Examples of local exhaust ventilation.

(A) Prints which appear in this rule are copied from "Industrial Ventilation, A Manual of Recommended Practice," of the "American Conference of Governmental Industrial Hygienists." They are identified with the name of the organization.

(B) Index.

(1) "Principles of Dilution Ventilation"
(2) "Principles of Exhaust Hoods"
(3) "Building Air Inlets and Outlets"
(4) "Principles of Duct Design"
(5) "Stackhead Designs"
(6) "Abrasive Blasting Ventilation"
(7) "Auto Spray Paint Booth"
(8) "Large Drive-Through Spray Paint Booth"
(9) "Backstand Idler Polishing Machine"
(10) "Bag Filling"
(11) "Bag Tube Packer"
(12) "Banbury Mixer"
(13) "Rubber Calender Rolls"
(14) "Barrel Filling"
(15) "Bin and Hopper Ventilation"
(16) "Bucket Elevator Ventilation"
(17) "Circular Automatic Buffing"
(18) "Soft Wheel Buffing Lathe"
(19) "Straight Line Automatic Buffing"
(20) "Buffing and Polishing"
(21) "Conveyor Belt Ventilation"
(22) "Core Grinder"
(23) "Crucible Melting Furnace - High Toxicity Material"
(24) "Dip Tank"
(25) "Horizontal Double-Spindle Disc Grinder"
(26) "Horizontal Single-Spindle Disc Grinder"
(27) "Vertical Spindle Disc Grinder"
(28) "Dry Box or Glove Hood for High Toxicity and Radioactive Materials"
(29) "Drying Oven Ventilation"
(30) "Electric Rocking Furnace"
(31) "Hood for Top Electrode Melting Furnace"
(32) "Side-draft Hood and Enclosing Hood"
(33) "Double Side-draft and Downdraft Hood"
(34) "Exhaust Requirement"
(35) "Service Garage Ventilation - Underfloor"
(36) "Service Garage Ventilation - Overhead"
(37) "Granite Cutting and Finishing"
(38) "Grinder Wheel Hood Speeds Below 6500 SFM"
(39) "Grinder Wheel Hood Speeds Above 6500 SFM"
(40) "Downdraft Hoods and Booth-type Hoods"
(41) "Push Pull Hoods"
(42) "Jointers"
(43) "Laboratory Hood"
(44) "Kitchen Range Hoods"
(45) "Kitchen Range Hood - Low Side Wall Hood"
(46) "Indoor Pistol and Small Bore Rifle Range"
(47) "Lathe Hood High Toxicity Materials"
(48) "Melting Pot and Furnace Non-tilt"
(49) "Melting Furnace Crucible Non-tilt"
(50) "Melting Furnace - Tilting"
(51) "Die Casting Hood"
(52) "Die Casting Machine or Melting Furnace"
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(54) "Metal Shears High Toxicity Materials"
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(57) "Mixer and Muller Hood"
(58) "Mixer and Muller Ventilation"
(59) "Upward Plenum, Downward Plenum, Central Slot"
(60) "Pickling Tank, Semi-lateral, End Take-off"
(61) "Design Data"
(62) "Small Paint Booth"
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(64) "Portable Chipping and Grinding Table"
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(67) "Shell Core Molding"
(68) "Disc Sanders"
(69) "Horizontal Belt Sanders"
(70) "Multiple Drum Sander"
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(72) "Abrasive Cut-off Saw Ventilation"
(73) "Fluidized Beds"
(74) "Band Saws"
(75) "Swing Saws"
(76) "Table Saw"
(77) "Radial Saw"
(78) "Screens"
(79) "Soldering and Arc Welding"
(80) "Solvent Degreasing Tanks"
(81) "Swing Grinder"
(82) "Table Slot"
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(84) "Tumbling Mills"
(85) "Arc Welding"
(86) "Torch Cutting Ventilation"
(87) "Extractor Head for Cone Wheels and Mounted Points"
(88) "Hood for Cup Type Surface Grinders and Wire Brushes"
(89) "Pneumatic Chisel Sleeve"
(90) "Extractor Head for Small Radial Grinders"
(91) "Extractor Hood for Disc Sander"
(92) "Extractor Tool for Vibratory Sander"
(93) "Typical System Low Volume High Velocity"

Effective: 1/1/86
Poor air inlet

Poor air inlet

Poor air inlet

Fair air inlet

Fair air inlet

Fair air inlet

Good air inlet

Good air inlet

Good air inlet

POOR FAN LOCATIONS

GOOD FAN LOCATION

Plenum

Plenum

Best exhaust (local)
Calculate air volume
as booth/100cfm/sqft
open area.
Best air inlet

Note:
Inlet air requires tempering
during winter months.

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PRINCIPLES OF DILUTION VENTILATION
Capture Velocity — Air velocity at any point in front of the hood or at the hood opening necessary to overcome opposing air currents and to capture the contaminated air at that point by causing it to flow into the hood.

Face Velocity — Air velocity at the hood opening.

Slat Velocity — Air velocity through the openings in a slat-type hood, fpm. It is used primarily as a means of obtaining uniform air distribution across the face of the hood.

Plenum Velocity — Air velocity in the plenum, fpm. For good air distribution with slat-types of hoods, the maximum plenum velocity should be 1/2 of the Slat Velocity or less.

Duct Velocity — Air velocity through the duct cross section, fpm. When solid material is present in the air stream, the duct velocity must be equal to the minimum Transport Velocity.

Transport (Conveying) Velocity — Minimum air velocity required to move the particulates in the air stream, fpm.
GOOD
High discharge stack relative to building height, air inlet on roof.

POOR
Low discharge stack relative to building height, air inlet on roof and wall.
DUCT ENLARGEMENT

1 inch change in diameter to every 5 inches in length
GOOD

BAD

DUCT CONTRACTION

1 inch change in diameter to every 5 inches in length
GOOD

BAD

STACKHEAD

2000
2400
3000

2 4 6 8 10 12

Diameters

4000 rpm

WEATHER CAP

Wrong

Deflecting weather cap discharges downward.

Vertical discharge cap throws upward where dilution will take place.

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PRINCIPLES OF DUCT DESIGN
VERTICAL DISCHARGE
No loss

OFFSET ELBOWS
Calculate losses due to elbows

OFFSET STACK

1. Rain protection characteristics of these caps are superior to a deflecting cap located 0.75D from top of stack.

2. The length of upper stack is related to rain protection. Excessive additional distance may cause "Blowout" of effluent at the gap between upper and lower sections.
SECTION THRU TYPICAL ROOM

Rooms: 60-100 fpm downdraft; usual choice 80 fpm; or 100 fpm cross-draft. Operator in room requires Bureau of Mines approved abrasive blasting helmets.

Rotary tables: 200 cfm/sq ft of total openings (taken without curtains).

Cabinets: 20 air changes per minute.

At least 500 fpm inward velocity at all operating openings. Openings to be baffled.

Entry loss: 1 VP; or calculate from individual losses.

For small cabinets: Use rear plenum or trap to settle.

Trap loss: 1.5 VP

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ABRASIVE BLASTING VENTILATION
\[ Q = 100 \, \text{cfm/sq ft of cross-section area} \]

Entry loss = 0.50 VP plus resistance of each filter bank when dirty

Duct velocity = 1000 - 3000 fpm

Air filters to be sized for 275 cfm/sq ft of filter

Paint filters: combustibility Class 2 or better

size and number of filter for minimum area shown

\[ E = \text{duct diam} + 6" \]

Typical filter installation

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**AUTO SPRAY PAINT BOOTH**
Q* 50 cfm/sq ft of cross-sectional area  
(when WxH is greater than 150 sq ft)  
Entry loss = 0.50VP plus resistance of each filter bank when dirty  
Duct velocity = 1000 - 3000 fpm  
Air filters: Size for 275 cfm/sq ft of filters  
Paint filters: Combustibility Class 2 or better, consult mfr for size and number  

Note:  
Fan interlock with make-air supply and compressed air to spray gun is desirable
Side opening should be minimum. 
1/4" maximum is desirable.

Adjustable tongue. Not more than 1/4" from belt.

Hinged side panel for maintenance.

.75" for heavy dust accumulations
housing may extend to floor.

<table>
<thead>
<tr>
<th>Belt width inches</th>
<th>Exhaust volume cfm Good enclosure</th>
<th>Exhaust volume cfm Poor enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2</td>
<td>220</td>
<td>330</td>
</tr>
<tr>
<td>2</td>
<td>390</td>
<td>600</td>
</tr>
<tr>
<td>3</td>
<td>500</td>
<td>750</td>
</tr>
<tr>
<td>4</td>
<td>610</td>
<td>920</td>
</tr>
<tr>
<td>5</td>
<td>880</td>
<td>1300</td>
</tr>
<tr>
<td>6</td>
<td>1200</td>
<td>1600</td>
</tr>
</tbody>
</table>

* Hood as shown. No more than 25% of wheel exposed.
Entry loss = 0.40 VP
Duct velocity = 3500 fpm minimum

Note:
For titanium and magnesium, eliminate hopper and use 5000 fpm through hood cross section.
Bin

Hood attached to bin.

Principal dust source.

Scale support.

500 fpm maximum

\[ Q = 400 \text{ to } 500 \text{ cfm} - \text{non-toxic dust} \]
\[ 1000 \text{ to } 1500 \text{ cfm} - \text{toxic dust} \]

Duct velocity = 3500 fpm minimum

Entry loss = 0.25 VP

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BAG FILLING
\[ Q = 500 \text{ cfm/filling tube} \]
\[ = 500 \text{ cfm at Feed Hopper} \]
\[ = 950 \text{ cfm at Spill Hopper} \]
Duct velocity = 3500 fpm minimum
Branch entry loss = 0.25 VP (A & C)
\[ = 1.00 \text{ VP at open end (B)} \]
Q = 200 - 300 cfm/sq ft open face area.
500 cfm/ft of belt width if belt feeder used.
Duct velocity = 3500 fpm minimum.
Entry loss = 0.25 VP at hood
1.0 VP at trunnion
\( Q = 125 \text{ cfm/sq ft hood area (125 WL)} \)
\( \text{Duct velocity} = 1000 - 3000 \text{ fpm} \)
\( \text{Entry loss} = 0.25 \text{ duct VP} \)
Q = 100 cfm/sq ft barrel top min
Duct velocity = 3500 minimum
Entry loss = 0.25 VP + 1.78 slot VP
Manual loading.

Q = 150 cfm/sq ft open face area
Duct velocity = 3500 fpm minimum
Entry loss = 0.25 VP for 45° taper

Q = 50 cfm x drum dia (ft) for weighted lid
150 cfm x drum dia (ft) for loose lid
Duct velocity = 3500 fpm minimum
Entry loss = 0.25 VP

Q = 300-400 cfm
Duct velocity = 3500 fpm min
Entry loss = 0.25 VP
**MECHANICAL LOADING**

Duct velocity = 3500 fpm min
Q = 200 cfm/sq ft of all open area.
Enter loss = 0.25 VP

**MANUAL LOADING**

Duct velocity = 3500 fpm minimum
Q = 150 cfm/sq ft face
Entry loss = 0.25 VP

---

**Belt Speed**

Less than 200 fpm - 350 cfm/ft of belt width.
Not less than 150 cfm/ft of opening.

Over 200 fpm - 500 cfm/ft of belt width.
Not less than 200 cfm/ft of opening.

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**Bin & Hopper Ventilation**
Alternate exhaust point

Additional ventilation for hopper, bin, or screen

Preferred exhaust point

For casing only
\[ Q = 100 \text{ cfm/sq ft casing cross section} \]
Duct velocity = 3500 fpm minimum
Entry loss = 1.0 VP or calculate from individual losses

Take-off detail

Additional ventilation for conveyor discharge

Tight casing

Take-off at top for hot materials, at top and bottom if elevator is over 30 ft high, otherwise optional.

Belt speed Volume
Less than 200 fpm — 350 cfm/ft of belt width. Not less than 150 cfm/ft of opening
Over 200 fpm — 500 cfm/ft of belt width. Not less than 200 cfm/ft of opening

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BUCKET ELEVATOR VENTILATION
\[ Q = 500 \text{ cfm/wheel, minimum} \]
Not less than 250 cfm/sq ft total open area

Duct velocity = 3500 fpm minimum
Entry loss = 1.78 slot VP plus 0.25 duct VP
Use ammeters to gage wheel pressures

On small, 2 or 3 spindle machines, one take-off may be used
Multiple take-offs desirable
Provide automatic sprinklers or other fire protection. Consult
Fire and insurance Codes
### Table: Exhaust Volume

<table>
<thead>
<tr>
<th>Wheel Diameter Inches</th>
<th>Wheel Width Inches</th>
<th>Exhaust Volume cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>to 9</td>
<td>2</td>
<td>400</td>
</tr>
<tr>
<td>over 9 to 16</td>
<td>3</td>
<td>670</td>
</tr>
<tr>
<td>over 16 to 19</td>
<td>4</td>
<td>800</td>
</tr>
<tr>
<td>over 19 to 24</td>
<td>5</td>
<td>1100</td>
</tr>
<tr>
<td>over 24 to 30</td>
<td>6</td>
<td>1400</td>
</tr>
<tr>
<td>over 30 to 36</td>
<td>6</td>
<td>1800</td>
</tr>
</tbody>
</table>

Note: For wider wheels than listed, increase cfm with width
Duct velocity = 4500 fpm minimum
Entry loss = 0.40 VP

---

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Soft Wheel Buffing Lathe
Use one branch duct for each wheel
Hinged access doors for maintenance, normally closed

45°

Slow speed belt conveyor

\[ Q = 500 \text{ cfm/wheel, minimum} \]
\[ \text{Not less than } 150 \text{ cfm/sq ft total open area} \]
\[ \text{Duct velocity } \geq 4500 \text{ fpm minimum} \]
\[ \text{Entry loss } = 1.78 \text{ slot } VP \text{ plus } 0.25 \text{ duct } VP \]
\[ \text{Use ammeters to gage wheel pressures} \]
\[ \text{Wheel adjustments on outside of enclosure at the rear} \]

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STRAIGHT LINE AUTOMATIC BUFFING
Minimum duct velocity: 4500 fpm branch. 3500 fpm main.

Entry loss: 0.65 VP for straight take-off. 0.40 VP for tapered take-off.

<table>
<thead>
<tr>
<th>Wheel diam.</th>
<th>Wheel width *</th>
<th>Exhaust volume cfm Good enclosure</th>
<th>Exhaust volume cfm Poor enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches</td>
<td>inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 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>670</td>
</tr>
<tr>
<td>over 16 to 19</td>
<td>4</td>
<td>610</td>
<td>800</td>
</tr>
<tr>
<td>over 19 to 24</td>
<td>5</td>
<td>740</td>
<td>1100</td>
</tr>
<tr>
<td>over 24 to 30</td>
<td>6</td>
<td>1040</td>
<td>1400</td>
</tr>
<tr>
<td>over 30 to 36</td>
<td>6</td>
<td>1175</td>
<td>1800</td>
</tr>
</tbody>
</table>

* In cases of extra wide wheels, use wheel width to determine exhaust volume.
1. Conveyor transfer less than 3' fall. For greater fall provide additional exhaust at lower belt. See 3 below.

2. Conveyor to elevator with magnetic separator.

DESIGN DATA

Transfer points:
Enclose to provide 150-200 fpm indraft at all openings.
Minimum Q=350 cfm/ft belt width for belt speeds under 200 fpm
= 500 cfm/ft belt width for belt speeds over 200 fpm and for magnetic separators
Duct velocity =3500 fpm minimum
Entry loss = 0.25VP

Conveyor belts:
Cover belt between transfer points
Exhaust at transfer points
Exhaust additional 350 cfm/ft of belt width at 30° intervals. Use 45° tapered connections.
Entry loss = 0.25 VP

Note:
Dry, very dusty materials may require exhaust volumes 1.5 to 2.0 times stated values.

2" clearance for load on belt

Detail of belt opening

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CONVEYOR BELT VENTILATION
Disc diameter | Duct diameter | cfm  
---|---|---
up to 20" | 6" | 900  
over 20" to 30" | 8" | 1600  
over 30" to 53" | 12" | 3500  
over 53" to 72" | 16" | 6300  

Minimum duct velocity = 4500 fpm branch  
3500 fpm main  
Minimum slot velocity = 2000 fpm  
Enter loss = 1.0 slot velocity pressure plus 0.40 duct VP  

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CORE GRINDER
\[ Q = 175 \text{ cfm/sq ft of furnace top with curved slot and flanges} \]

Slot velocity = 2000 fpm
Duct velocity = 3500 fpm

Entry loss = 1.78 slot VP + 0.25 duct VP

---

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**CRUCIBLE MELTING FURNACE**
**HIGH TOXICITY MATERIAL**
Locate takeoffs 15° on center
Q = 50 cfm/sq ft drainboard area,
but not less than 100 fpm intake
through openings
Entry loss = 0.25 duct VP
Duct velocity = 1000 - 3000 fpm

For best results enclose drainboard as a drying tunnel.

45° min slope

1000 fpm maximum plenum velocity

Q = 125 cfm/sq ft of tank and drainboard area
Slat velocity = 2000 fpm
Entry loss = 1.78 slat VP + 0.25 duct VP
Duct velocity = 1000 - 3000 fpm

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DIP TANK
Disc diam. inches | Exhaust volume cfm
---|---
up to 19 | 610
over 19 to 25 | 880
over 25 to 30 | 1200
over 30 to 53 | 1770
over 53 to 72 | 6280

Minimum duct velocity = 4500 fpm branch, 3500 fpm main.
Entry loss = 0.65 velocity pressure for straight take-off.
= 0.45 velocity pressure for tapered take-off.

Note: Practically complete enclosure of discs with machine housing and exhaust from the housing is acceptable.

Endless belt conveyor or any other method.

Section A-A

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HORIZONTAL DOUBLE-SPINDLE DISC GRINDER
Opening to suit work. To be at least twice the area of the branch duct.

<table>
<thead>
<tr>
<th>Disc diam., inches</th>
<th>Exhaust volume, cfm</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>

Minimum duct velocity = 4500 fpm branch, 3500 fpm main.
Entry loss = 0.65 VP for straight take-off.
= 0.45 VP for tapered take-off.

Note: If best practical hood is a poor enclosure, increase exhaust volume accordingly.
<table>
<thead>
<tr>
<th>Disc diam., inches</th>
<th>1/2 or more of disc covered</th>
<th>Disc not covered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.*</td>
<td>Exhaust, cfm</td>
</tr>
<tr>
<td>up to 20</td>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>over 20 to 30</td>
<td>2</td>
<td>780</td>
</tr>
<tr>
<td>over 30 to 33</td>
<td>2</td>
<td>1770</td>
</tr>
<tr>
<td>over 53 to 72</td>
<td>2</td>
<td>3140</td>
</tr>
</tbody>
</table>

* Number of exhaust outlets around periphery of hood, or equal distribution provided by other means.

Slot velocity = 2000 fpm
Duct velocity = 4500 fpm minimum in branch
3500 fpm minimum in main
Entry loss = 1.0 slot VP + 0.5 branch duct VP

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VERTICAL SPINDLE DISC GRINDER
To final air cleaning filter and,
fan outside of building

Air lock

Glass window

Roughing filter

Self closing door

Glove ports


Q = 50 cfm/sq ft of open door area and 0.25" SP
on a closed system
Entry loss = 0.50 VP
Duct velocity = 2000 - 4000 fpm
Filters: 1. Inlet air filters in doors.
2. Roughing filter at exhaust connection to hood.
3. Final air cleaning filter.

All facilities totally enclosed in hood. Exterior controls may be advisable.
Arm length rubber gloves are sealed to glove port rings.
Strippable plastic on interior and air cleaner on exhaust outlet may be
used to facilitate decontamination of the system.
Filter units may be installed in the doors to allow the air flow necessary
for burners etc.

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DRY BOX OR GLOVE HOOD
FOR HIGH TOXICITY & RADIOACTIVE
MATERIALS
**SLOT TYPE**

\[ Q = 100 \text{ cfm/sq ft door plus } 1/2 \text{ products of combustion} \]

Entry loss = 1.0 slot VP plus 0.25 duct VP

Duct velocity = 1000 - 3000 fpm

Size plenum for 500 fpm maximum

Slot on three sides size for 1000 fpm
Locate on inside or outside of door

---

**CANOPY TYPE**

\[ Q = 200 \text{ cfm/sq ft of hood face} \]

plus 1/2 products of combustion

Entry loss = 0.25 VP

Duct velocity = 1000 - 3000 fpm

Note:
For dryers, include volume of water vapor liberated

---

Note:
Hoods at each end of oven. Reduce size of doors as much as possible. Separate vent must be added for products of combustion.
$Q = 400 \text{ cfm/ft of opening}$

Duct velocity $= 1000 - 3500 \text{ fpm}$

Entry loss $= 1.78 \text{VP slot} + 0.25 \text{VP duct}$

* For horizontal runs, transport velocity is necessary
Flanged by-passing connection — no exhaust during furnace tilting and pouring

Exhaust transition

Electrodes

Slag door hood

Hood is fastened to furnace roof and swings with roof

Furnace body

Hood over pouring spout

For Q, SP and operating temperature, consult manufacturers
Approximate exhaust volume = 2500 cfm/ton of charge(11)(22)(23)

Alternate designs:
1. Other exhaust designs utilize direct furnace roof tap. For details consult manufacturers.
2. Canopy hood exhaust can be utilized but requires large exhaust air volumes; \( Q = 200 \text{ cfm/sq ft of open area} \) between furnace and lower edge of canopy.
SIDE DRAFT HOOD

Duct velocity = 3500 fpm minimum,
Entry loss = 1.78 slot VP + 0.25 duct VP

ENCLOSING HOOD
Provides best control with least volume,
Duct velocity = 3500 fpm minimum,
Entry loss = 0.25 VP

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FOUNDRY SHAKEOUT
DOUBLE SIDE-DRAFT
Proportions same as single side-draft hood except for overhang.

PLUNNUM chamber and slots full length of shakeout-in tunnel.

DOWNDRAFT HOOD
Slots sized for 1500 - 2000 fpm
Duct velocity = 4000 fpm minimum
Size D for 1000 fpm or less
Entry loss = 1.75 slot VP plus fittings
For cool casings only
Difficult to prevent plugging or excess fines removal

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FOUNDRY SHAKEOUT
### Shakeout exhaust, minimum

<table>
<thead>
<tr>
<th>Type of hood</th>
<th>Hot castings</th>
<th>Cool castings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enclosing**</td>
<td>200 cfm/sq ft opening</td>
<td>200 cfm/sq ft opening</td>
</tr>
<tr>
<td></td>
<td>At least 200 cfm/sq ft</td>
<td>At least 150 cfm/sq ft</td>
</tr>
<tr>
<td></td>
<td>grate area</td>
<td>grate area</td>
</tr>
<tr>
<td>Enclosed two sides and</td>
<td>300 cfm/sq ft grate area</td>
<td>275 cfm/sq ft grate area</td>
</tr>
<tr>
<td>1/3 top area **</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Side hood (as shown or</td>
<td>400-500 cfm/sq ft grate area</td>
<td>350-400 cfm/sq ft grate area</td>
</tr>
<tr>
<td>equivalent)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double side hood **</td>
<td>400 cfm/sq ft grate area</td>
<td>300 cfm/sq ft grate area</td>
</tr>
<tr>
<td>Downdraft **</td>
<td>Not recommended</td>
<td>200-250 cfm/sq ft grate area</td>
</tr>
<tr>
<td></td>
<td>600 cfm/sq ft grate area</td>
<td></td>
</tr>
</tbody>
</table>

*Choose higher values when:
(1) Castings are quite hot
(2) Sand to metal ratio is low
(3) Cross-drafts are high

**Shakeout hoppers require exhaust with 10% of the total exhaust volume.
***Grate area must be greater than flask area. If castings and sand completely cover grate, ventilation will not function.

---

[Diagram of exhaust system with labels: Grate, Shield, Area = 4 x duct area minimum, End view, Hopper exhaust detail, AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS, FOUNDRY SHAKEOUT]
**Note:** In ventilating a garage, use either the overhead or under floor system. Exhaust to be discharged above roof.

- **Flex duct to tailpipe**
- Double or single floor plates suitable. Self-closing floor plates desirable.
- To fan and discharge above roof
- Along ceiling of floor below or in trench. If in trench, drain tile with cemented joints is suitable. Must be sloped and drained for flushing.
- Size main for 2000 cfm or less.
- Sump or dry well

### UNDER FLOOR SYSTEM

#### EXHAUST REQUIREMENTS *

<table>
<thead>
<tr>
<th>Type</th>
<th>cfm per vehicle</th>
<th>Flex duct ID (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobiles and trucks up to 200 hp</td>
<td>100</td>
<td>3&quot;</td>
</tr>
<tr>
<td>Automobiles and trucks over 200 hp</td>
<td>200</td>
<td>4&quot;</td>
</tr>
<tr>
<td>Diesel</td>
<td>400</td>
<td>4 1/2&quot;</td>
</tr>
</tbody>
</table>

*On dynamometer test rolls

Automobiles and light duty trucks = 2 x cfm above

Heavy duty trucks = 1200 cfm minimum.

**3" dia permissible for short runs with proper fan.**

For friction loss of flexible duct; consult manufacturers' data.

Dilution ventilation is necessary for cars in motion or idling outside of stalls.

**DILUTION RATES:**

- 5000 cfm/running automobile
- 10,000 cfm (or more)/truck
- 100 cfm/horsepower for diesel

Use adapters on dual exhausts and special tailpipes.

---

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**Service Garage Ventilation Underfloor**
Main duct:
Plenum design best — size for 2000 fpm maximum
or design as in Section 6

At least 5'

Weatherhood

Fan

Flexible joint

Hose can be counterweighted

30°-45°

10'-12' from floor

All joints soldered

For dual nozzles
Use one hose with "Y"
or
Use two outlets per stall

<table>
<thead>
<tr>
<th>Vehicle horsepower</th>
<th>cfm/vehicle</th>
<th>Flexible duct diam</th>
<th>Branch connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 200 hp</td>
<td>100</td>
<td>3&quot;</td>
<td>4&quot;</td>
</tr>
<tr>
<td>Over 200 hp</td>
<td>200</td>
<td>4&quot;</td>
<td>4&quot;</td>
</tr>
<tr>
<td>Diesel</td>
<td>400</td>
<td>4 1/2&quot;</td>
<td>6&quot;</td>
</tr>
</tbody>
</table>

On dynamometer test rolls
Automobiles and light duty trucks = 2 x cfm above
Heavy duty trucks = 1200 cfm minimum

For friction loss of flexible duct, consult manufacturers' data

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SERVICE GARAGE VENTILATION
OVERHEAD
PNEUMATIC HAND TOOLS

Q = 540 cfm, tool 10" max distance from hood.
Resistance of unit = 8" wg at branch duct connection
Minimum duct velocity = 4000 fpm

Note:
Work may be done in a booth similar to spray booth; face velocity = 200 fpm
See VS-101

Abrasive blasting to be done in a room or cabinet; 500 fpm at all openings. See "Abrasive Blasting"

SURFACING MACHINE HOOD

<table>
<thead>
<tr>
<th>Tool diam</th>
<th>cfm</th>
<th>Branch diam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 2-3/8&quot;</td>
<td>500</td>
<td>4&quot;</td>
</tr>
<tr>
<td>2-3/8&quot; to 2-7/8&quot;</td>
<td>1000</td>
<td>5-1/2&quot;</td>
</tr>
<tr>
<td>Entry loss = 1.0VW</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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GRANITE CUTTING AND FINISHING
Adjustable tongue (keep adjust to not more than 1/4" from wheel)

1" clearance

1" to 1 1/2"

EXHAUST VOLUME, 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>to 5</td>
<td>1</td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>over 5 to 10</td>
<td>1/2</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>3</td>
<td>390</td>
<td>610</td>
</tr>
<tr>
<td>over 16 to 20</td>
<td>4</td>
<td>500</td>
<td>740</td>
</tr>
<tr>
<td>over 20 to 24</td>
<td>5</td>
<td>610</td>
<td>880</td>
</tr>
<tr>
<td>over 24 to 30</td>
<td>6</td>
<td>880</td>
<td>1200</td>
</tr>
<tr>
<td>over 30 to 36</td>
<td>7</td>
<td>1200</td>
<td>1570</td>
</tr>
</tbody>
</table>

* No more than 25% of wheel exposed

Minimum duct velocity: 4500 fpm in branch
3500 fpm in main

Entry loss = 0.65 VP for straight takeoff
0.40 VP for tapered takeoff

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GRINDER WHEEL HOOD
SPEEDS BELOW 6500 sfm
EXHAUST VOLUME, CFM

<table>
<thead>
<tr>
<th>Wheel diam inches</th>
<th>Wheel width inches</th>
<th>Good enclosure</th>
<th>Poor enclosure</th>
</tr>
</thead>
<tbody>
<tr>
<td>to 5</td>
<td>1</td>
<td>220</td>
<td>390</td>
</tr>
<tr>
<td>over 5 to 10</td>
<td>1 1/2</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>1040</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>1570</td>
</tr>
<tr>
<td>over 30 to 36</td>
<td>6</td>
<td>1570</td>
<td>1990</td>
</tr>
</tbody>
</table>

* Special hood and tool rest as shown
Minimum duct velocity = 4,500 fpm in branch
3,500 fpm in main
Entry loss = 0.65 VP for straight takeoff
0.40 VP for tapered takeoff

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GRINDER WHEEL HOOD
SPEEDS ABOVE 6500 sfm
**DOWN DRAFT HOODS**

Not recommended for hot or heat-producing operations if downdraft area is large. See "Capture Velocity" in this Section.

**BOOTH-TYPE HOODS**

\[ Q = AV \]

(A = face area, sq. ft.; V = face velocity, ft/min)

Baffles are optional for air distribution; not required if a water wall booth or other means for distribution is provided.

S varies from 4 inches to 6 inches, depending on size of booth.

T varies from 6 inches to 12 inches, depending on size of booth.

Increase the number of panels with size of booth.

For booths 3 feet by 3 feet and smaller, provide one panel 6 inches larger than fan diameter.
**PUSH PULL HOODS**

**Exhaust Hood**

- Quantity of air exhausted,
  \[ Q_e = 100 \text{ to } 150 \text{ cfm/ft. of tank area, depending on temperature of liquid, cross drafts, agitation, etc.} \]
- Hood height should be,
  \[ H = D \times \tan 10^\circ \times 0.18D \]

**Pressure Slot**

- Quantity of air supplied,
  \[ Q_i = \frac{1}{D \times E} \times Q_2 \]
  where; \( D \) = length of throw, feet
  \( E \) = entrainment factor.

<table>
<thead>
<tr>
<th>Throw length, D, feet</th>
<th>Entrainment factor, E</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 8</td>
<td>2.0</td>
</tr>
<tr>
<td>8 - 16</td>
<td>1.4</td>
</tr>
<tr>
<td>16 - 24</td>
<td>1.0</td>
</tr>
<tr>
<td>over 24</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Slot width \( W \) should be designed for a velocity of 1000 to 2000 fpm.

Design such systems so they can be easily modified or adjusted to obtain desired results.
Min. velocity at this space, 2000 fpm

1/2" minimum clearance

Cleanout or dead-end cap.

<table>
<thead>
<tr>
<th>Knife length, inches</th>
<th>Exhaust volume, cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 6 incl.</td>
<td>350</td>
</tr>
<tr>
<td>over 6 to 12 incl.</td>
<td>440</td>
</tr>
<tr>
<td>over 12 to 20 incl.</td>
<td>550</td>
</tr>
<tr>
<td>over 20</td>
<td>800</td>
</tr>
</tbody>
</table>

Duct velocity = 3500 fpm
Entry loss = 1.0 slot VP + 0.25 duct VP

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JOINTERS
AIRFOIL HOOD

Room air by-pass does not open until sash is 75% closed
Movable sash can have horizontal sliding panels
Recessed bottom
Airfoil sill

For air conservation use sliding sash

Q = 100 - 150 cfm/sq ft open door area
Entry loss = 0.5 VP
Duct velocity = 1000 - 2000 fpm
to suit conditions

Compensating Hood

Maximum air supply volume = 50% exhaust volume

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LABORATORY HOOD
Hood Against Wall

Q = 80 cfm/sq.ft of hood area (80 WL)
Not less than 50 cfm/sq.ft of face area (50 PH)
Duct velocity = 1000 - 4000 fpm, to suit conditions
Entry loss = 0.25 (filter resistance) + 0.50 duct VP
P = perimeter of hood = 2W + L

Island Type Hood

Q = 125 cfm/sq.ft of hood area (125 WL)
Not less than 50 cfm/sq.ft of face area (50 PH)
Duct velocity = 1000 - 4000 fpm, to suit conditions
Entry loss = 0.25 (filter resistance) + 0.50 duct VP
P = perimeter of hood = 2W + 2L

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Kitchen Range Hoods
LOW SIDE WALL HOOD

Q = 200 cfm/linear ft of cooking surface (200 L)
Duct velocity = 1000-4000 fpm, to suit conditions
Entry loss = 0.25" (filters) + 0.25 duct VP

NOTES FOR KITCHEN HOODS

Filters:
1. Select practical filter size.
2. Determine number of filters required from manufacturer's data.
   (Usually: 2 cfm maximum exhaust for each sq in of filter area)
3. Install at 45°-60° to horizontal. Never horizontal.
4. Filter mounting height
   a. No exposed cooking flame — 2½" minimum to lowest edge of filter.
   b. Charcoal and similar fires — 4½" minimum to lowest edge of filter.
   c. Other exposed fires ——— 3½" minimum to lowest edge of filter
5. Shield filters from direct radiant heat
6. Provide removable grease drip pan
7. Clean pan and filters regularly.

Fan:
Use upblast discharge fan. Downblast is not recommended.

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KITCHEN RANGE HOOD

Adjust fan specification for expected exhaust air temperature.
0 = 50 HW, but not less than 20 cfm/sq ft of room cross sectional area.

Notes:

Make-up air:
Minimum temperature = 70 F
Sidewall grilles:
Maximum grille velocity = 400 fpm
Discharge air downward
Ceiling diffusers:
Size for uniform distribution
Approved lead dust respirator is necessary during clean-up
Acoustical material on walls, ceiling and thick fabric on bench top are recommended

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INDOOR PISTOL AND SMALL BORE RIFLE RANGE VENTILATION
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LATHE HOOD
HIGH TOXICITY MATERIALS
Q = 100 - 200 scfm/sq ft of opening plus volume of products of combustion.
Duct velocity = 2000 - 3500 fpm.

Entry loss = 0.50VP
* Correct for temperature.
** For horizontal runs, transport velocity is necessary.

NOTE: Separate flue required if combustion gases are not vented through the hoods.

Work openings. Keep as small as practical. Doors advisable.

Dross chute, min angle = 60°

Door for dross pan, removable.

Stationary Furnace or Melting Pot

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Melting Pot & Furnace Non-Tilt
Q = 200 scfm/sq ft of opening including doors, plus products of combustion.*
Entry loss = 0.5 V.P.
Duct velocity = 1000 - 3500 fpm **
* Correct for temperature.
** For horizontal runs, transport velocity is necessary.

**NOTE:** Some principle of sliding or swinging doors is applied to individual furnace enclosures.

Q = 200 cfm /sq ft of total opening, minimum.

---

Exhaust stack
Fireproof drop panel from roof.
Canopy to clear crane; or slot for crane bridge, or separate cranes inside and outside, or manual crucible removal.

---

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**MELTING FURNACE CRUCIBLE NON-TILT**
Q = 200 LW; but not less than 200 scfm/sq ft of all openings with doors open.*
Entry loss = 0.25 VP
Duct velocity = 1000 - 3500 fpm**
*Correct for temperature and combustion products.
**For horizontal runs, transport velocity is necessary.

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MELTING FURNACE - TILTING
Flange type fitting for easy removal of hood (if necessary).

Hinged baffle for preventing short circuiting of air.

Note: Place hood as close to machine as possible. If more than 4 inches from back of machine, hinged side baffles should be used.

Note: Products of combustion require separate flue or may be vented into hood.

\[ Q = 300WH \]
Entry loss = 0.25 duct VP
Duct velocity = 2500 - 3000 fpm
Stack and mobile hood match here

Crane beam

Die hoist

Hood travels on die hoist crane

Q = 300WL
Duct velocity = 1000 - 3000 fpm
Entry loss = 0.25 duct VP

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DIE CASTING MACHINE OR MELTING FURNACE
<table>
<thead>
<tr>
<th>Belt width, inches</th>
<th>Exhaust volume, cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 3</td>
<td>220</td>
</tr>
<tr>
<td>3 to 5</td>
<td>300</td>
</tr>
<tr>
<td>5 to 7</td>
<td>390</td>
</tr>
<tr>
<td>7 to 9</td>
<td>500</td>
</tr>
<tr>
<td>9 to 11</td>
<td>610</td>
</tr>
<tr>
<td>11 to 13</td>
<td>740</td>
</tr>
</tbody>
</table>

Minimum duct velocity = 4500 fpm branch, 3500 fpm main. 
Entry loss = 0.65 velocity pressure for straight take-off. 
0.45 velocity pressure for tapered take-off.
METALLIZING BOOTH

Non-toxic: \( Q = 125 \text{ cfm/sq.ft. face area} \)

Toxic: Provide approved air-supplied respirator.
\( Q = 200 \text{ cfm/sq.ft. face area} \)

Duct velocity = 3000 fpm minimum
Entry loss = 1.78 slot VP + 0.25 duct VP
Small lathe, etc., may be mounted in booth

Local hood not satisfactory for spraying toxic metals.

Note: Local hood not satisfactory for spraying toxic metals.

\( Q = 200 \text{ cfm/sq ft. face openings} \)
Duct velocity = 3500 fpm minimum
Entry loss = 0.75 VP

LOCAL HOOD

Hood extends as low as possible to clear lathe tail. Hood may be connected to move with tool rest.

Gun (on tool post)

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METAL SPRAYING
To prevent condensation, insulation or strip heaters may be necessary or use dilution fitting.

Hood behind skip between rails \( Q = 250 \text{ LW cfm} \)

Slots

Opening for skip loading

\( Q = 150 \text{ cfm/sq ft through all openings but not less than:} \)

<table>
<thead>
<tr>
<th>Mixer diam, feet</th>
<th>Exhaust, cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>750</td>
</tr>
<tr>
<td>6</td>
<td>900</td>
</tr>
<tr>
<td>7</td>
<td>1050</td>
</tr>
<tr>
<td>8</td>
<td>1200</td>
</tr>
<tr>
<td>10</td>
<td>1575</td>
</tr>
</tbody>
</table>

For Cooling Mullers, See VS-108

Other types of mixers: enclose as much as possible and provide 150 cfm/sq ft of remaining openings

When flammable solvents are used in mixer, calculate minimum exhaust volume for dilution to 25% of the LEL

Duct velocity = 3500 fpm, min

Entry loss = 0.25 VP

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MIXER AND MULLER HOOD
To prevent condensation, insulation or strip heaters may be necessary or use dilution fitting.

Hood behind skip between rails O: 250 LW cfm

Enclosing Hood

Muller

Skip

Slots

Opening for skip loading

$Q = 150 \text{ cfm/sq ft through all openings but not less than:}$

<table>
<thead>
<tr>
<th>Mixer diam, feet</th>
<th>Exhaust, cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>750</td>
</tr>
<tr>
<td>6</td>
<td>900</td>
</tr>
<tr>
<td>7</td>
<td>1050</td>
</tr>
<tr>
<td>8</td>
<td>1200</td>
</tr>
<tr>
<td>10</td>
<td>1575</td>
</tr>
</tbody>
</table>

For Cooling Mullers, See VS-10B

Other types of mixers: enclose as much as possible and provide 150 cfm/sq ft of remaining openings.

When flammable solvents are used in mixer, calculate minimum exhaust volume for dilution to 25% of the LEL.

Duct velocity = 3500 fpm, min

Entry loss = 0.25 VP

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MIXER AND MULLER HOOD
To prevent condensation, insulation or strip heaters may be necessary or use dilution fitting.

Muller

Sand bin

Batch hopper

45°

Low-velocity duct used with cooling type muller.

Bond hopper

Muller

Cooling fan blow-through arrangement

---

**Minimum exhaust volume**

<table>
<thead>
<tr>
<th>Location</th>
<th>Muller type</th>
<th>No cooling</th>
<th>Blow-thru cooling</th>
<th>Draw-thru Cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch hopper</td>
<td>Note 1</td>
<td>600</td>
<td>600</td>
<td>Note 1</td>
</tr>
<tr>
<td>Bond hopper</td>
<td>Note 2</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Muller</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>4' diameter</td>
<td>750</td>
<td>Note 3</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>6 diameter</td>
<td>900</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>7 diameter</td>
<td>1050</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>8 diameter</td>
<td>1200</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>10 diameter</td>
<td>1575</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

Duct velocity = 4500 fpm minimum
Entry loss = 0.25 VP

Notes:
1. Batch hopper requires separate exhaust with blow-thru cooling. With other fan arrangement, (muller under suction) separate exhaust may not be required. (If skip hopper is used, see VS-107)
2. Maintain 150 fpm velocity through all openings in muller hood. Exhaust volume shown are the minimum to be used.
3. Cooling mullers do not require exhaust if maintained in dust tight condition. Blow-thru fan must be off during loading. If muller is not dust tight, exhaust as in note 2 plus cooling air volume.
4. When flammable solvents are used in mixer, calculate minimum exhaust volume for dilution to 25% of the LEL

---

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**Mixer and Muller Ventilation**
A. UPWARD PLENUM

B. DOWNWARD PLENUM

C. CENTRAL SLOT

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OPEN SURFACE TANKS
D. PICKLING TANK

To extend over tank as far as possible

E. SEMI-LATERAL

Max. plenum velocity = 1/2 slot velocity

F. END TAKE-OFF

Slot velocity 2000 fps
A. Duct velocity = 2000 fpm minimum.
B. Entry loss = 1.78 slot VP plus duct entry loss.
C. Maximum plenum velocity = one-half slot velocity.
D. Slot velocity = 2000 fpm unless distribution provided by well-designed fish-tail.
E. Provide ample excess area at small end of plenum.
F. If L exceeds 6 to 10 feet, multiple take-offs are advisable.
G. If W = 20 inches, slot on one side suitable.
    If W = 20 to 36 inches, slots on both sides desirable.
    If W is much greater than 36 inches, slots on both sides are necessary unless all other conditions are optimum.
H. Liquid level to be at least 6 inches below bottom of slot.
I. Hood types A, C, D and E, are preferred--Plenum acts as baffle to room air currents.
J. Provide enclosures or removable covers on tank if possible.
K. Provide ductwork with clean-outs and drains, and corrosion resistant coating if necessary.
## MINIMUM* EXHAUST VOLUME
### OPEN SURFACE TANKS

<table>
<thead>
<tr>
<th>Operation</th>
<th>CFM/sq. ft. of tank</th>
<th>Collector Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plating (Chrome, Cyanide solutions if needed)</td>
<td>150</td>
<td>X</td>
</tr>
<tr>
<td>Anodizing</td>
<td>120</td>
<td>X</td>
</tr>
<tr>
<td>Pickling:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold Acid</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Hot Acid</td>
<td>250</td>
<td>X</td>
</tr>
<tr>
<td>Nitric and Sulfuric Acids</td>
<td>250</td>
<td>X</td>
</tr>
<tr>
<td>Nitric and Hydrofluoric Acids</td>
<td>250</td>
<td>X</td>
</tr>
<tr>
<td>Cleaning:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caustic or Electrolytic-not boiling</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Caustic or Electrolytic-boiling</td>
<td>250</td>
<td>X</td>
</tr>
<tr>
<td>Bright Dip-strong Nitric Acid</td>
<td>250</td>
<td>X</td>
</tr>
<tr>
<td>Stripping:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentrated Nitric Acid</td>
<td>250</td>
<td>X</td>
</tr>
<tr>
<td>Concentrated Nitric and Sulfuric Acids</td>
<td>250</td>
<td>X</td>
</tr>
<tr>
<td>Salts Baths (molten salt)</td>
<td>120</td>
<td>X</td>
</tr>
<tr>
<td>Salt Solution (Parkerize, Bonderize, etc.):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not boiling</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Boiling</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>Hot Water (if ventilation desired):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not boiling</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Boiling</td>
<td>250</td>
<td></td>
</tr>
</tbody>
</table>

* Values listed are the minimum satisfactory values under good plant conditions.
1. Solid Baffle
   \[ B = 0.75D \]
   \[ \text{Baffle area} = 0.60WH \]

2. Angular Baffle
   \[ B = D + 6'' \]
   \[ \text{Baffle area} = 0.60WH \]

3. Split Baffle or Filters
   \[ B = D + 6'' \]
   \[ \text{Baffles or filters} = 0.75WH \]
   Filter combustibility Class 2 or better. Consult NFBU or insurance underwriters.

Design data:
Any combination of branch ducts and baffles may be used.
\[ W = \text{work size} + 12'' \]
\[ H = \text{work size} + 12'' \]
\[ C = 0.75W \text{ or } H, \text{ whichever is larger.} \]
\[ Q = 200 \text{ cfm/sq.ft} \text{ (200WH)} \] for face area up to 4 sq.ft.
\[ = 150 \text{ cfm/sq.ft} \] for face area over 4 sq.ft.
Entry loss = Baffles: 1.78 slot VP + 0.50 duct VP
= Filters: Dirty filter resistance + 0.50 duct VP
Duct velocity = 1000 – 3000 fpm

Note: Baffle arrangements shown are for air distribution only. Filters and/or other air cleaning devices may be required to meet air pollution codes or local conditions.
1. Split Baffle or Filters
   B = .75 D
   Baffle or filter area = .75 WH
   Filter combustibility Class 2 or better.
   Consult AIA or Insurance Underwriters

DESIGN DATA
Any combination of duct connections and baffles may be used. Large, deep booths do not require baffles. Consult manufacturers for water-curtain designs. Use explosion proof fixtures and non-sparking fan. Electrostatic spray booth requires automatic high-voltage disconnects for conveyor failure, fan failure or grounding.

Walk-in booth
W = work size + 6'
H = work size + 3' (minimum = 7')
C = work size + 6'
Q = 100 cfm/sq.ft. booth cross section
May be 75 cfm/sq.ft. for very large, deep booths. Operator may require approved respirator.
Entry loss = Baffles: LTE slot VP +
0.50 duct VP
= Filters: dirty filter resistance + 0.50 duct VP
Duct velocity = 1000 - 3000 fpm

Operator outside booth
W = work size + 2'
H = work size + 2'
C = 0.75 x larger front dimension
Q = 100 - 150 cfm/sq.ft. of open area, including conveyor openings.

Note: Baffle arrangements shown are air distribution only. Filters and/or other air cleaning devices may be required to meet air pollution codes or local conditions.
Opening to be sized to handle 3/4 of total air at 1000 fpm
Opening to be sized to handle 1/4 of total air at 200 fpm

Q = 150 cfm/sq.ft. of hood face
Duct velocity = 3500 fpm
Entry loss = 0.25 VP

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PORTABLE CHIPPING AND GRINDING TABLE
Q = 150 - 250 cfm/sq. ft. of bench area.
Minimum duct velocity = 3500 fpm
Entry loss = 0.25 VP for tapered take-off.

Grinding in booth, 100 fpm face velocity also suitable.

For downdraft grilles in floor: Q = 100 cfm/sq ft of working area.

Provide equal distribution. Provide for cleanout.
SMALL MOLDS

Unflanged hood: \( Q = 200 \left(10X^2 + \text{hood area}\right) \).
Flanged hood, reduce \( Q \) 25%.
Duct velocity \( = 2000 \text{ fpm} \).
Entry loss \( = 0.25VP \) (for slots, \( 1.78 \text{ slot VP} + 0.25 \text{ duct VP} \)).

PARTIAL SIDE ENCLOSURE

Use slots for distribution.
Slot velocity = \( 1500 - 2000 \text{ fpm} \).

NOTE:

For large molds and ladles,
provide large side-draft hood similar to sketchout.

\( Q = 400 \text{ cfm} \) per ft. of working area.

\( Q = 200 - 300 \text{ cfm} \) per ft. of hood.
Q = 250 cfm/sq ft canopy - single unit
150 cfm/sq ft canopy - double unit
Entry loss = 0.25 VP for tapered take-off

Slotted side draft hoods required to remove smoke as hot cores emerge from machine.
Capture velocity = 75 fpm minimum
Q = 75(10h^2/3) hood area
Entry loss = 1.78 slot VP + 0.25 duct VP

Conveyor or cooling area require ventilation for large cores. Scrap conveyor or tote boxes may require ventilation also.
### Table: Disc Diameter and Exhaust Volume

<table>
<thead>
<tr>
<th>Disc diameter, inches</th>
<th>Total exhaust volume cfm</th>
<th>Applies to duct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 12 incl.</td>
<td>350</td>
<td>A</td>
</tr>
<tr>
<td>over 12 to 18 incl.</td>
<td>440</td>
<td>A</td>
</tr>
<tr>
<td>over 18 to 26 incl.</td>
<td>550</td>
<td>A</td>
</tr>
<tr>
<td>over 26 to 32 incl.</td>
<td>700*</td>
<td>A-B</td>
</tr>
<tr>
<td>over 32 to 38 incl.</td>
<td>900*</td>
<td>A-B</td>
</tr>
<tr>
<td>over 38 to 48 incl.</td>
<td>1250*</td>
<td>A-B-C</td>
</tr>
</tbody>
</table>

* Two bottom branches
* * One top and two bottom branches.

Duct velocity = 3500 fpm
Entry loss: Depends on hood design.
1.0 slot VP + 0.25 duct VP

---

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**Disc Sanders**
### Horizontal Belt Sanders

<table>
<thead>
<tr>
<th>Belt width, inches</th>
<th>Exhaust volume, cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Head end</td>
</tr>
<tr>
<td>Up to 6 incl.</td>
<td>440</td>
</tr>
<tr>
<td>over 6 to 9 incl.</td>
<td>550</td>
</tr>
<tr>
<td>over 9 to 14 incl</td>
<td>800</td>
</tr>
<tr>
<td>over 14</td>
<td>1100</td>
</tr>
</tbody>
</table>

Duct velocity = 3500 fpm  
Entry losses = 0.40 VP for tapered take-off
Drum covers necessary. Hinge or otherwise provide for maintenance.

### Exhaust Volumes

<table>
<thead>
<tr>
<th>Drum length, inches</th>
<th>Total exhaust for machine cfm/drum*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 31&quot;</td>
<td>550</td>
</tr>
<tr>
<td>31&quot; to 49&quot;</td>
<td>785</td>
</tr>
<tr>
<td>49&quot; to 67&quot;</td>
<td>1100</td>
</tr>
<tr>
<td>over 67&quot;</td>
<td>1400</td>
</tr>
<tr>
<td>Brush rolls</td>
<td>350 cfm at brush</td>
</tr>
</tbody>
</table>

*One hood per drum is minimum Additional hood at feed side is desirable

Duct velocity = 3500 fps
Entry loss = 0.25 duct VP

---

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**MULTIPLE DRUM SANDER**
Drum surface, sq inches | Exhaust volume, cfm
---|---
Up to 200 incl. (and less than 10' diam.) | 350
over 200 to 400 incl. | 550
over 400 to 700 incl. | 785
over 700 to 1400 incl. | 1100
over 1400 to 2400 incl. | 1400

Duct velocity = 3500 fpm
Entry loss: Depends on hood design.
1.78 slot VP plus 0.25 duct VP
Reduce open area with baffles

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

Top takeoff optional

Rear takeoff best

Hinged cleanout door

Q = 250 cfm/sq ft of open face area
Duct velocity = 3500 fpm minimum
Entry loss = 0.50 VP no taper
0.25 VP with taper

Stationary installation—
  Indoor and outdoor: Connect to exhaust system and dust collector
  Discharge outdoors

Portable use—
  Indoor and outdoor: Use adequate unit collector and fan
  Outdoor only: Use adequate fan, discharge at least 10' above ground
Fluidized beds

Q = 150 cfm/sq ft of bed (150LW)
Slot velocity = 2000 fps
Entry loss = 1.78 slot VP + 0.25 duct VP
Duct velocity = 2500-3000 fps
W not to exceed 36"

For circular beds or other hood designs,
Free board must be maintained to prevent material carryout.
Blade width, inches | Exhaust volume, cfm
----------------------|-----------------------
Up to 2               | 350 350 700          
over 2 to 3           | 350 550 900          
over 3 to 4           | 550 800 1350         
over 4 to 6           | 550 1100 1650        
over 6 to 8           | 550 1400 1950        

Duct velocity = 3500 fpm
Entry loss = 1.15 V^2 in duct riser (Point A)
TYPE HOOD WHERE TABLE IS NOT CUT THRU

FRONT VIEW OF HOOD

TYPE HOOD WHERE TABLE IS CUT THRU

<table>
<thead>
<tr>
<th>Saw diameter, inches</th>
<th>Exhaust volume, cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 20 incl.</td>
<td>350</td>
</tr>
<tr>
<td>over 20</td>
<td>440</td>
</tr>
</tbody>
</table>

Duct velocity = 3500 fpm
Entry loss = 1.78 slot VP + 0.25 duct VP

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SWING SAWS
Table, rip, mitre and variety saws

<table>
<thead>
<tr>
<th>Saw diameter, inches</th>
<th>Exhaust volume, cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 16 incl.</td>
<td>350</td>
</tr>
<tr>
<td>over 16 to 24 incl.</td>
<td>440</td>
</tr>
<tr>
<td>over 24</td>
<td>550</td>
</tr>
<tr>
<td>variety with dado</td>
<td>550</td>
</tr>
</tbody>
</table>

Duct velocity = 3500 fps
Entry loss = 1.0 slot VP + 0.25 duct VP
Duct velocity = 3500 fpm
Entry loss = 3.5VP in duct riser (Point A)

For booth enclosure, see VS-401
FLAT DECK SCREEN

Q = 200 cfm/sq ft through hood openings, but not less than 50 cfm/sq ft screen area. No increase for multiple decks.
Duct velocity = 3500 fpm minimum
Entry loss = 0.50VP

CYLINDRICAL SCREEN

Q = 100 cfm/sq ft circular cross section of screen, at least 400 cfm/sq ft of enclosure opening
Duct velocity = 3500 fpm minimum
Entry loss = 0.50VP

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SCREENS
PORTABLE EXHAUST

<table>
<thead>
<tr>
<th>X, inches</th>
<th>cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>250</td>
</tr>
<tr>
<td>9</td>
<td>400</td>
</tr>
<tr>
<td>12</td>
<td>1000</td>
</tr>
</tbody>
</table>

Face velocity = 1500 fpm
Duct velocity = 3000 fpm minimum
Entry loss = 0.25 duct VP

GENERAL VENTILATION, where local exhaust cannot be used:

<table>
<thead>
<tr>
<th>Rod, diam</th>
<th>cfm/welder*</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/32</td>
<td>1000</td>
</tr>
<tr>
<td>3/16</td>
<td>1500</td>
</tr>
<tr>
<td>1/4</td>
<td>3500</td>
</tr>
<tr>
<td>3/8</td>
<td>4500</td>
</tr>
</tbody>
</table>

*For toxic materials higher airflow is necessary.

OTHER TYPES OF HOODS

Booth:
Q = 100 cfm/sq ft of face opening
See "Spray Painting"

SOLDERING AND ARC WELDING

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Q = 50LW
Slot velocity = 1000 fpm maximum
Entry loss = 1.78 slot VP + 0.25 duct VP
Duct velocity = 2500-3000 fpm

Also provide:
1. Separate flue for combustion products if direct-fired unit.
2. For cleaning operation, an air-line respirator is necessary.
3. For pit units, the pit should be mechanically ventilated.

NOTE: Provide downdraft grille for parts that cannot be removed dry; Q = 50 cfm /sq ft grille area.
Branch take-off at top or back. Central location or multiple branches if several booths are used.

Additional adjoining booths if needed.

45° slope

Booth encloses grinder frame and suspension

Grinder to operate in or close to face opening

4'-6' large opening - face velocity = 100 to 150 fpm - never below 100 fpm
2'-0" to 2'-5" small opening grinder in front - face velocity = 200 fpm

Minimum duct velocity = 3000 fpm
Entry loss = 0.5 VVP

NOTE: Small local exhaust hoods mounted behind grinder wheel may trap the stream of sparks, but are usually not effective in control of airborne dust.
Q = 50-100 cfm/sq ft of table top.
Duct velocity = 2500 - 3000 fpm
Entry loss = 1.78 slot VP + 0.25 duct VP
Note: See "Open Surface Tanks" for other suitable slot types. Air quantities may be calculated on dilution basis if data is available.
Maximum plenum velocity = 1/2 slot velocity
Large plenum essential for good distribution.
$Q = 50 \text{ cfm/sq ft of cross-sectional trailer area}$

Entry loss = 0.25 VP

Duct velocity = 1000 - 3000 fpm

NOTE: Operator must wear an air-supplied respirator
**SECTION THRU HOLLOW TRUINION TUMBLER**

Duct velocity: 5000 fpm
Entry loss: 3.25" 8.25" H2O (depends on design*)

**STAVE MILL (END SECTION)**

Duct velocity: 3500 fpm minimum
Entry loss varies with take-off
0.25 - 0.50 VP

---

**EXHAUST VOLUMES**

<table>
<thead>
<tr>
<th>Square mill</th>
<th>Round mill</th>
<th>cfm **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side diam in.</td>
<td>I.D. in inches</td>
<td>Trunnion</td>
</tr>
<tr>
<td>Up to 24 incl.</td>
<td>Up to 24 incl.</td>
<td>24 - 30</td>
</tr>
<tr>
<td>25 - 30</td>
<td>31 - 36</td>
<td>690</td>
</tr>
<tr>
<td>31 - 36</td>
<td>37 - 42</td>
<td>930</td>
</tr>
<tr>
<td>37 - 42</td>
<td>43 - 48</td>
<td>1750</td>
</tr>
<tr>
<td>43 - 48</td>
<td>49 - 54</td>
<td>2200</td>
</tr>
<tr>
<td>49 - 54</td>
<td>55 - 60</td>
<td>2730</td>
</tr>
<tr>
<td>55 - 60</td>
<td>61 - 66</td>
<td>3300</td>
</tr>
<tr>
<td>61 - 66</td>
<td>67 - 72</td>
<td>3920</td>
</tr>
<tr>
<td>67 - 72</td>
<td>4600</td>
<td>4600</td>
</tr>
</tbody>
</table>

*Low loss designs have larger air total openings in end bell
Holes in end discs are sized for velocities of 1250 - 1800 fpm
**For lengths over 70", increase cfm proportionately

---

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TUMBLING MILLS
PORTABLE EXHAUST

<table>
<thead>
<tr>
<th>( X ), inches</th>
<th>cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>250</td>
</tr>
<tr>
<td>9</td>
<td>400</td>
</tr>
<tr>
<td>12</td>
<td>1000</td>
</tr>
</tbody>
</table>

Face velocity = 1500 fpm  
Duct velocity = 3000 fpm minimum  
Entry loss = 0.50 VP  
Also see "Granite Cutting" VS-906

OTHER TYPES OF HOODS

Sidedraft:  
See "Soldering"

Booth:  
Q=100 cfm/ft² of face opening  
See "Spray Painting" VS-603, VS-604  
"Metal Spraying" VS-415

GENERAL VENTILATION, where local exhaust cannot be used:

<table>
<thead>
<tr>
<th>Rod, diam</th>
<th>cfm/welder*</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/32</td>
<td>1000</td>
</tr>
<tr>
<td>3/16</td>
<td>1500</td>
</tr>
<tr>
<td>1/4</td>
<td>3500</td>
</tr>
<tr>
<td>3/8</td>
<td>4500</td>
</tr>
</tbody>
</table>

*For toxic materials higher airflows are necessary.

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ARC WELDING
Exhaust duct 3'-0" center to center maximum

45° tapered takeoffs

Cleanout doors

Enclose base of table

\[ Q = 150 \text{ cfm/sq ft of gross table area} \]
\[ \text{Duct velocity} = 2000-4000 \text{ fpm} * \]
\[ \text{Entry loss} = 10 \text{ VP through grating} \]
\[ 0.25 \text{ duct VP} - \text{tapered takeoff} \]

* For horizontal runs, transport velocity is necessary
Q = 10 to 40 cfm/inch dia
Branch static pressure = 6"Hg to 12"Hg
Slot velocity = 10,000 to 25,000 fpm
Flexible hose = 5/8" to 1 1/2" ID
Extension hose = Up to 8 ft long

Grinding wheel sizes = 1" to 3" dia
1" to 4" long

Peripheral speed = 6,000 to 10,000 linear fpm

Cone wheel used for internal grinding on castings and dies

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Extractor Head for Cone Wheels and Mounted Points
Q = 10-50 cfm/inch dia or width
Branch static pressure = 6" to 12" Hg
Slot velocity = 10,000 to 25,000 fpm
Flexible hose = 5/8" to 1 1/2" ID
Extension hose = Up to 8 ft long
Peripheral speed = 6,000 to 10,000 linear fpm

Adapter plate to fit grinder
Hood adjustable for wheel wear
Minimum clearance

Hood fitted to grinder

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HOOD FOR CUP TYPE SURFACE
GRINDERS AND WIRE BRUSHES
Dust is extracted through ports molded in the rubber sleeve, ports are on either side of the cutting edge of the chisel.

\[ Q = 8 \text{ to } 60 \text{ cfm} \]

- Static pressure: 6'' to 12'' Hg
- Slot velocity: 10,000 to 25,000 fpm
- Flexible hose: 3/8'' to 1 1/2'' ID
- Extension hose: Up to 8 ft long
- Chisel sizes: 13/16'' octagonal
  - 7/8'' octagonal
  - 7/8'' hexagonal

Rubber sleeve

Slots

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PNEUMATIC CHISEL SLEEVE
These extractor heads have been specifically designed for work done inside castings or in awkward places when radial wheels of small diameter are most suitable. The heads are narrower than the grinding wheels and can precede the wheel when a groove is being ground.

Q = 10 - 45 cfm/inch dia
Branch static pressure = 6" to 12" Hg
Slot velocity = 10,000 to 25,000 fpm
Flexible hose = 5/8" to 7/8" ID
Extension hose = Up to 8 ft long
Grinding wheel sizes = 8" dia x 1" wide
2" dia x 1/2" wide
Peripheral speed = 6,000 to 10,000 linear fpm
Q = 10 - 30 cfm/inch dia
Branch static pressure = 6" to 12" Hg
Slot velocity = 10,000 to 25,000 fpm
Flexible hose = 5/8" to 1 1/2" ID
Extension hose = Up to 8 ft long
Sanding disc size = 5" to 9" dia
Peripheral speed = 4,500 - 14,000 linear fpm

Extractor hood for disc sander
This design is suitable for sanders running up to 15,000 cycles per minute.

Q = 100 to 200 cfm
Branch static pressure = 6" to 12" Hg
Slot velocity = 10,000 to 25,000 fpm
Flexible hose = 1" to 2" ID
Extension hose = Up to 9 ft long

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EXTRACTOR TOOL FOR
VIBRATORY SANDER
System Notes

Bell and socket, smooth-flow type tubing and fittings should be used throughout the system.

When system will be used for vacuum cleaning of abrasive materials, Schedule No. 40 pipe and C.I. drainage fittings, or heavier, should be used in place of tubing.

To Atmosphere

6" Motor

Exhauster

Vacu-Matic Bag Cleaner (Optional)

48" Bag Filter

Primary Separator (36" dia) (Optional)

2 1/8"

2 1/2"

3"

3 1/2"

4"

2 1/8"

2 1/8"

2 1/8"

2 1/8"

2 1/2"

Swing frame grinder

2 1/8"

7" - 7200 rpm Disc sander

2 1/8" Chipping hammer

2 1/8" 6" - 10,000 rpm Cup stone grinder

2 1/8" 6" x 1", 10,000 rpm Wheel grinder

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TYPICAL SYSTEM
LOW VOLUME HIGH VELOCITY