American National Standard — Exhaust Systems for Grinding, Polishing, and Buffing

Secretariat

American Industrial Hygiene Association

Approved: June 11, 2008

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FOREWORD (This foreword is not part of the American National Standard/AIHA Z9.6–2008)

A standard for ventilation of grinding, polishing, and buffing equipment was originally developed by the Industrial Hygiene Codes Committee of the American Foundrymen’s Association (now known as the American Foundrymen’s Society, or AFS) and was approved by the Board of Directors of that organization on December 4, 1936. Realizing that grinding, polishing, and buffing equipment is used in many industries and wishing to make technical material used by the foundry industry more widely available, the American Foundrymen’s Association submitted this standard to the American Standards Association (now ANSI) for approval as an American National Standard. ASA referred the standard to the Z9 Committee on Exhaust Systems, a canvas of interested parties was conducted by letter ballot, and the standard was issued as Z43.1–1941 on August 14, 1941.

The Dust Control Committee of the American Foundrymen’s Society revised and updated the standard, submitted the revision to the American Standards Association, and it was reissued under the guidance of the Z9 committee as Z43.1–1966. ANSI withdrew the standard in 1988 when no further work was done on it. The Z9 Committee, however, believed it was important to maintain this consensus information and chartered a Z9.6 subcommittee in 1992 to rewrite Z43.1 as ANSI Z9.6. This new standard provides updated information on ventilation for grinding, polishing, and buffing operations that conforms to current accepted practices.

New technology and research continues to change this field and it is hoped that future versions of the standard will reflect this growth in knowledge. Suggestions for improvement are welcome. They should be sent to the American Industrial Hygiene Association, 2700 Prosperity Avenue, Suite 250, Fairfax, VA 22031.

How to Use this Standard

The requirements of the standard beginning in Section 4 are presented in a two-column format. The left column presents the requirements of the standard; the right column provides clarification and explanation of the requirements.

Figures 1–15 are incorporated as part of the standard.

Standard requirements should be considered minimum criteria and can be adapted to the needs of the User establishment. Demonstrably equal or better approaches are acceptable. When deviating from the Standard, documentation should be provided.

The Standard is auditable by those trained in ventilation. An Audit Form is provided in the Appendix.
ANSI/AIHA Z9.6–2008

This standard was developed and approved for submittal to ANSI by the Z9 Accredited Standards Committee on Safety Standards for Exhaust Systems. Consensus was reached through a process involving the entire Z9 Committee in a series of reviews and in the final vote of approval. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the Z9 Committee had the following members:

L. DiBerardinis, Chair  
J. Price, Vice Chair  
Mili Mavely, Secretariat Representative

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**Individual Members**

- D. Blackburn
- D.J. Burton
- J.L. Cook
- L. DiBerardinis
- C. Figueroa
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- L. Hathon
- R.L. Karbowski
- T. Knutson
- N. McManus
- D. O'Brien
- K. Paulson
- J.M. Price
- J.C. Rock
- M. Rollins
- J.W. Sheehy

Subcommittee Z9.6 on Exhaust Systems for Grinding, Polishing, and Buffing, which developed this standard, had the following members:

- M. Rollins, Chair  
- L. Cook  
- G. Adams  
- R.L. Karbowski  
- D.J. Burton
American National Standard —
Exhaust Systems for Grinding, Polishing, and Buffing

1 Scope and Application

1.1 Scope. The requirements and emission and exposure control principles described in this standard represent the minimum criteria intended 1) to protect the health of personnel engaged in and working in the vicinity of grinding, polishing, and buffing operations; and 2) to control contaminants generated by those operations.

1.2 Application. The Standard applies to processes, equipment and operations that use power-driven machinery to grind, polish, or buff a product without the use of a liquid coolant. Where liquid coolants are used, the user controls exposures, pooling of liquids, draining of ducts, use of mist eliminators, and so forth, that are not covered in the Standard.

1.3 Where federal, state, or local regulations or codes are more stringent, those regulations and codes shall have control.

2 Referenced Standards and Publications

2.1 General. The regulations, codes, standards, and guidelines cited in Sections 2.2, 2.3, and 2.4 contain provisions that through reference constitute provisions of this American National Standard. The related documents cited in 2.5 contain additional information but are not essential for complying with the requirements of this standard.

At the time of publication, the editions indicated were current. All standards and guidelines are subject to revision, and Users of this American National Standard are encouraged to consult the most recent editions of the standards and guidelines listed below.

2.2 American National Standards


ANSI/ASSE Z87.1–2003, Occupational and Educational Personal Eye and Face Protection Devices.

2.3 Occupational Safety and Health Administration Standards

Code of Federal Regulations, Title 29, Part 1910, Section 133, Eye and Face Protection.


2.4 Other Publications

3 Definitions. The following paragraphs explain terms used in Standard paragraphs and figures.

3.1 Air Cleaning Equipment. A device or combination of devices for separating contaminants from the air handled by an exhaust ventilation system.

3.2 Balanced. In local exhaust systems a balanced system is one in which the desired air flowrate is achieved simultaneously in all branches of the system. Balance is usually achieved through good design, proper fitting and duct selection, and, when necessary, by the use of balancing dampers.

3.3 Branch duct. A duct connecting an exhaust hood to a main or submain duct.

3.4 Commissioning, Commissioning Plan. A process or plan in which an exhaust ventilation system's performance is identified, verified, and documented before, during, and after design, construction, or remodeling to assure proper operation and compliance with codes, standards, and user intentions. Commissioning ends when tests and demonstrations have verified that the system operates as intended. A commissioning agent is often used to administer the commissioning process, tailored to the needs of the system.

3.5 Contaminant. Also, Air Contaminant, Stressor. A substance (smoke, dust, fume, mist, vapor or gas) whose presence in air is harmful, hazardous, or a nuisance to humans.

3.6 Control Velocity. Also, Capture Velocity. The velocity of air at a point in space sufficient to draw contaminants and contaminated air into an exhaust hood.

3.7 Cradle. A movable fixture, upon which the part to be ground or polished is supported.
3.8 **Cut-off wheels.** Wheels of metal or organic bonded abrasives used for sawing and cutting. These wheels may be of the non-reinforced, reinforced, heavily reinforced, or metal center type. Cut-off wheels have diameter, thickness, and hole size dimensions.

3.9 **Design.** The process that includes characterizing the interactions between emissions, workers, and the air; determining appropriate air flowrates, static pressures, and other operational parameters; specifying equipment and system components.

3.10 **Designer.** Persons charged with designing a ventilation system; may include mechanical engineers, industrial hygiene engineers, and others with design education and experience. See 3.9 for a definition of design.

3.11 **Disc wheel:** All power-driven, rotating discs faced with abrasive materials, artificial or natural, and used for grinding or polishing on the side of the assembled disc.

3.12 **Document; to Document; Documentation.** The formal process of planning and recording of the rationale for decisions made by the User, the designer, or others. Also, the written procedures developed for operating, testing, and maintaining an LEV system.

3.13 **Ductwork.** Elongated rigid or flexible enclosures used to convey air and entrained contaminants from one location to another.

3.14 **Entry.** The point at which a segment of ductwork (i.e., branch or submain) enters another segment of ductwork (i.e., submain or main); entry from a hood to a duct; and entry from a plenum to a duct. The “Entry loss” (or “hood entry loss, He”) is the static pressure loss of the hood or capture device. Formulas for entry losses are provided in Figures 1–15.

3.15 **Exhaust Hood.** Also, **Hood.** A shaped opening designed to capture or control air contaminants. The exhaust hood typically encloses, captures, receives, and/or removes emissions or contaminated air from process equipment enclosures, or directly from an emission source. The term also applies to exhaust ventilated enclosures, exhaust ventilated tools, and exhaust apparatus or devices attached or integral with, the process equipment.

3.16 **Exhaust Rate.** Also, **Exhaust Volume Flowrate, Air Flowrate, Q.** The air volume flowrate through an exhaust hood or in a duct. Usually in cubic feet per minute (cfm) or cubic meters per second (cms).

3.17 **Exhaust System, Local Exhaust System, LEV System.** A mechanical system for removing contaminated air from a space, comprised of one or more of the following elements: exhaust hood, ductwork, air cleaning equipment, exhauster or fan, and stack. An exhaust system operates as a functional entity and the performance of all parts is affected by the design and performance of all other parts.

3.18 **Face Velocity.** Average velocity of the air in the plane of a hood opening with a directional vector perpendicular to that plane.

3.19 **Fan.** Also, **Exhauster, Ejector.** Mechanical device used to provide pressure and move air through an LEV system.

3.20 **Grinding, polishing, or buffing.** The removal of material from or the finishing or polishing of a workpiece or part, using an abrasive tool. As the part is being ground, buffed or polished, particles are removed and leave the object at a high speed plus the tool is reduced in size and emits particles, all of which must be controlled.

3.21 **Grinding wheel:** All power-driven, rotating grinding or abrasive wheels except disc wheels as defined in this standard consisting of abrasive particles held together by artificial or natural bonds and used for peripheral grinding.

3.23 Hood. See Exhaust Hood.

3.24 Horizontal double-spindle disc grinder: A grinding machine carrying two power-driven, rotating, coaxial, horizontal spindles on the inside ends of which are mounted abrasive disc wheels used for grinding two surfaces simultaneously.

3.25 Horizontal single-spindle disc grinder: A grinding machine carrying an abrasive disc wheel on one or both ends of a power-driven, rotating single horizontal spindle.

3.26 IH, Industrial Hygiene, Industrial Hygienist. The profession devoted to the anticipation, recognition, evaluation and control of employee exposures to airborne contaminants. A CIH is an IH certified by the American Board of Industrial Hygiene.

3.27 LEV. Local Exhaust Ventilation; see Exhaust System.

3.28 Main duct: A duct connecting two or more branches to the air moving device or air cleaning device.

3.29 Makeup Air. Also, Replacement Air, Supply Air. Outside or acceptably clean air supplied to replace air that is exhausted through an LEV system. Makeup air commonly refers to building ventilation while replacement air refers to air replaced as part of the industrial process, but overlap occurs in usage.

3.30 Occupational Exposure Limit (OEL). A concentration of contaminant in air not to be exceeded in the breathing zone of employees. Published OELs include: Permissible Exposure Limit (PELs; established by OSHA) Workplace Environmental Exposure Levels (WEEEs, sponsored by AIHA), Recommended Exposure Limits (RELs, sponsored by NIOSH), and threshold limit value (TLVs®, sponsored by ACGIH®). In some cases the user may develop in-house OELs (i.e., when published OELs are not available).

3.31 Polishing and buffing wheel: All power-driven, rotating wheels composed all or in part of textile fabrics, wood, felt, leather, or paper, and which may be coated with abrasives on the periphery of the wheel for purposes of polishing, buffing, and light grinding.

3.32 Portable grinder: Any power-driven, rotating grinding, polishing, or buffing wheel mounted in such manner that it may be manipulated and operated by hand.


3.34 Replacement Air. See Makeup Air.

3.35 Scratch brush wheel: All power-driven, rotating wheels made from wire or bristles and used for scratch cleaning and brushing purposes.

3.36 Swing-frame grinder: Any power-driven, rotating grinding, polishing, or buffing wheel mounted in such a manner that the wheel with its supporting framework can be manipulated over stationary objects.

3.37 Slot Velocity. The average velocity of the air in the plane of the slot with a directional vector perpendicular to that plane.

3.38 Standard Conditions, Standard Dry Air. Air at 70°F (20°C) and 29.92 inches Hg (101,325 Pa; 14.696 psia) absolute pressure, with little or no moisture content, weighing 0.075 lbs/cu foot (1.2 kg/cu meter).


3.40 Transport Velocity. The air velocity in ductwork required to prevent dry air contaminants from settling out in the ductwork; also, “scouring velocity,” or “minimum duct velocity.”

3.41 User. “User” refers to the person assuming immediate and ultimate responsibility for the application of the standard, e.g.,
the design, operation and/or maintenance of a ventilation system or a component of the system. “User” could include the employer, owner, foreman, architect, engineer, and/or other responsible persons, depending on the part of the standard being applied.

3.42 Velocity, V: The speed of air, usually in feet per minute (fpm) or meters per second (mps).

3.43 Velocity pressure, VP: The kinetic pressure in the direction of flow necessary to cause a fluid at rest to flow at a given velocity. It is usually expressed in inches of water gauge.

4 Hazardous Materials Exposure Control

4.1 To the maximum extent feasible, the concentration of air contaminants at the breathing zone of the operator and adjacent personnel shall be maintained, through engineering and administrative controls, at or below OEL concentrations permitted by the federal, state, or local agency having jurisdiction.

3.44 Vertical spindle disc grinder: A grinding machine having a vertical, rotating, power-driven spindle carrying a horizontal abrasive disc wheel.

3.45 Worker, Operator, Employee. Those using or operating grinding, polishing and buffing equipment covered by this Standard.

4 Hazardous Materials Exposure Control

4.1 Where technical and other feasibility issues make compliance with Section 4.1 impossible, the user should also comply with Section 4.2.

Grinding, buffing, and/or polishing of hazardous materials or objects with surface coatings containing hazardous materials, or when using abrasive wheels containing hazardous materials, may create airborne concentrations of those materials in the breathing zone of individuals which may be hazardous.

Examples of engineering controls include mechanical ventilation, isolation, substitution, automation and wet methods. Administrative controls include worker training and the use of appropriate work practices.

Permitted OEL exposure concentrations are found, for example, in OSHA 29 CFR 1910, Subpart Z Toxic and Hazardous Substances. (The “OSHA PEL”)

In the absence of legally mandated acceptable OEL concentrations, or when the User so elects, other consensus guidelines such as those established in the latest edition of the ACGIH® Threshold Limit Values® for Chemical Substances and Physical Agents and Biological Exposure Indices® Handbook can be used. See Section 2.4.
4.2 Feasible engineering and administrative control measures shall also be used to control over-exposures to the eyes, skin and gastro-intestinal systems of operators and adjacent personnel.

4.2 Skin exposure can lead to dermatitis and other skin diseases. Ingesting some metals (e.g., lead, arsenic, cadmium) can be as hazardous as being exposed through the pulmonary system. The eye is especially susceptible to high velocity particles. An industrial hygienist can assist in determining hazards and appropriate controls.

5 Personal Protective Equipment (PPE)

5.1 When conformance with Section 4 cannot be achieved by feasible engineering or administrative controls alone, appropriate PPE shall be provided.

5.1 Sections 5.2–5.4 provide specific PPE requirements.

In many cases, PPE should be used even when Section 4 can be complied with. The user should determine and document the need (or lack thereof) for the use of PPE.

5.2 When conformance to Section 4.1 cannot be achieved by engineering or administrative controls, appropriate respiratory protection shall be provided.

5.2 When conformance to Section 4.1 cannot be achieved by engineering or administrative controls, appropriate respiratory protection shall be provided.

5.2.1 Respiratory Protection. Where respirators are provided, a respirator program that meets the requirements of OSHA 29 CFR 1910.134, Respiratory Protection, shall be implemented.

5.3 Eye Protection. Equipment to protect the eyes and face against contact with materials ejected from the grinding, polishing, and buffing operations shall be provided to the operator and others working adjacent to the operation.

5.3 Eye Protection. Equipment to protect the eyes and face against contact with materials ejected from the grinding, polishing, and buffing operations shall be provided to the operator and others working adjacent to the operation.

5.3.1 Eye Protective Equipment shall conform to the requirements set forth in ANSI/ASSE Z87.1–2003 Occupational and Educational Personal Eye and Face Protection Devices, and OSHA 29 CFR 1910.133, Eye and Face Protection.

5.4 Skin Protection. Equipment and clothing to protect the skin against contact with materials associated with the grinding, polishing, and buffing operations shall be provided to the operator and others working adjacent to the operation, as needed.

5.4 Skin protection should be provided where skin exposure could result in dermatitis, abrasion, cuts, or absorption. An industrial hygienist can assist in determining skin-related hazards and protection.
6 Ventilation System Design and Operation


6.2 Materials of construction shall be fire-resistant and protected from corrosion where required by the intended use.

6.3 Collection of Contaminants. All ventilation exhaust systems shall be provided with air cleaning devices as mandated by federal, state, or local regulations and as provided for in Section 9, ANSI/AIHA Z9.2–2006 Fundamentals Governing the Design and Operation of Local Exhaust Systems.

6.4 Recirculation of Exhaust Air. Any recirculation of exhaust air to the work environment shall be done in conformance with ANSI/AIHA Z9.7 - 2006, Recirculation of Air from Industrial Process Exhaust Systems.

6.4.1 Makeup air used to replace exhausted air shall conform with the provisions of Section 6 of ANSI/AIHA Z9.2–2006, Fundamentals Governing the Design and Operation of Local Exhaust Systems.

6.5 Ongoing and Preventive Maintenance. A preventive maintenance program consisting of periodic inspection, adjustment, and lubrication of system components shall be instituted for each system. Components shall be serviced in accordance with the manufacturer’s recommendations.


6 Ventilation System Design and Operation

6.1 There are overlaps between these two major information sources. In the event of conflicting requirements, the more stringent should be used.

6.3 Users of this standard should contact the local air pollution control authority to determine air cleaning requirements and to obtain a permit.

6.4 The recirculation of exhaust air from grinding, polishing, and buffing processes is a potentially dangerous and/or hazardous practice. If done improperly, hazardous concentrations of air contaminants can be created in the work environment.

6.5 Maintenance. Proper operation of a system over time is dependent on regular and preventive maintenance. Effective maintenance will ensure that the system functions as designed and provides adequate capture and control of contaminated air.
6.6 Housekeeping. Dust on the floor, on enclosures, on adjacent horizontal surfaces, and in other locations shall be cleaned periodically.

6.6 Where toxic materials (e.g., heavy metals such as lead) are present in the dusts, care must be taken to avoid pulvation and over-exposures. Cleaning approaches using wet methods and/or a high efficiency particulate air (HEPA) filtered vacuum should be used.

7 Commissioning and Testing of Exhaust Ventilation Systems


7 Commissioning and Testing of Exhaust Ventilation Systems

7.1 After an exhaust system is installed, it should be tested initially and periodically to assure that it performs according to design or operating performance criteria, normally established before installation and during the commissioning process.

Performance criteria (e.g. “the flowrate should be 1,000 scfm; the hood static pressure should be 0.75" w.g.,”) are useful because testing and measurements can confirm satisfactory performance.

Exhaust system components to be tested usually include the hood or exhausted tool or enclosure, the air cleaner, and the fan. Performance criteria should usually include such parameters as: hood static pressure; minimum air volume flowrate; average; minimum, and maximum hood face velocities; visual containment; measured containment performance factors; capture velocity; slot velocity; transport velocity; pressure drop across air cleaners; fan total pressure; motor amperage; and so forth, as appropriate.

8 Hoods and Enclosures

8.1 As noted in the Foreword, standard requirements should be considered minimum criteria and can be adapted to the needs of the User establishment. Demonstrably equal or better approaches are acceptable. When deviating from the Standard, documentation should be provided. Design criteria provided in Figures 1–15 have been used for many years and probably represent the “standard of care.”

8 Hoods and Enclosures

8.1 Hoods used in exhaust ventilation systems for grinding, polishing, and buffing operations shall be designed, constructed, commissioned, operated, tested and maintained in accordance with the requirements of Sections 7 and 11-14 of ANSI/AIHA Z9.2–2006, Fundamentals Governing the Design and Operation of Local Exhaust Systems and/or ACGIH®'s Industrial Ventilation — A Manual of Recommended Practice, 26th Edition: O&M (Volumes 1 and 2).
8.2 Grinding and Abrasive Cut-Off Wheel Hoods. Exhaust hoods and/or guards shall, as a minimum, adhere to requirements specified in ANSI B7.1–2000, The Use, Care, and Protection of Abrasive Wheels.

8.2.1 Hoods and enclosures connected to exhaust systems shall be designed, located, placed and used so that particulate shall fall or be projected into the hoods in the direction of the airflow.

8.2.2 No wheels, discs, straps, or belts shall be operated in such manner and in such a direction as to cause particulate to be thrown into the operator's breathing zone.

8.2.3 Exhaust hoods for floor stands, pedestals, and bench grinders shall be designed in accordance with Figures 4a and 4b.

8.2.3.1 The adjustable tongue shown in these figures shall be kept in working order and shall be adjusted to within 1/4-inch of the wheel periphery at all times.

8.3 Swing-Frame Grinders. Swing-frame grinders shall be provided with exhaust booths.

8.4 Portable Grinder Enclosures. Portable grinding operations, whenever the nature of the work permits, shall be conducted within a partial enclosure.

8.2. It is the dual function of grinding and abrasive cut-off wheel hoods to protect the operator from the hazards of bursting wheels, as well as to provide a means for the removal of contaminants generated.

8.2.1 Due to the variety of work and types of grinding machines used, it may be necessary to design hoods adaptable to the particular machine in question. These hoods should be located as close as possible to the operation. Figures 1 through 3 are examples of hood applications to miscellaneous operations that illustrate this principle.

Note: Size hood opening to receive the entire stream of grinding emissions. The face velocity of the hood should be at least 200 fpm and could be as high as 1000 fpm.

8.2.3 The user may need to modify these design criteria to meet local needs. This clarification applies to all the requirements of Section 8.

8.2.3.1 The tongue has the important function of acting as a baffle in breaking up the peripheral air current surrounding the wheel, thereby permitting the air flowing into the hood to entrain the contaminants generated.

8.3. The exhaust booth shown in Figure 5 provides appropriate criteria.

8.4 The grinding operation should be arranged so that the work is between the operator and the exhaust system and that contaminants generated are drawn away from the operators breathing zone. A turntable that allows the operator to maintain the flow of contaminant into the collector should be used where work permits.
8.4.1 The opening in the enclosure shall be no larger than is actually required in the operation, and an average face air velocity of not less than 200 feet per minute (fpm) shall be maintained.

8.5 Polishing and Buffing Hoods. Hoods for polishing, buffing, and scratch brush wheels shall be constructed as shown in Figure 7.

8.5.1 When extremely wide wheels are necessary, the wheel shall be operated within a partial enclosure similar to the one shown in Figure 9.

8.6 Cradle Grinding and Polishing Operations. Cradle grinding and polishing operations shall be performed within a partial enclosure similar to the one shown in Figure 9.

8.6.1 The operator shall be positioned outside the working face of the opening of the enclosure.

8.6.2 The face opening of the enclosure shall not be any greater in area than that actually required for the performance of the operation.

8.6.3 The average air velocity into the working face of the enclosure shall not be less than 150 fpm.

8.7 Automatic Rotary and Straight Line Buffing and Polishing. Automatic rotary or straight line buffers or polishers involving multiple heads shall be ventilated by complete enclosures.

8.7.1 The average air velocity into the working face of the opening shall be not less than 250 fpm.

In Figure 6, application of an enclosure to portable grinding operations is shown.

The user should provide documentation if "the nature of the work" does not allow the use of a partial enclosure.

8.5 For large or irregular shaped work, hood designs can be modified to suit the conditions.

A typical hood design approach for large parts is shown in Figure 8.
8.7.2 On straight line machines, where the work is fed via conveyor through the grinding/polishing operation, work shall be fed and received from the ends, and the top and sides of the conveyor shall be enclosed.

8.7.3 Exhaust volumes shown in Figures 10 and 11 shall be maintained to prevent contaminant from escaping the hood.

8.7.4 The enclosure shall be cleaned periodically.

8.8 Horizontal Single-Spindle Disc Grinder Hoods. Hoods for horizontal single-spindle disc grinders shall be constructed to conform with the hood shown in Figure 12.

8.8.1 There shall be a space between the back of the wheel and the hood, and a space around the periphery of the wheel of at least 1 inch, in order to permit the suction to act around the wheel periphery.

8.8.2 The opening on the side of the disc shall be no larger than is required for the grinding operation, but it shall never be less than twice the area of the branch duct.

8.9 Horizontal Double-Spindle Disc Grinder Hoods. Horizontal double-spindle disc grinders shall have a hood encircling the wheels and grinding chamber similar to that illustrated in Figure 13.

8.9.1 The openings for passing the work into the grinding chamber shall be kept as small as possible and shall never be less than twice the area of the branch ducts.

8.10 Vertical Spindle Disc Grinder Hoods. Vertical spindle disc grinders shall be encircled with a hood constructed so that the heavy particles are drawn off at the surface of the disc and the lighter dust is exhausted through a continuous slot at the top of the hood, as shown in Figure 14.

8.11 Grinding and Polishing Belt Hoods. Grinding and polishing belt hoods shall be constructed as close to the operation as possible.

8.7.2 The bottom may also be enclosed for additional containment, if appropriate cleanouts are provided.

8.11 The hood should extend almost to the belt and 1-inch wide openings should be provided on either side. A typical hood for a belt operation is shown in Figure 15.
9 Dilution Ventilation Systems

9.1 Dilution or general exhaust ventilation systems used for the control of fugitive emissions from grinding, polishing, and buffing operations shall be designed, constructed, commissioned, balanced, operated, tested and maintained in accordance with the requirements of ANSI/AIHA Z9.10–2007 Fundamentals Governing the Design and Operation of Dilution Ventilation Systems in Industrial Occupancies.
Wheel guard designed in accordance with ANSI B7.1

Top take-off (optional)

Rear take-off (best)

Hinged clean-out door

Booth width to suit regular work

Hinged side doors may be opened for longer pieces

Saw operates at face of booth

Close-in area under table

Reduce open area with baffles

Q = 250 cfm/ft² of open face area
Minimum duct velocity = 4000 fpm
Entry loss
  \( h_e = 0.25 \, V_P \) for tapered take-off
  \( h_e = 0.50 \, V_P \) for straight take-off

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Q = 0.043 Vs (10X² + A)

Minimum duct velocity = 3500 fpm

hₚ = 0.25 VPₚ

X = distance from hood face to center of wheel, ft

A = hood face area, ft²

Vs = wheel speed, surface feet per minute (sfm)

= \pi \left( \frac{D}{12} \right) R

D = diameter in inches

R = rpm of grinding wheel

Example for:
X = 4 inch
A = 3 inch by 4.5 inch

<table>
<thead>
<tr>
<th>Vₛ</th>
<th>Q, cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>52</td>
</tr>
<tr>
<td>2000</td>
<td>100</td>
</tr>
<tr>
<td>3000</td>
<td>160</td>
</tr>
<tr>
<td>4000</td>
<td>210</td>
</tr>
<tr>
<td>5000</td>
<td>260</td>
</tr>
<tr>
<td>6000</td>
<td>310</td>
</tr>
<tr>
<td>7000</td>
<td>360</td>
</tr>
<tr>
<td>8000</td>
<td>420</td>
</tr>
<tr>
<td>9000</td>
<td>470</td>
</tr>
<tr>
<td>10,000</td>
<td>520</td>
</tr>
</tbody>
</table>

Figure 2 — Surface Grinder. [From ACGIH®, Industrial Ventilation: A Manual of Recommended Practice, 26th Edition. Copyright 2007. Reprinted with permission.]
Figure 3 — Vertical spindle-cup wheel grinder exhaust hood.

Minimum duct velocity = 4000 fpm
Entry loss

- $h_e = 0.45 V P_d$ for tapered take-off
- $h_e = 0.65 V P_d$ for straight take-off

<table>
<thead>
<tr>
<th>Wheel diameter inches</th>
<th>Exhaust volume, cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 5</td>
<td>220</td>
</tr>
<tr>
<td>over 5 to 10</td>
<td>390</td>
</tr>
</tbody>
</table>
Adjustable tongue — (keep adjusted to not more than 1/4 inch from wheel)

1 inch clearance

Direction of rotation

Chip trap if desired

Exhaust flow rates, cfm

<table>
<thead>
<tr>
<th>Wheel diameter inches</th>
<th>Wheel width inches</th>
<th>Good enclosure*</th>
<th>Poor enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 5</td>
<td>1</td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>over 5 to 10</td>
<td>1.5</td>
<td>220</td>
<td>300</td>
</tr>
<tr>
<td>over 10 to 14</td>
<td>2</td>
<td>300</td>
<td>500</td>
</tr>
<tr>
<td>over 14 to 16</td>
<td>2</td>
<td>390</td>
<td>610</td>
</tr>
<tr>
<td>over 16 to 20</td>
<td>3</td>
<td>500</td>
<td>740</td>
</tr>
<tr>
<td>over 20 to 24</td>
<td>4</td>
<td>610</td>
<td>880</td>
</tr>
<tr>
<td>over 24 to 30</td>
<td>5</td>
<td>880</td>
<td>1200</td>
</tr>
<tr>
<td>over 30 to 36</td>
<td>6</td>
<td>1200</td>
<td>1600</td>
</tr>
</tbody>
</table>

*Special hood and tool rest as shown, no more than 25 percent of the wheel exposed.

Minimum duct velocity = 4000 fpm

\[ h_e = 0.40 \, V_{Pd} \text{ for tapered take-off} \]

\[ h_e = 0.65 \, V_{Pd} \text{ for straight take-off} \]

Figure 4a — Grinding wheel hood surface speeds less than or equal to 6500 SFPM. [From ACGIH®, *Industrial Ventilation: A Manual of Recommended Practice*, 26th Edition. Copyright 2007. Reprinted with permission.]
**ANSI/AIHA Z9.6–2008**

Adjustable tongue — (keep adjusted to not more than 1/4 inch from wheel)

1 to 1-1/2 inch

Direction of rotation

1 inch clearance

Special tool rest 1/2 inch

1/4 inch

2-7/8 inches

45°

Door with clean-out when desirable

Exhaust flow rates, cfm

<table>
<thead>
<tr>
<th>Wheel diameter inches</th>
<th>Wheel width inches</th>
<th>Good enclosure*</th>
<th>Poor enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 5</td>
<td>1</td>
<td>220</td>
<td>390</td>
</tr>
<tr>
<td>over 5 to 10</td>
<td>1.5</td>
<td>390</td>
<td>610</td>
</tr>
<tr>
<td>over 10 to 14</td>
<td>2</td>
<td>500</td>
<td>740</td>
</tr>
<tr>
<td>over 14 to 16</td>
<td>2</td>
<td>610</td>
<td>880</td>
</tr>
<tr>
<td>over 16 to 20</td>
<td>3</td>
<td>740</td>
<td>1000</td>
</tr>
<tr>
<td>over 20 to 24</td>
<td>4</td>
<td>880</td>
<td>1200</td>
</tr>
<tr>
<td>over 24 to 30</td>
<td>5</td>
<td>1200</td>
<td>1600</td>
</tr>
<tr>
<td>over 30 to 36</td>
<td>6</td>
<td>1600</td>
<td>2000</td>
</tr>
</tbody>
</table>

*Special hood and tool rest as shown, no more than 25 percent of the wheel exposed.

Minimum duct velocity = 4000 fpm

\[ h_e = 0.40 V_{Pd} \] for tapered take-off

\[ h_e = 0.65 V_{Pd} \] for straight take-off

**Figure 4b** — Grinding wheel hood surface speeds greater than 6500 SFPM. [From ACGIH®, *Industrial Ventilation: A Manual of Recommended Practice*, 26th Edition. Copyright 2007. Reprinted with permission.]
Baffle the front to reduce the opening as much as possible.
Minimum velocity at enclosure face is 150 ft/min
Entry loss = 0.45 \( V_{p0} \) for tapered take-off
Entry loss = 0.65 \( V_{p0} \) for straight take-off
Exhaust volume
- 150 cfm per ft\(^2\) of opening for large (4–6 ft.) openings
- 200 cfm per ft\(^2\) of opening for small (2–2.5 ft.) openings
Duct velocity
- 3500 fpm minimum
- 4500 fpm if material is wet or sticky

**Figure 5** — Swing-frame grinder exhaust hood.
Minimum face velocity = 200 fpm
Entry loss
\[ h_e = 1.78 \, V_P + 1.0 \, V_P_d \]

Figure 6 — Portable grinder work exhaust hood and branch duct connections.
Minimum duct velocity = 3500 fpm; 4500 fpm if wet or sticky

Entry loss

\[ h_e = 0.40 \text{ VPd} \text{ for tapered take-off} \]
\[ h_e = 0.65 \text{ VPd} \text{ for straight take-off} \]

Note:
1. Consult applicable NFPA codes for prevention of fire and explosion.
2. Caution: Do not mix ferrous and nonferrous metals in the same exhaust system.

<table>
<thead>
<tr>
<th>Wheel diameter inches</th>
<th>Wheel width inches</th>
<th>Exhaust flow rate cfm good* enclosure</th>
<th>Exhaust flow rate cfm poor enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 9</td>
<td>2</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>over 9 to 16</td>
<td>3</td>
<td>500</td>
<td>610</td>
</tr>
<tr>
<td>over 16 to 19</td>
<td>4</td>
<td>610</td>
<td>740</td>
</tr>
<tr>
<td>over 19 to 24</td>
<td>5</td>
<td>740</td>
<td>1200</td>
</tr>
<tr>
<td>over 24 to 30</td>
<td>6</td>
<td>1040</td>
<td>1500</td>
</tr>
<tr>
<td>over 30 to 36</td>
<td>6</td>
<td>1200</td>
<td>2000</td>
</tr>
</tbody>
</table>

*Not more than 25% of the wheel is exposed.

Figure 7 — Polishing and buffing hoods. [From ACGIH®, Industrial Ventilation: A Manual of Recommended Practice, 26th Edition. Copyright 2007. Reprinted with permission.]
Minimum duct velocity = 3500 fpm; 4500 fpm if wet or sticky

Entry loss

\[ h_e = 0.40 \, VP_d \] for tapered take-off

\[ h_e = 0.65 \, VP_d \] for straight take-off

Note:

1. Consult applicable NFPA codes for prevention of fire and explosion.
2. For titanium, aluminum, and magnesium, eliminate hopper and use 5000 fpm through hood cross section.
3. Caution: Do not mix ferrous and nonferrous metals in the same exhaust system.

<table>
<thead>
<tr>
<th>Belt width inches</th>
<th>Exhaust flow rate cfm good enclosure*</th>
<th>Exhaust flow rate cfm poor enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>220</td>
<td>300</td>
</tr>
<tr>
<td>2.0</td>
<td>390</td>
<td>610</td>
</tr>
<tr>
<td>3.0</td>
<td>500</td>
<td>740</td>
</tr>
<tr>
<td>4.0</td>
<td>610</td>
<td>880</td>
</tr>
<tr>
<td>5.0</td>
<td>880</td>
<td>1200</td>
</tr>
<tr>
<td>6.0</td>
<td>1200</td>
<td>1570</td>
</tr>
</tbody>
</table>

*Hood as shown; no more than 25% of the wheel exposed
\[ h_e = 0.40 \, VP_d \]

Baffle the front to reduce the opening as much as possible.

Minimum velocity at enclosure face is 150 fpm

- Entry loss = 0.45 VP₀ for tapered take-off
- Entry loss = 0.65 VP₀ for straight take-off

Exhaust volume

- 150 cfm per ft² of opening for large (4–6 ft.) openings
- 200 cfm per ft² of opening for small (2–2.5 ft.) openings

Duct velocity

- 3500 fpm minimum
- 4500 fpm if material is wet or sticky

**Figure 9** — Cradle polishing or grinding exhaust hood and branch duct connections.
Q = 500 cfm/wheel, minimum
Not less than 250 cfm/ft² total open area

Minimum duct velocity = 3500 fpm; 4500 fpm if material is wet or sticky

\[ h_s = 1.78 \, VP_d + 0.25 \, VP_d \]

Note:
1. Consult applicable NFPA codes for prevention of fire and explosion.
2. Caution: Do not mix ferrous and nonferrous metals in the same exhaust system.
3. Wheel adjustments on outside of enclosure.
4. For highly toxic material, enclose the return strand of the belt conveyor.
5. Inside of enclosure may have to be cleaned periodically.

ANSI/AIHA Z9.6–2008

Provide openings in solid walls to promote air flow.

Q = 500 cfm/wheel, minimum
Not less than 250 cfm/ft$^2$ total open area

Minimum duct velocity = 3500 fpm; 4500 fpm if material is wet or sticky

$h_e = 1.78 \, V_{P_d} + 0.25 \, V_{P_d}$

On small, 2 or 3 spindle machines, one take-off may be used.

Note:
1. Consult applicable NFPA codes for prevention of fire and explosion.
2. Caution: Do not mix ferrous and nonferrous metals in the same exhaust system.
3. Inside of enclosure may have to be cleaned periodically.

Minimum duct velocity = 4000 fpm
Entry loss
\[ h_e = 0.45 VP_d \] for tapered take-off
\[ h_e = 0.65 VP_d \] for straight take-off

Note: If grinding wheels are used for disc grinding purposes, hoods must conform to structural strength and materials as described in American National Standard for the Use, Care, and Protection of Abrasive Wheels, ANSI B7.1.

<table>
<thead>
<tr>
<th>Wheel diameter inches</th>
<th>Volume exhausted, ft³</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 12</td>
<td>220</td>
</tr>
<tr>
<td>over 12 to 19</td>
<td>390</td>
</tr>
<tr>
<td>over 19 to 30</td>
<td>610</td>
</tr>
<tr>
<td>over 30 to 36</td>
<td>880</td>
</tr>
</tbody>
</table>

Figure 12 — Horizontal single-spindle disc grinder exhaust hood and branch duct connections.
Entry loss
\[ h_e = 0.45 \, V P_d \] for tapered take-off
\[ h_e = 0.65 \, V P_d \] for straight take-off

Design as separate hoods for multiple take-offs

<table>
<thead>
<tr>
<th>Disc diameter</th>
<th>Number of exhaust take-off</th>
<th>Volume exhausted (ft³) at 4500 fpm</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 19</td>
<td>1</td>
<td>610</td>
<td></td>
</tr>
<tr>
<td>over 19 to 25</td>
<td>1</td>
<td>880</td>
<td></td>
</tr>
<tr>
<td>over 25 to 30</td>
<td>1</td>
<td>1200</td>
<td></td>
</tr>
<tr>
<td>over 30 to 53</td>
<td>2</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>over 53 to 72</td>
<td>4</td>
<td>6300</td>
<td></td>
</tr>
</tbody>
</table>

Any method of feeding parts to be ground may be used.

Figure 13 — Horizontal double-spindle disc exhaust hood and branch duct connections. [From ACGIH®, Industrial Ventilation: A Manual of Recommended Practice, 26th Edition. Copyright 2007. Reprinted with permission.]
Figure 14 — Vertical spindle disc grinder exhaust hood and branch duct connections. [From ACGIH®, Industrial Ventilation: A Manual of Recommended Practice, 26th Edition. Copyright 2007. Reprinted with permission.]