



11.0 VENTILATION

11.1 SECTION CONTENTS

This section contains basic information on local exhaust ventilation systems for controlling airborne contaminants and highlights safety features to consider in design.

Design of ventilation systems typically requires detailed engineering to ensure applicable regulations and standards are met. An engineer or specialist knowledgeable in principles of ventilation should be consulted for proper design.

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NOTE: An asterisk (*) after a section of text indicates that the information in that section is new or revised as of September 1996.

11.2 GENERAL REQUIREMENTS OF MECHANICAL VENTILATION

A. DESIGN AND OPERATION OF MECHANICAL VENTILATION

Cal-OSHA 5143(a)

1. The construction, installation, inspection, testing, and maintenance of exhaust systems shall conform to all requirements of Article 107. Additional guidance may be obtained from the American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2-1971 and the Standard for the Installation of Blower and Exhaust Systems, NFPA No. 91-1973. Note: Ventilation requirements for control of flammable vapors are prescribed in Sections 5153(d) and 5416.
2. The exhaust system shall be so designed, constructed, maintained and operated as to prevent harmful exposure by maintaining a volume and velocity of exhaust air sufficient to gather dusts, fumes, mists, vapors or gases from said equipment or process and to convey them to suitable points of safe disposal, thereby preventing their dispersion in harmful quantities into the atmosphere of work rooms or other places where persons are employed.
3. Exhaust ducts, inlet ducts, and fan plenums shall be so designed, constructed, and supported as to prevent collapse of the ducts and/or failure of the supporting system.
4. Exhaust ducts which convey dusts, fumes, and mists shall be provided with inspection or clean-out doors at intervals not to exceed 12 feet of horizontal running length for ducts up to 12 inches in diameter, but the distance may be greater for larger ducts. A clean-out door or doors shall be provided for servicing the fan and, where necessary, a drain shall be provided.
5. Two or more operations shall not be connected to the same exhaust system where the combination of substances removed may constitute a fire, explosion, or chemical reaction hazard in the duct system.
6. The ventilation rate of every mechanical ventilation system used to prevent harmful exposure shall be tested after initial installation, alterations, or maintenance, and at least annually, by means of a pivot traverse of the exhaust duct or equivalent measurements. Records of these tests shall be retained for at least five years.
7. The exhaust system shall be in operation continually during all operations for which it is designed. The system shall continue to operate for some time after the cessation of said operations, the length of time to depend upon the individual circumstances and effectiveness of the ventilation system.

Chevron Guidelines

1. Ventilation or other means of engineering control shall be provided whenever exposures of personnel to air contaminants exceed the exposure limits specified in regulations (see 29 CFR 1910.1000 or 8 C.C.R 5155).
2. The ventilation system may require review/approval by an industrial hygienist or other technically qualified person.
3. The plant and equipment layout should be arranged to minimize cross-drafts and turbulence which impair the effectiveness of ventilation systems.
4. Two or more operations shall not be connected to the same exhaust system where the combination of substances removed may constitute a fire, explosion, or chemical reaction hazard in the duct system.
5. The ventilation rate of every mechanical ventilation system used to prevent harmful exposure shall be tested after initial installation, alterations, or maintenance and at least annually. Records of these tests shall be retained for at least 5 years.
6. 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 cleanout doors may be greater for larger pipes. (See ANSI Z9.2-1971). A clean-out door or doors shall be provided for servicing fans, and where necessary, a drain shall be provided.
7. See *Figures 11.1* and *11.2* for hood design details.



B. DISPOSAL OF EXHAUST MATERIALS

Chevron Guidelines

1. The exhaust discharge of the ventilation system shall not be located where a harmful exposure is created in other accessible work areas.
2. Air exhaust with dust or particulates shall be discharged through dust-collecting equipment.

Cal-OSHA 5143(c)

1. The air outlet from every dust separator/collector and the dusts, fumes, mists, vapors or gases collected by an exhaust or ventilating system shall discharge to the outside atmosphere, provided that the exhaust system shall discharge to the outer air in such a manner that it will not cause a harmful exposure in any accessible workplace. Collecting systems which return air to work areas may be used if contaminants which accumulate in the work area do not result in harmful exposure to employees.
2. The air exhausted from blast-cleaning equipment, grinding, buffing, polishing equipment and all other equipment requiring exhausting of dust or particulate shall be discharged through dust-collecting equipment. Dust and refuse discharged from an exhaust system shall be disposed of in such a manner that it will not result in harmful exposure to employees.

C. MAKE-UP AIR

Chevron Guidelines

1. Air, free of contamination from other exhaust systems, chimneys, and stacks, shall be supplied for ventilation make-up air. Personnel comfort should be considered in the design of the make-up air supply.

Cal-OSHA 5143(d)

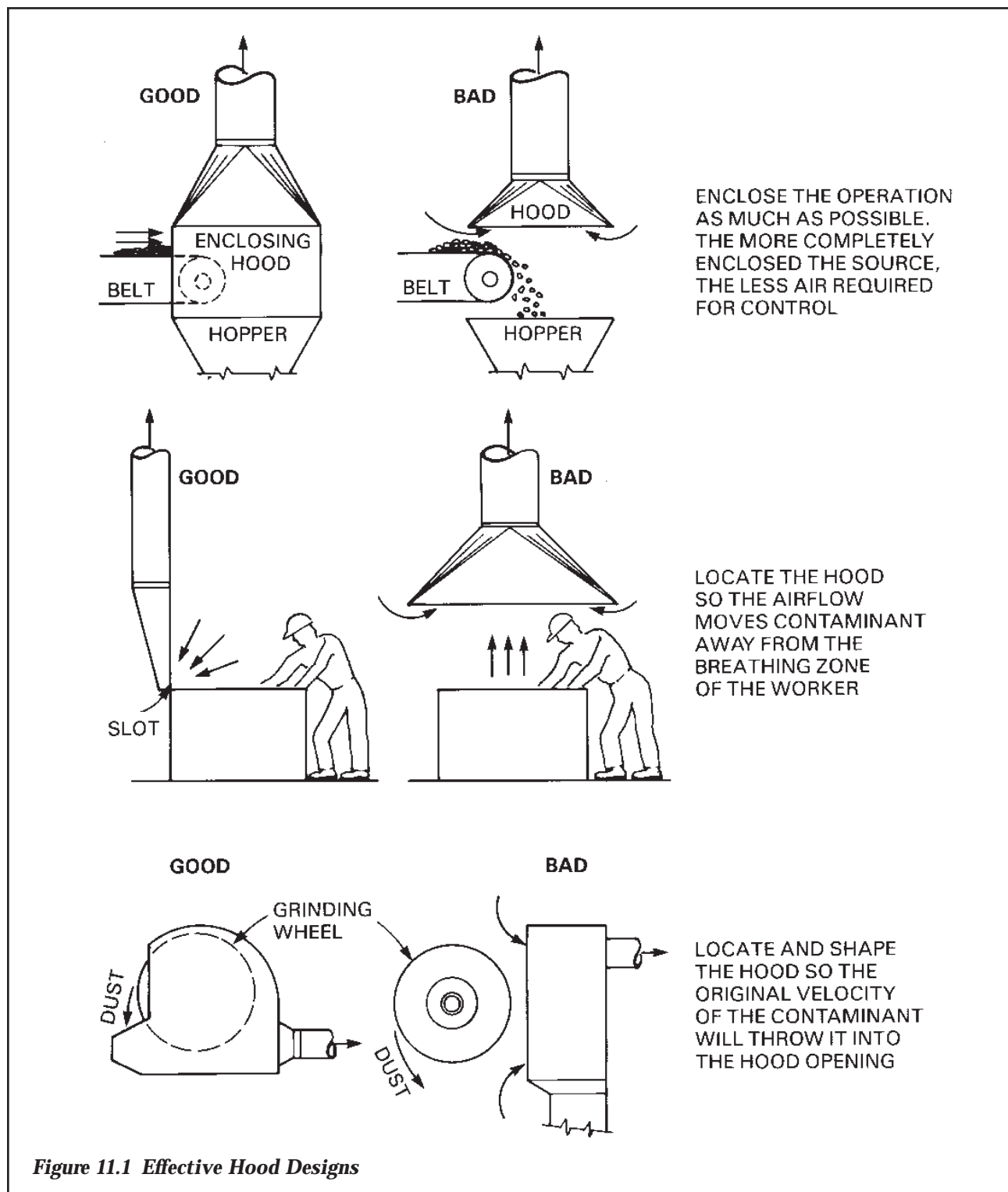
1. Clean, fresh air, free of contamination from adjacent industrial exhaust systems, chimneys, stacks, or vents, shall be supplied.
2. The outside air supply shall enter the workroom in a manner which will not reduce the effectiveness of any local exhaust systems.
3. All seams and joints shall be sealed if negative pressure exists within inlet ductwork such that there is a possibility of infiltration of harmful quantities of gases, fumes, or mists from areas through which ductwork passes.
4. Where the air supply is filtered, the filters shall be replaced or cleaned regularly to prevent significant reductions in airflow. 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 filters require cleaning or replacement.

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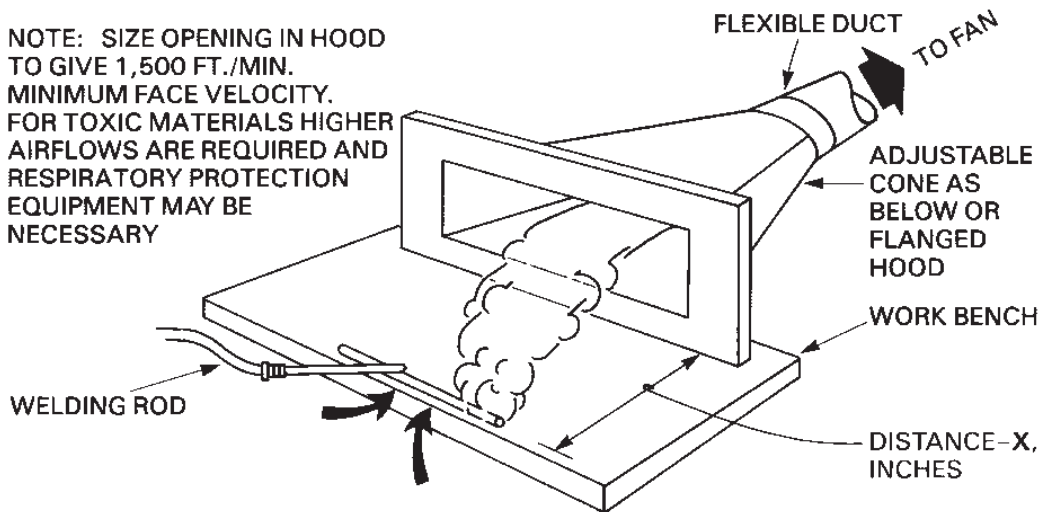
5. Where make-up air is heated by combustion, except gas, the products of combustion shall not be mixed with the make-up air and shall be vented to a point remote from all points where make-up air enters the building. For gas heating where combustion products are mixed with the make-up air, the following must exist:

- The gas must be nontoxic and have a distinctive and strong enough odor to warn workmen of its presence if unburned.
- The maximum rate of gas supply to the make-up air heater shall not yield in excess of 2000 ppm of total combustible gas in the mixture upon flame failure.
- A fan shall be provided to remove the mixture of heated air and combustion products from gas burner plenum chambers. (See Cal-OSHA 5143)



VELOCITY/AIR FLOW REQUIREMENT

NOTE: SIZE OPENING IN HOOD TO GIVE 1,500 FT./MIN. MINIMUM FACE VELOCITY. FOR TOXIC MATERIALS HIGHER AIRFLOWS ARE REQUIRED AND RESPIRATORY PROTECTION EQUIPMENT MAY BE NECESSARY



DISTANCE-X, INCHES	UP TO 6	6-9	9-12
MINIMUM AIRFLOW, FT. ³ /MIN. *	250	550	1,000
MAXIMUM DUCT DIAM., IN. **	3-1/2	5-1/2	7-1/2

* TO GIVE 100 FT./MIN. AT MAXIMUM DISTANCE, X

** BASED ON A MINIMUM DUCT VELOCITY OF 3,000 FT./MIN.

TYPICAL PURCHASED PACKAGE SYSTEM

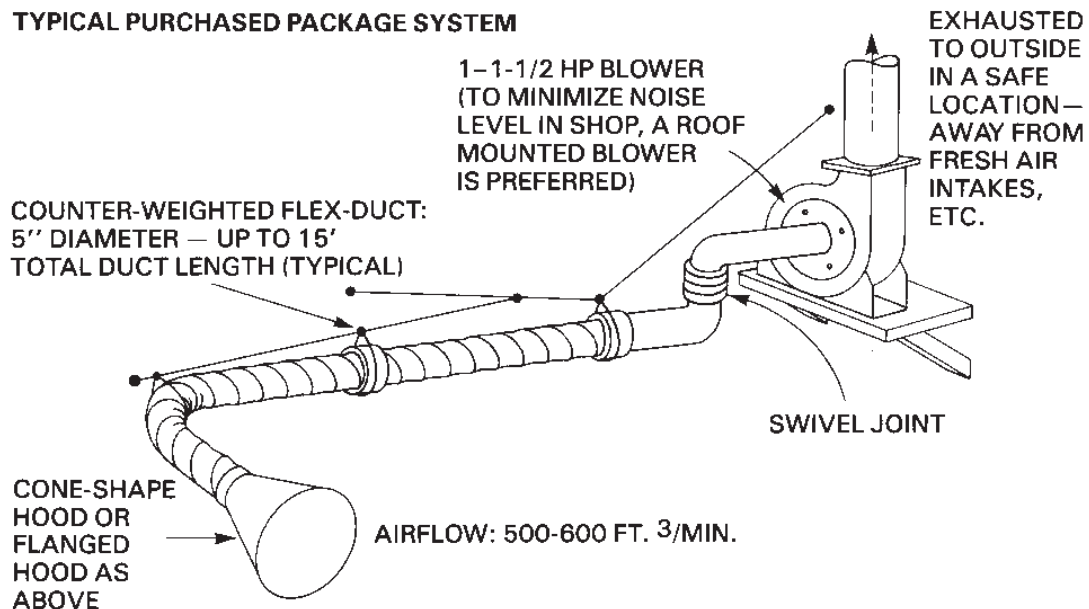


Figure 11.2 Welding Ventilation System



11.3 OTHER REQUIREMENTS FOR MECHANICAL VENTILATION

A. REQUIREMENTS FOR LAB-TYPE HOODS

Chevron Guidelines

1. The average face velocity is determined by measuring the velocity at 9-12 equal area points in the plane of the sash opening and calculating the average of these measurements.
2. Where the velocity requirements as shown in *Figure 11.3* cannot be achieved with the sash fully opened, the hood shall be marked to indicate the maximum allowable opening which gives the required velocity and administrative procedures shall be established to limit sash opening as marked when chemicals are handled. If administrative procedures are infeasible, the airflow shall be increased to meet the velocity requirements.
3. If the hood is located where cross-drafts from doors or windows may disturb airflow, the velocity requirements listed in *Figure 11.3* shall be increased by 50%.

SERVICE:	AVERAGE FACE VELOCITY	MIN. VELOCITY AT ANY POINT
Existing Hood - General Use	100 Ft./Min.	70 Ft./Min.
New or Existing Hood - Covered by OSHA Carcinogen Standard*	150 Ft./Min.	125 Ft./Min.
New Hood - General Use	125 Ft./Min.	100 Ft./Min.

* Required only when specified by an applicable carcinogen standard (e.g., 8 C.C.R. 5209, 29CFR1910.1003, etc.)

Figure 11.3 Velocity Requirements

Cal-OSHA 5154.1 (c) & (d)

1. Inspection doors or clean-out doors in exhaust ducts required by Section 5143(a)(3) do not apply to laboratory-type hood operations.
2. Laboratory-type hood face velocities shall be sufficient to maintain an inward flow of air at all openings into the hood under operating conditions. The hood shall provide confinement of the possible hazards and protection of the employees for the work which is performed. The exhaust system shall provide an average face velocity of at least 100 linear feet per minute with a minimum of 70 lfm at any point, except where more stringent special requirements are prescribed in other sections of the General Industry Safety Orders, such as Section 5209. The minimum velocity requirement excludes those measurements made within 1 inch of the perimeter of the work opening.
3. Mechanical ventilation shall remain in operation at all times when hoods are in use and for a sufficient time thereafter to clear hoods of airborne hazardous substances. When mechanical ventilation is not in operation, hazardous substances in the hood shall be covered or capped off.

Cal-OSHA 5154.1 (e)

4. The face velocity required by 5154.1(c) should be obtainable with the movable sashes fully opened. Where the required velocity can be obtained by partly closing the sash, the sash and/or jamb shall be marked to show the maximum opening at which the hood face velocity will meet the requirements of subsection 5154.1(c). Any hood failing to meet requirements of subsection 5154.1(c) above and this paragraph shall be considered deficient in airflow and shall be posted with placards, plainly visible, which prohibit use of hazardous substances within the hood.
5. When flammable gases or liquids are used, or when combustible liquids are heated above their flashpoints, hoods that are not bypassed shall have permanent stops installed which will restrict closure of the sash so that sufficient airflow is maintained to prevent explosions. Concentrations in the duct shall not exceed 20% of the lower explosive limits.
6. In addition to requirements in Section 5143(a)(5), a means shall be provided at the hood to continuously indicate that air is flowing into the exhaust system during operation. The ability of the

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hood to maintain an inward flow as required by 5154.1(c) shall be demonstrated using smoke tubes or other suitable qualitative methods upon initial installation; repairs or renovations of the facility, hood or ventilation system; or the addition of large equipment into the hood.

7. Exhaust stacks shall be located in such a manner with respect to air intakes as to preclude the recirculation of laboratory-type hood emissions within a building. To protect employees on the roof, any one of the following methods shall be utilized:
 - Chemical treatment, absorption on activated charcoal, or scrubbers;
 - Dilution of toxic materials below prescribed exposure limits prior to discharge;
 - Locked gates, doors or other equivalent means which prevent employee access to exhaust stack discharge areas while hoods are in operation unless personnel are provided with appropriate respirators and other personal protection; or
 - Exhaust stacks extending at least 7 feet above the roof and discharging vertically upward. Where rain protection is desired, high velocity discharge or concentric-duct, self-draining stacks (Figure V-9 of 5154.1) or equivalent may be used. Rain caps which divert the exhaust toward the roof are prohibited.
8. Where emissions from the exhaust stack are likely to cause harmful exposure to employees, an effective air cleaning system shall be provided. Where virulent pathogens are likely to be released in the hood, incinerators or equally effective means of disposal shall be provided in the exhaust system to prevent employee exposure. See Section 5154.2 for requirements for biological safety cabinets.
9. Blowers exhausting laboratory-type hoods in which hazardous substances are used shall be mounted outside the building or in service rooms outside the working area. For hoods with single, independent exhaust systems, blowers may be mounted inside the building provided that corrosion-resistant, sealed-joint duct-work is used.



B. OTHER VENTILATION REQUIREMENTS

Chevron Guidelines

1. Also refer to these special requirements:

	Fed-OSHA	Cal-OSHA
Ventilation Requirements for Welding, Brazing and Cutting	1910.252 (c)	5150
Ventilation Requirements for Abrasive Blasting Operations	1910.94 (a)	5151
Ventilation Requirements for Grinding, Polishing and Buffing Operations	1910.94 (b)	5152
Ventilation Requirements for Spray Coating Operations	1910.94 (c)	5153
Ventilation Requirements for Open-Surface Tank Operations	1910.94 (d)	5154
Ventilation Requirements for Biological Safety Cabinets	---	5154.2