), § 296-62-13635, filed 11/19/07, effective 01/02/08.]