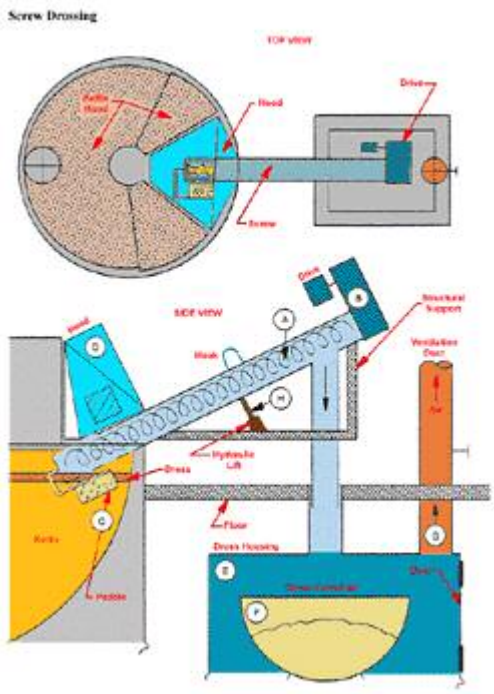
Lead > Secondary Lead Smelter eTool

Engineering Controls

The following engineering controls are effective means of lowering both in-plant lead exposure and lead emissions to the outside environment:

- Local Exhaust Ventilation Diagrams
- Supplied Air Islands
- Process Controls



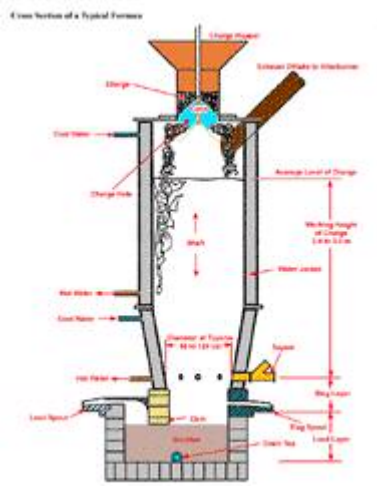
View full size Screw Drossing Diagram

Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

Lead > Secondary Lead Smelter eTool

Engineering Controls > Local Exhaust Ventilation Diagrams

- Air and Oxide Flow
- Battery Saw
- Battery Shredder
- Belt Conveying Head Pulley
- Blast Furnace Slag Tap Controls
- Bin and Hopper Ventilation
- Boot Wash Station
- Bucket Elevator Ventilation
- Central Vacuum System
- Clean Clothes Air Shower
- Controls for Lead Tapping and Molding
- Conveyor Belt Enclosure
- Conveyor Belt Loading
- Conveyor Belt Ventilation
- Cross-sectional View Blast Furnace
- Cross-sectional View Reverberatory Furnace
- Dross Pot Hood
- Dross Storage Ventilation
- Fixed Supplied Air Island
- Filtered, Tempered, Supplied-Air Cab
- Furnace Lead Tap Controls
- Furnace Slag Tapping Hood
- Hood for Cup Type Surface Grinder and Wire Brushes
- Hydraulic Tuyere Punch
- Hygiene Facility
- Ingot Casting
- Mechanical Drossing
- Modified Local Exhaust Ventilation System
- Moveable Exhaust Hood
- Portable Tool Exhaust
- Refining Kettle Enclosure
- Regenerative Sweeper
- Reverberatory Furnace
- Scrap Barrel
- Screw Drossing
- Scrubber
- Secondary Exhaust Hoods
- Shoe Cleaning Machine
- Slag/Dross/Skim Hood
- Supplied Air Island
- Tumbler
- Typical System Low Volume - High Velocity
- Vacuum Truck
- Work Bench



View full size Cross Section of a Typical Furnace diagram

eTool Home

Raw Materials Processing

Smelting

Refining and Casting

Environmental Controls

Maintenance

Engineering Controls

Local Exhaust Ventilation Diagrams

Supplied Air Islands

Process Controls

OSHA Requirements

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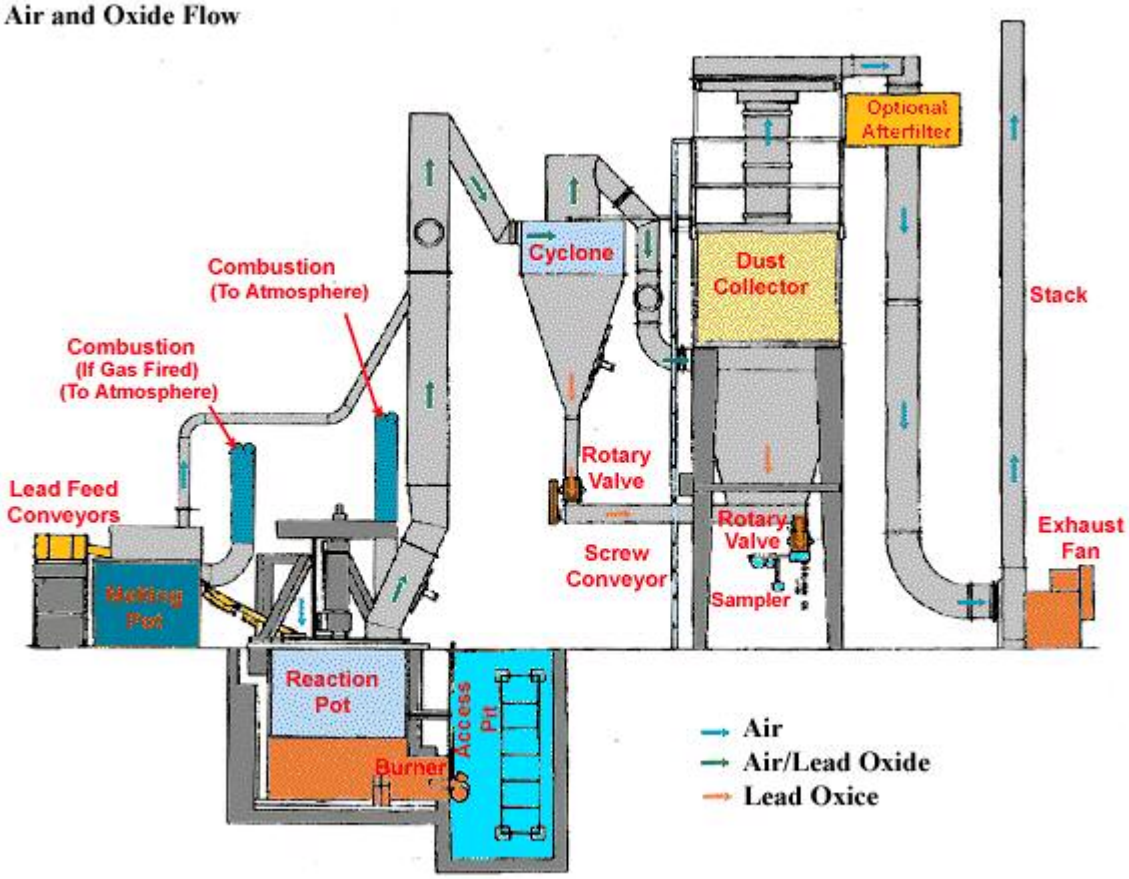
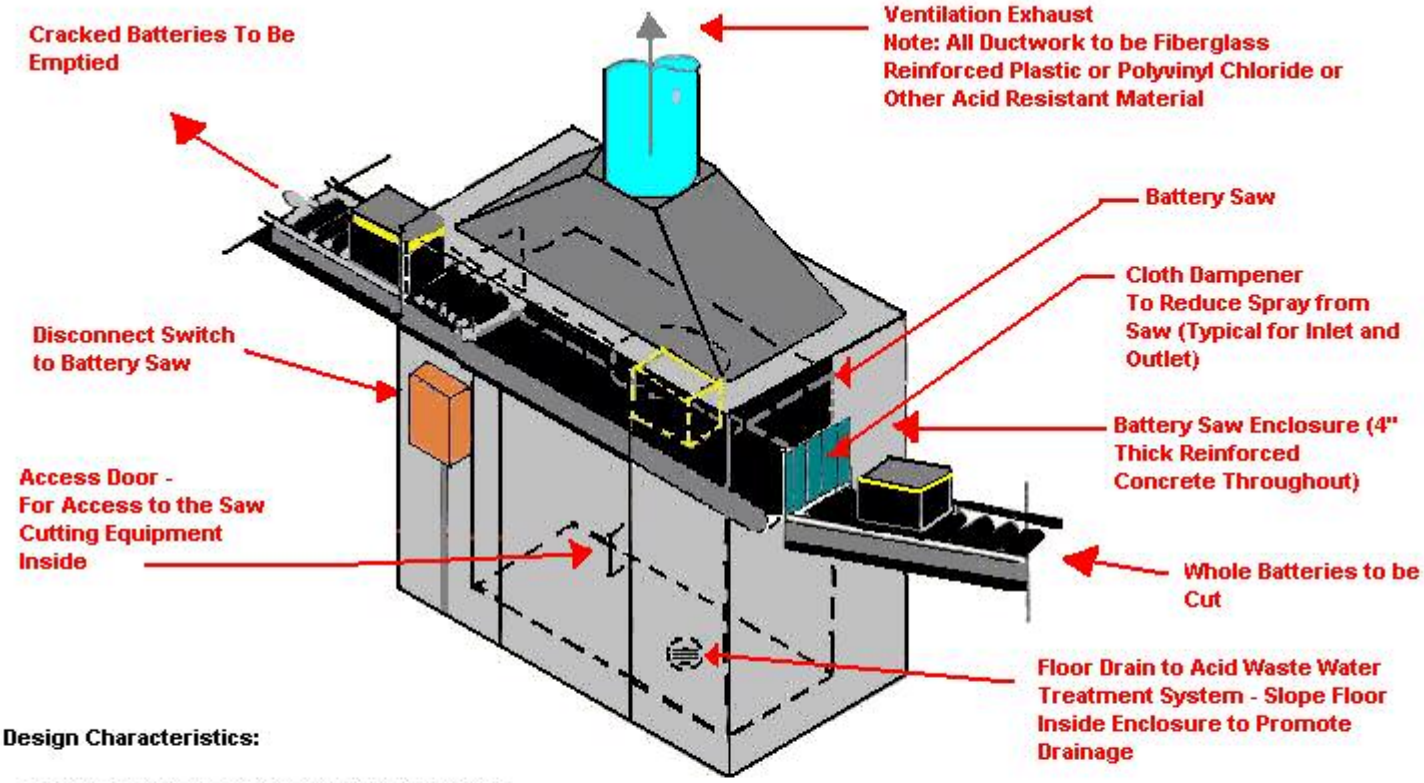
Air and Oxide Flow



Enclosure Hooding - Battery Saw Emission Control



Design Characteristics:

- Provide capture velocities at openings of 350 - 500 FPM

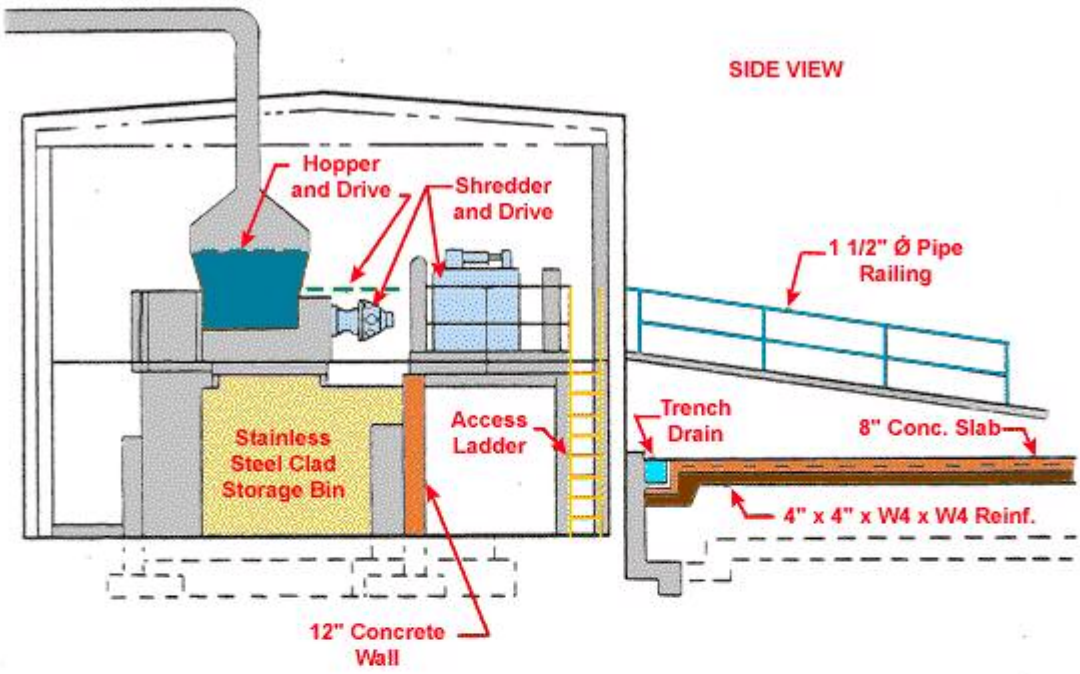
- Duct velocity - 3,500

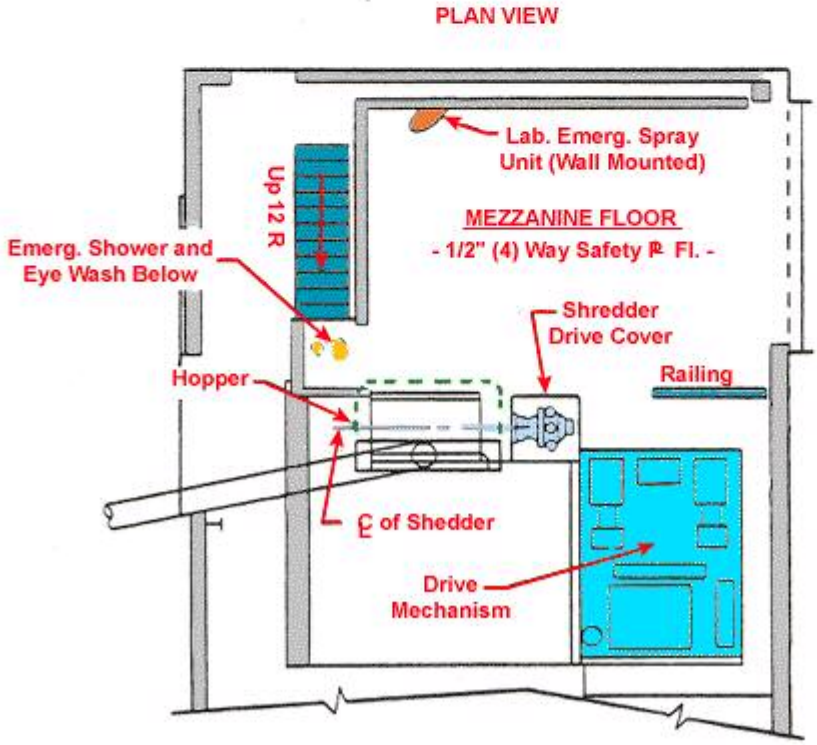
Application Tips:

- Provide drains in ductwork

- All air moving/handling equipment to be sulfuric acid resistant

Shredder Building





Battery Shredding and Emission Control

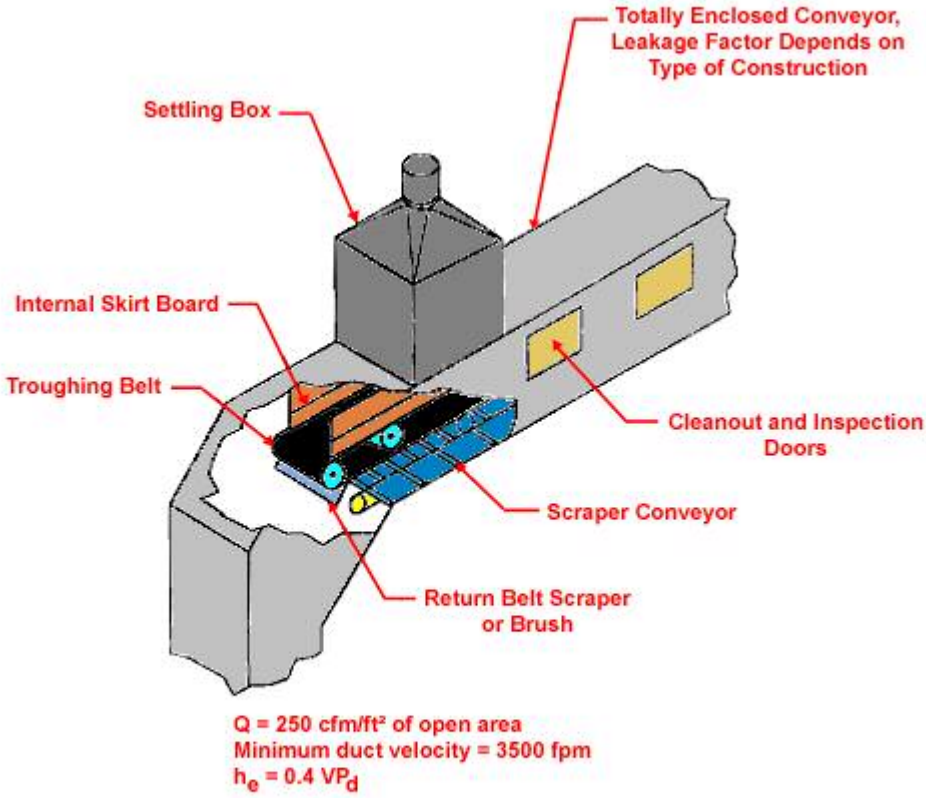
Application Tips:

- Provide local exhaust on shredder.
- Provide building exhaust to keep fugitive emissions inside the building.

Design Characteristics:

Q = 350 cfm/sq. ft. hood opening

Toxic Material Belt Conveying Head Pulley



American Conference of Governmental Industrial Hygienists	Date: 1 - 91
	Figure: VS - 50 - 21

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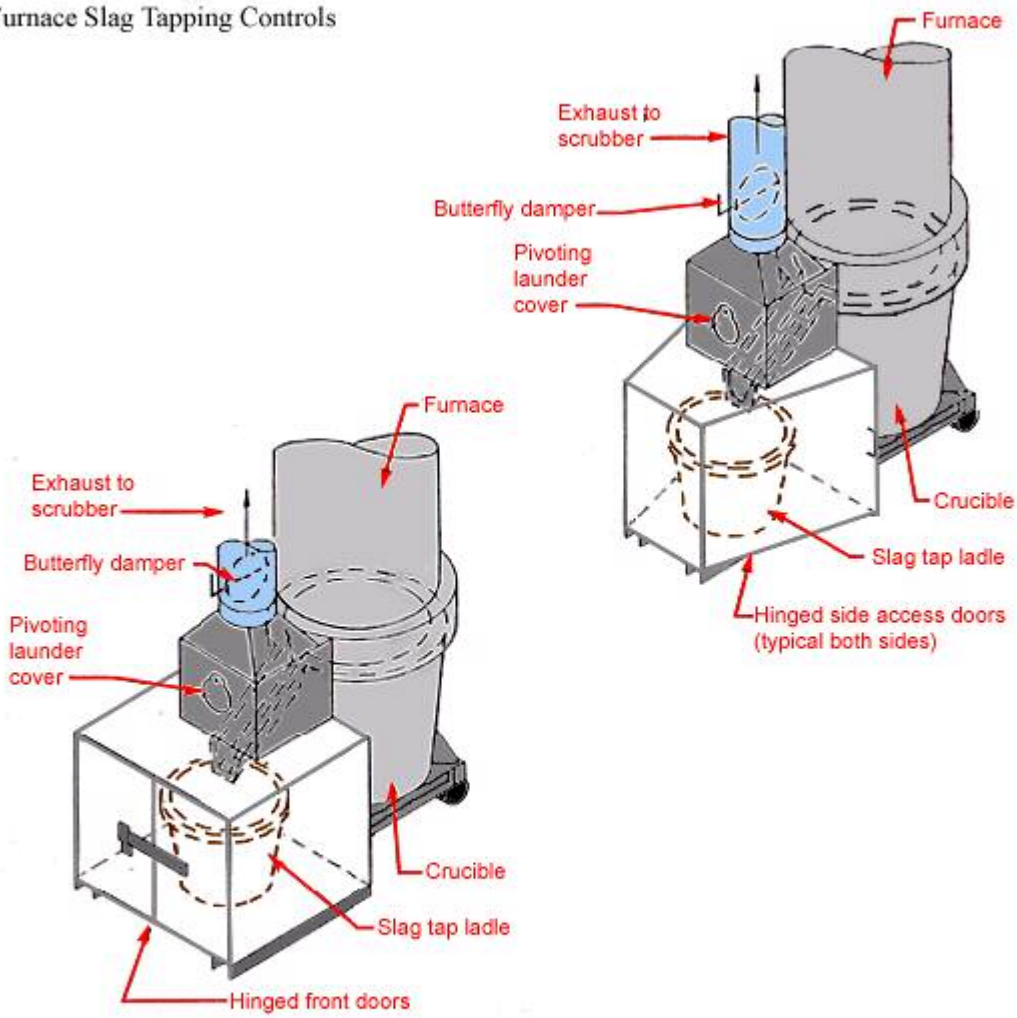
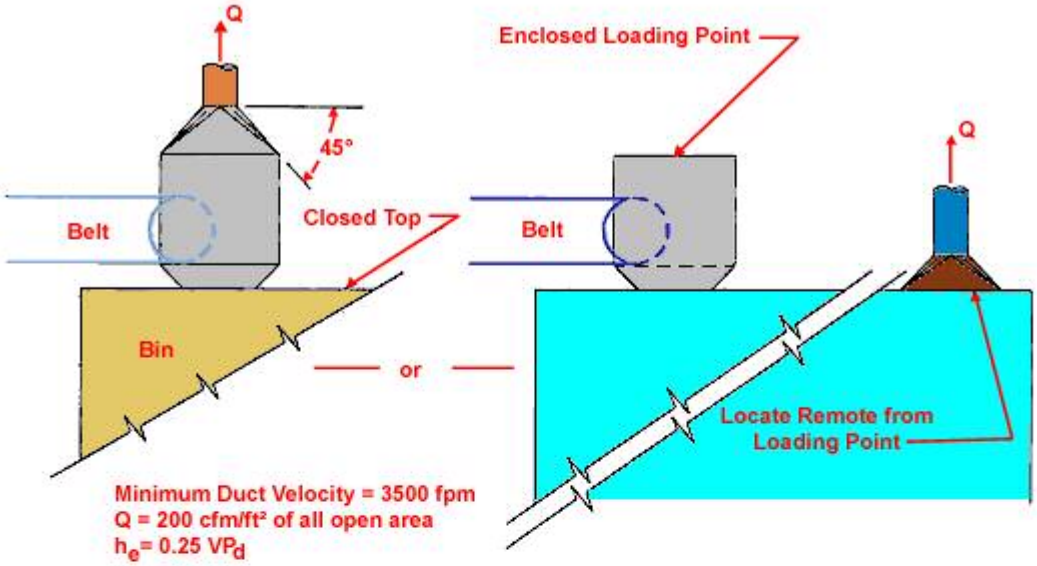
Enclosure Hooding - Blast
Furnace Slag Tapping Controls



Design Characteristics

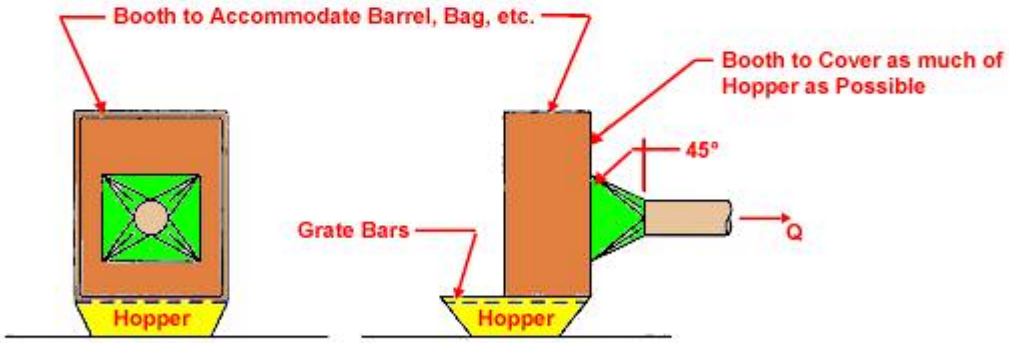
- Transport velocity in ducts: > 4000 fpm
- Enclosure to provide capture velocities at opening of 350 - 500 fpm

Bin and Hopper Ventilation



MECHANICAL LOADING

Belt Speed	Flowrate
Less than 200 fpm	350 cfm/ft of belt width. Not less than 150 crm/ft² of opening.
Over 200 fpm	500 cfm/ft of belt width. Not less than 200 cfm/ft² of opening.



MANUAL LOADING

American Conference of Governmental Industrial Hygienists	Date: 1 - 91
	Figure: VS - 50 - 10

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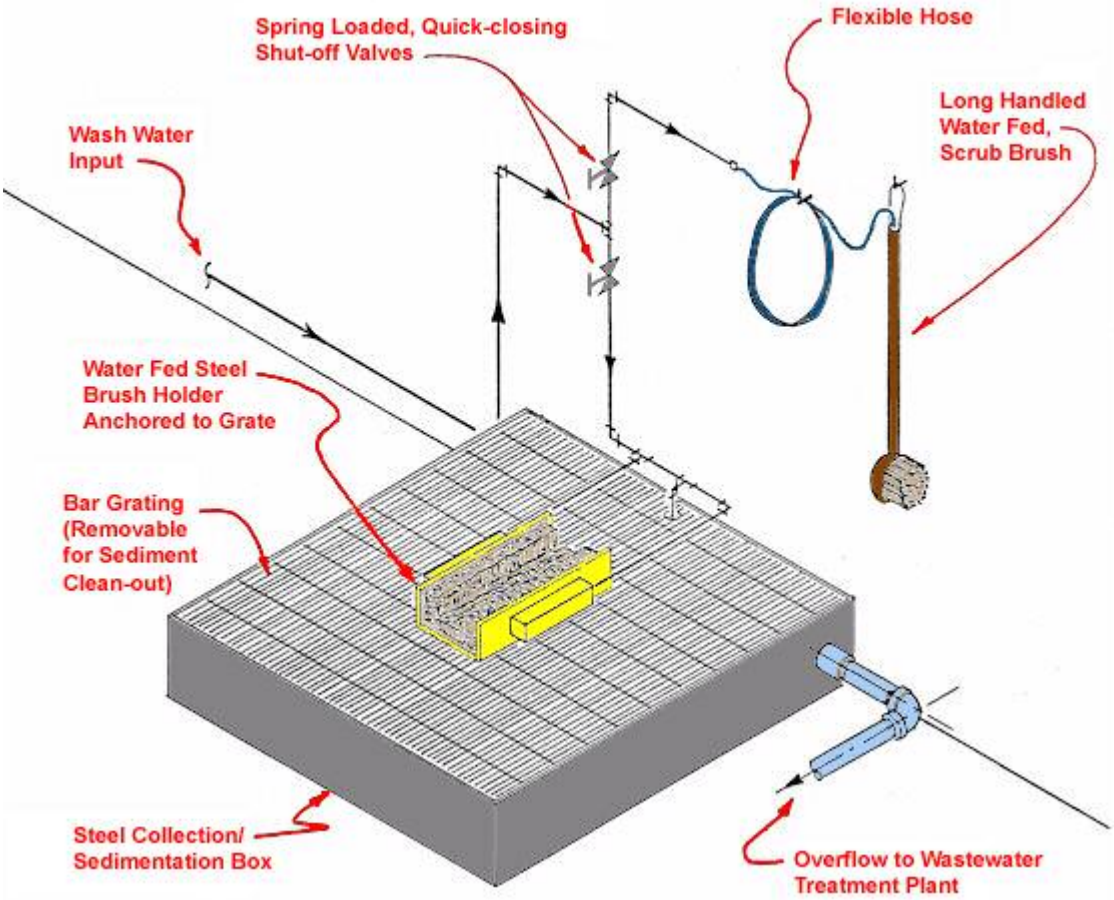
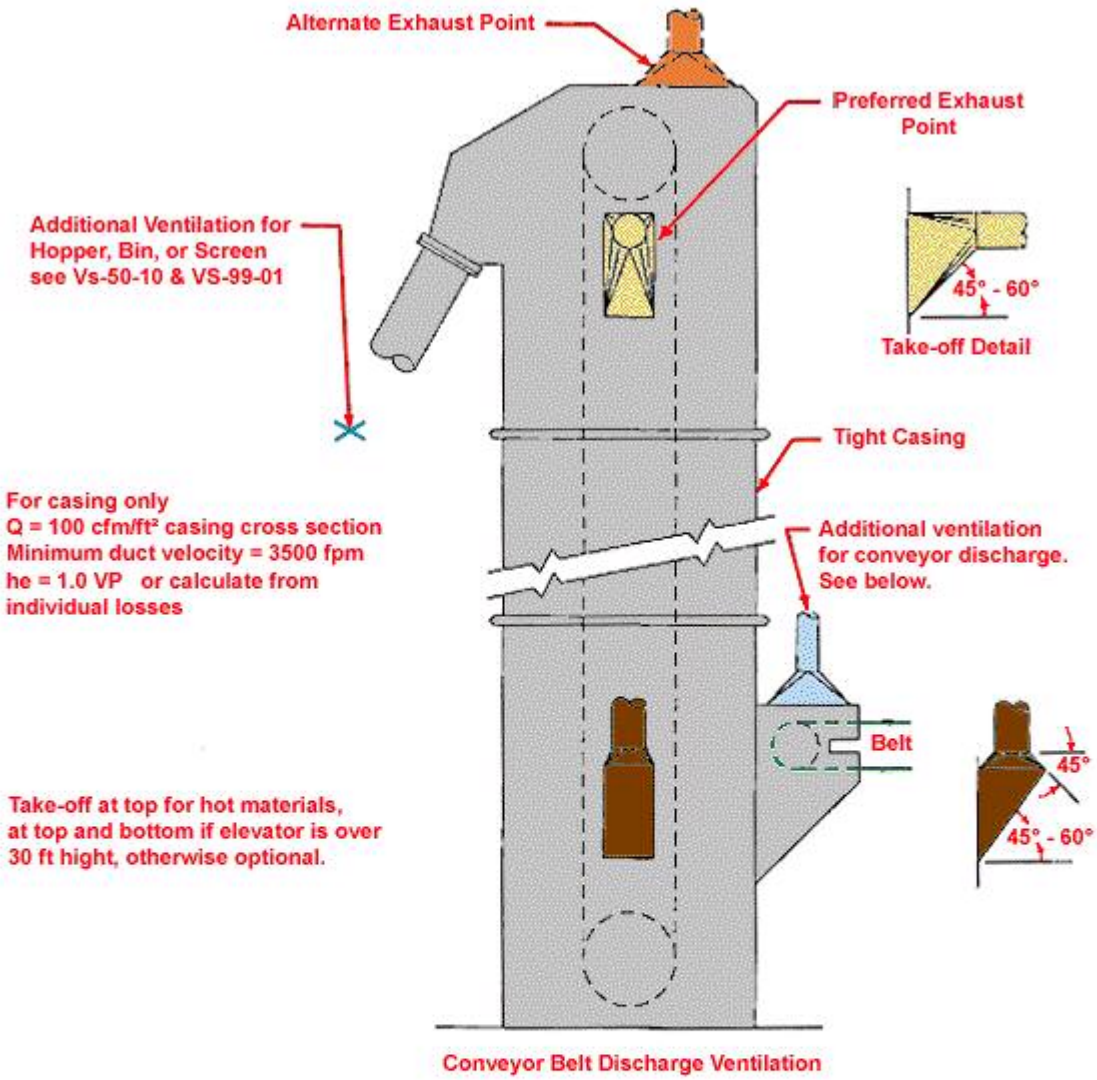
Boot Wash Station



Bucket Elevator Ventilation



Belt Speed	Flowrate
Less than 200 fpm	350 cfm/ft of belt width. Not less than 150 cfm/ft² of opening.
Over 200 fpm	500 cfm/ft of belt width. Not less than 200 cfm/ft² of opening.

Date: 1-91

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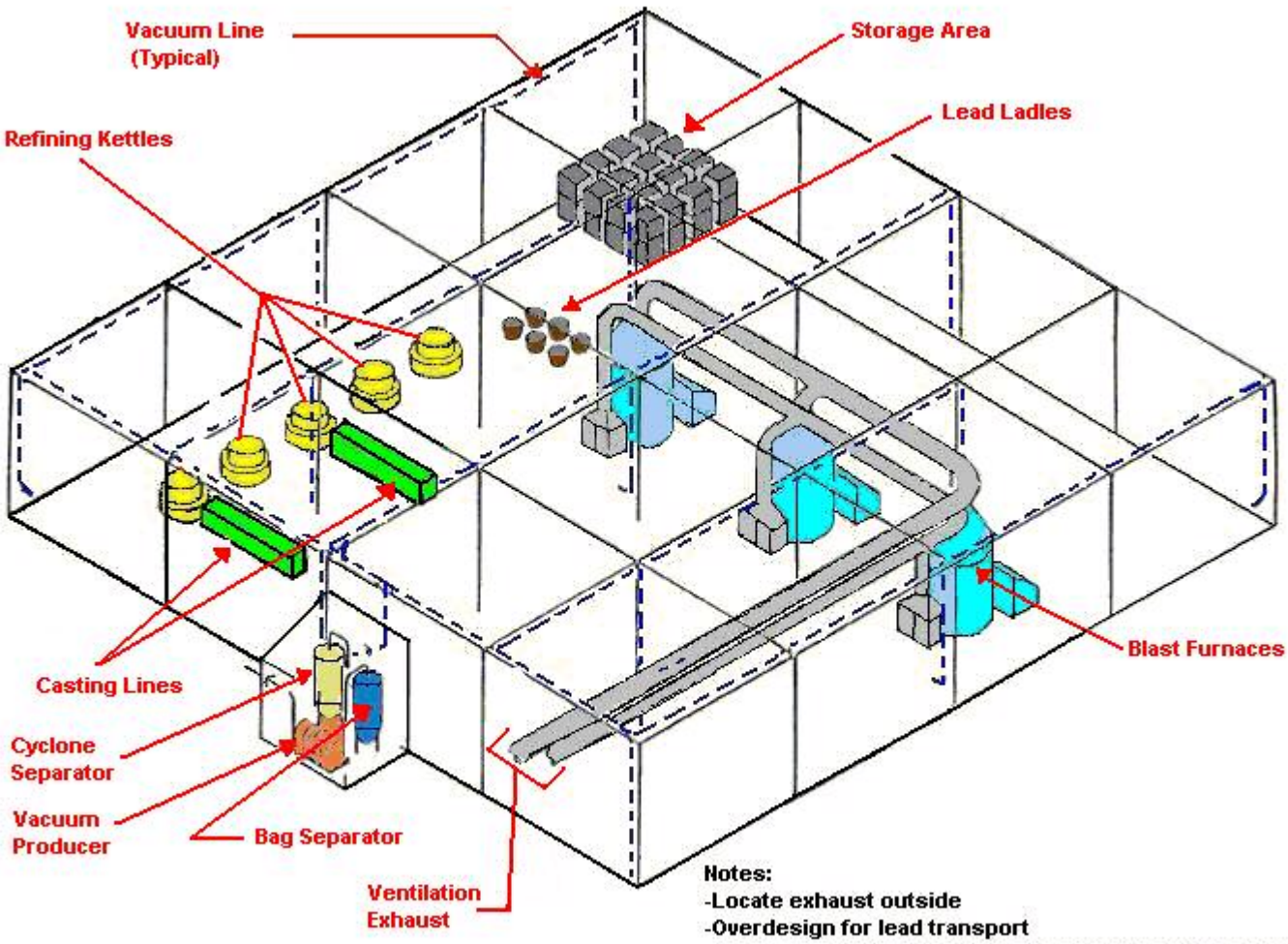
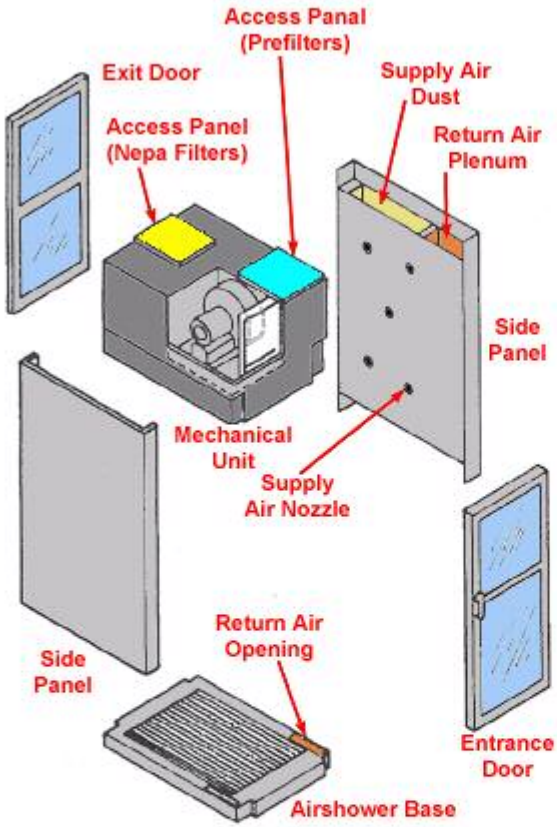
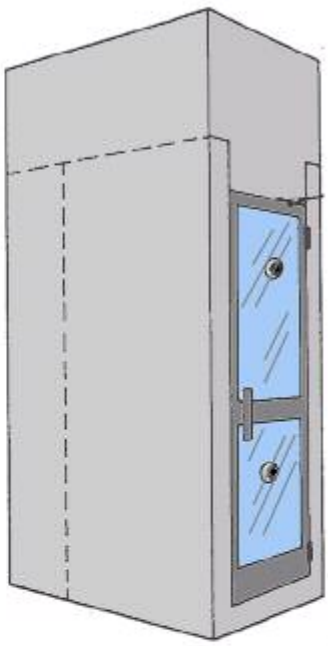
Central Vacuum System



Notes:
-Locate exhaust outside
-Overdesign for lead transport
-Provide ample hose and attachments at each access point
-Provide access point close to areas of high dust concentration

Clothes Cleaning Air Shower



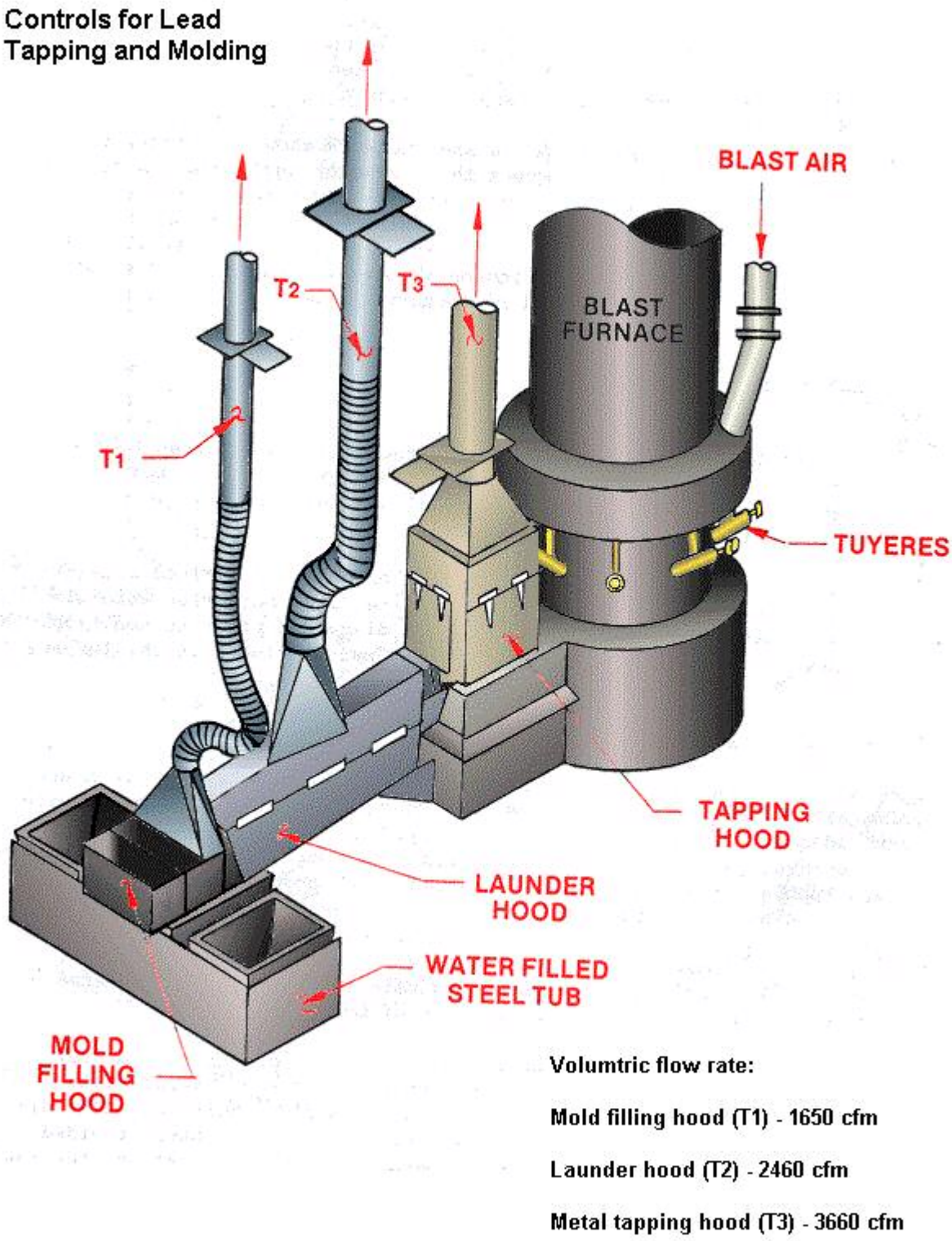


Design Characteristics

- Check with supplier.

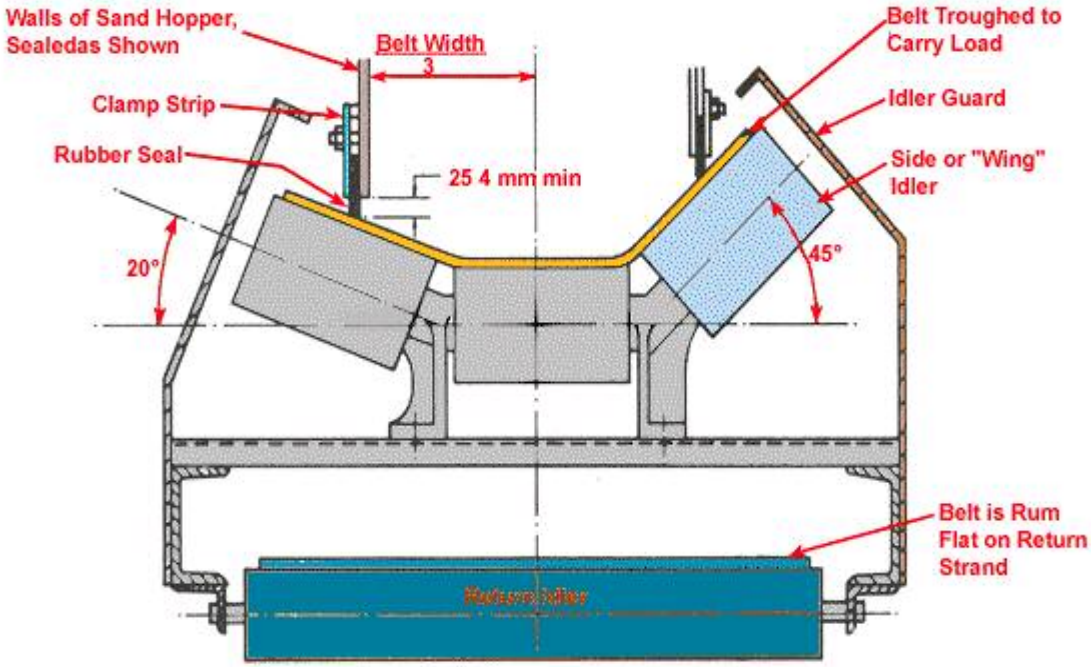
Application Tips

- Install at entrance to clean-rooms, lunchroom, etc.
- Allow time for full use by employees.
- Provide daily cleaning and maintenance.

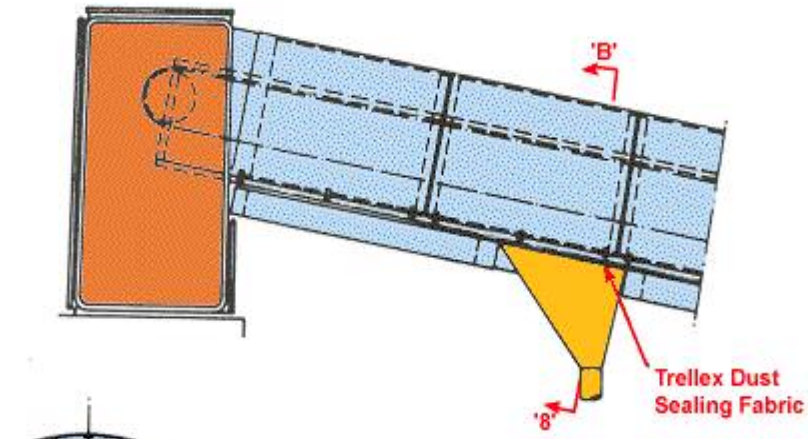


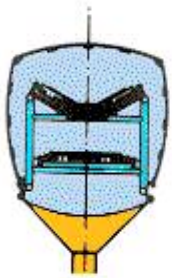
Proceedings of the Symposium on Occupational Health Hazard Control Technology in the Foundry and Secondary Non-Ferrous Smelting Industries, U.S. Department of Health and Human Services, NIOSH Publication No. 81-114 (1981).

Section Through Conveyor Showing a 20° and 45° Troughing Idler, Chute, and Sealing Skirt with Idler Guard



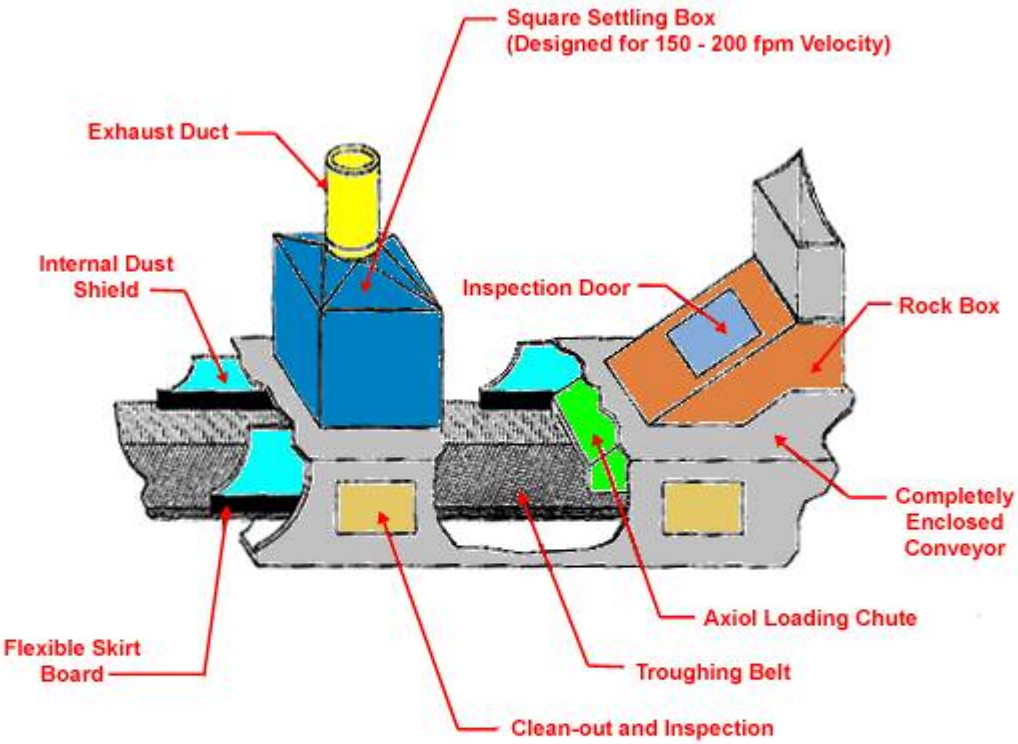
Eclosure of Belt Conveyor





Section Through '8 - B'

Toxic Material
Conveyor Belt Loading



Q = 250 cfm/ft² of open area
Minimum duct velocity = 3500 fpm
$h_e = 0.4\ VP_d$

American Conference of Governmental Industrial Hygienists	Date: 1 - 91
	Figure: VS - 50 - 22

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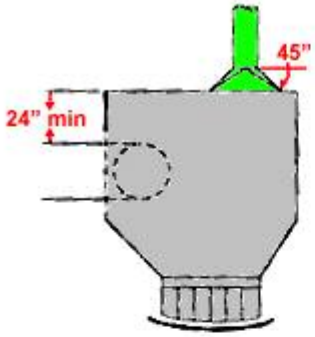
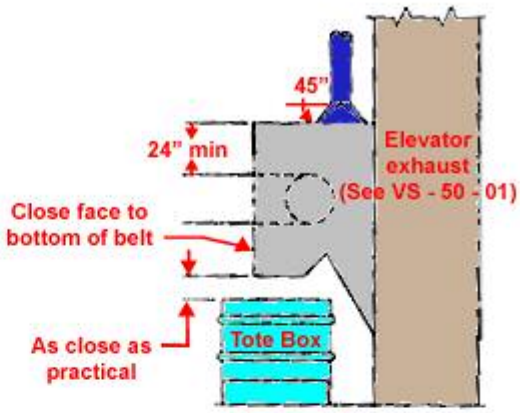
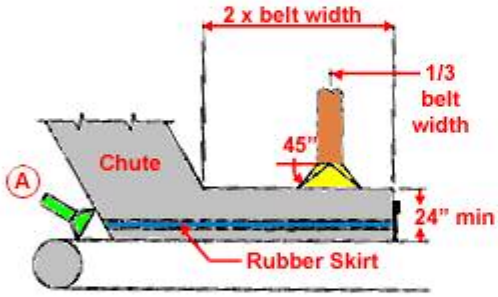
Conveyor Belt Ventilation



1. Conveyor transfer less than 3' fall. For greater fall, provide additional exhaust at lower belt. See 3 below.
$h_e = 0.25\ VP_d$



2. Conveyor to elevator with magnetic separator.
$h_e = 0.25\ VP_d$



3. Chute to belt transfer and conveyor transfer, greater than 3' fall. Use additional exhaust at (A) for dusty material as follows:
Belt width 12"–36", Q=700 cfm
Belt width above 36", Q=1000 cfm
$h_e = 0.25\ VP_d$

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

DESIGN DATA

Transfer points:

Enclose to provide 150 – 200 fpm indraft at all openings. (Underground mining tunnel ventilation will interfere with conveyor exhaust systems.)

DETAIL OF BELT OPENING

Q = 350 cfm/ft belt width for belt speeds under 200 fpm. (minimum)
= 500 cfm/ft belt width for belt speeds over 200 fpm and for magnetic separators. (minimum)
Minimum duct velocity = 3500 fpm
$h_e = 0.25\ VP_d$

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.

American Conference of Governmental Industrial Hygienists	Date: 1 - 91
	Figure: VS - 50 - 20

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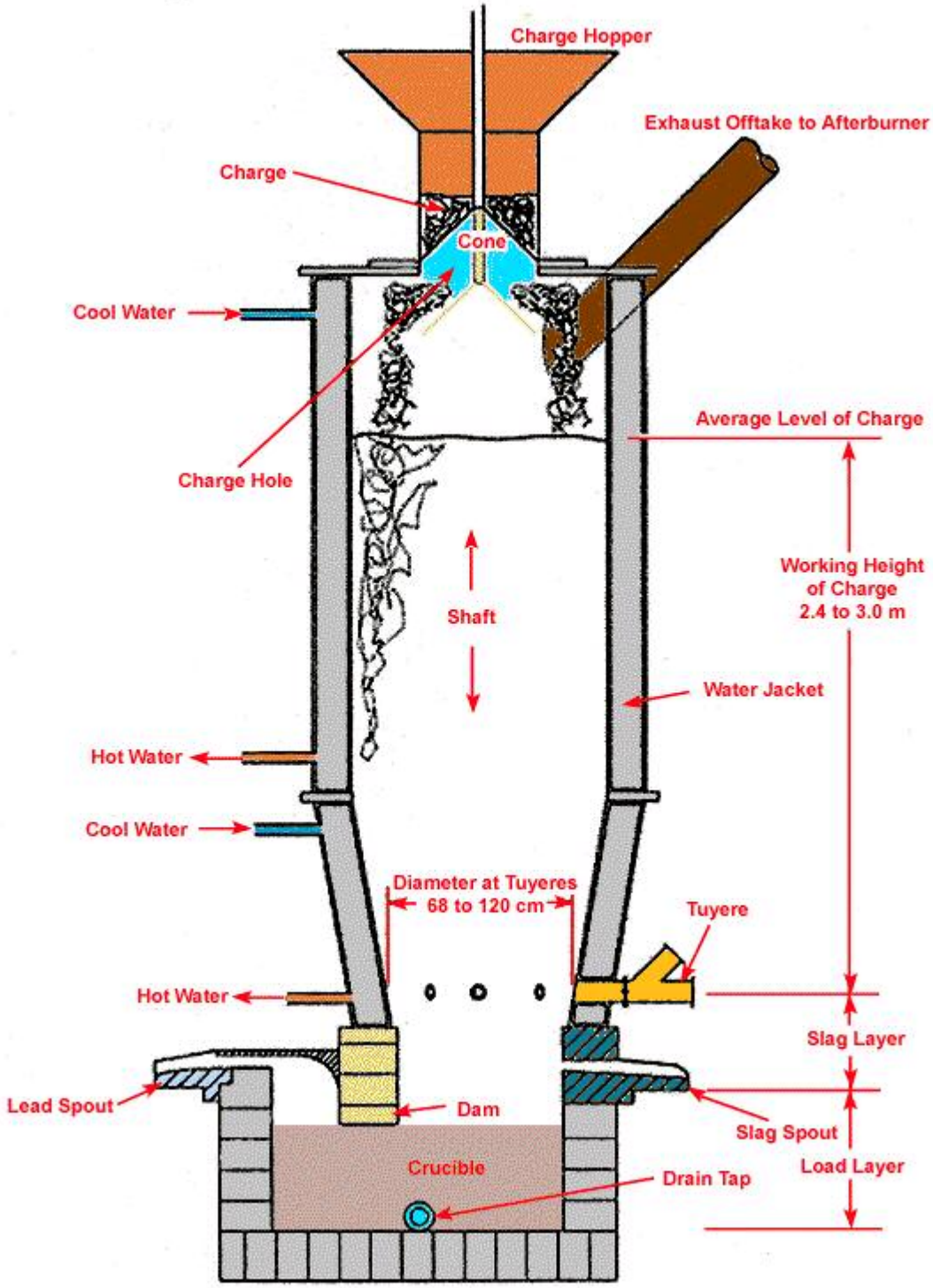
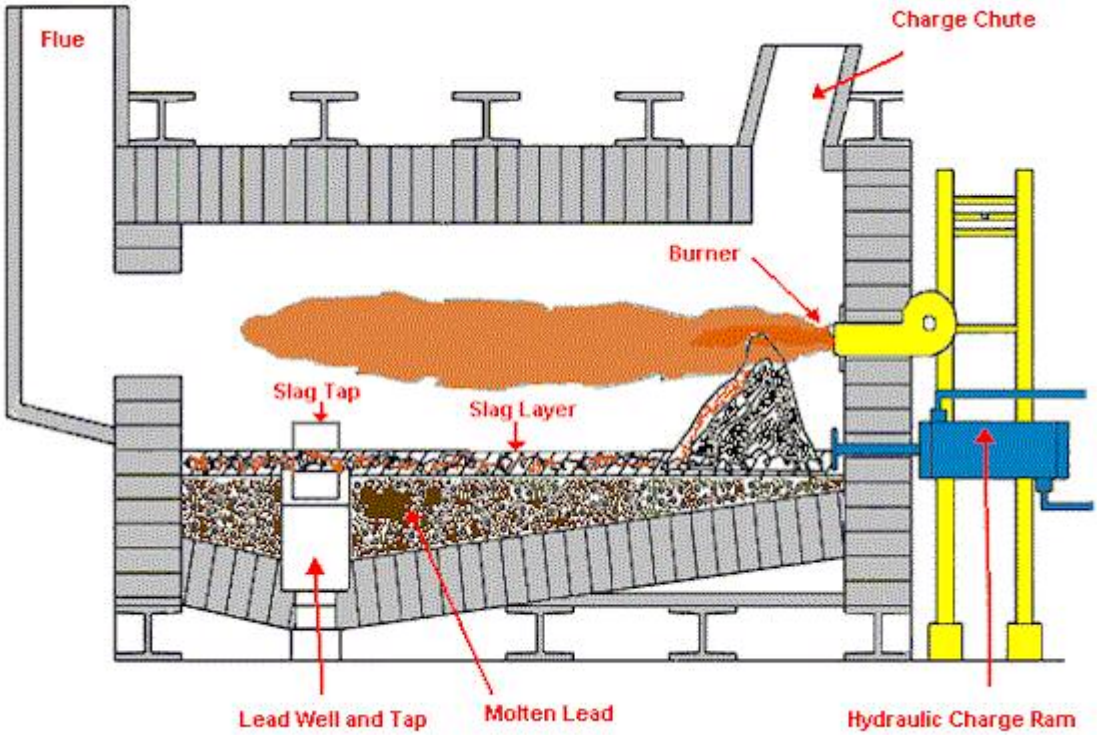
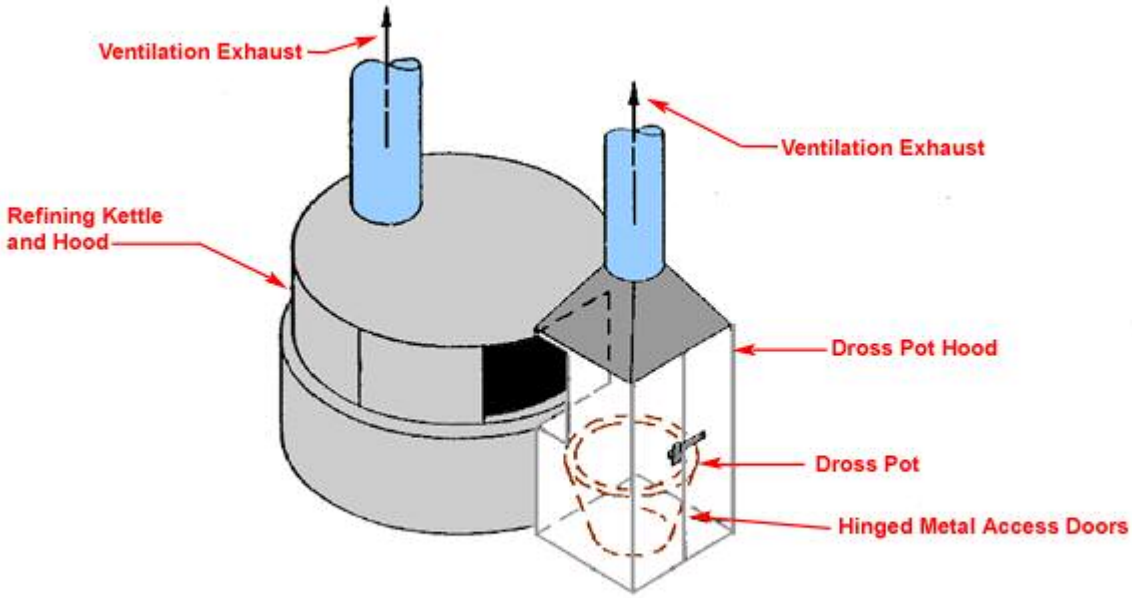
Cross Section of a Typical Furnace



Reverberatory Furnace



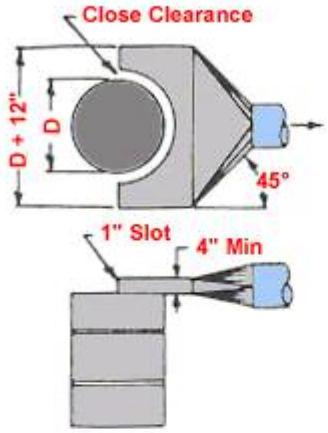
Dross Pot Hood



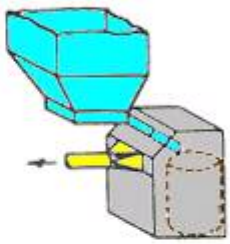
Design Characteristics

- **Enclosure to provide capture velocites at openings of 350 - 500 FPM**
- **Transport velocities in ducts: ≥ 4000 FPM**

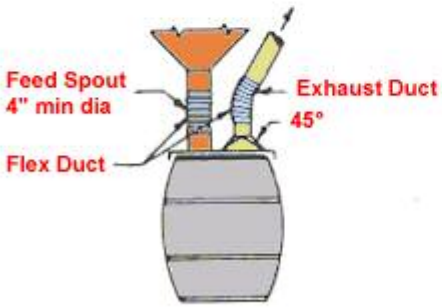
Dross and Skimmings Storage Ventilation



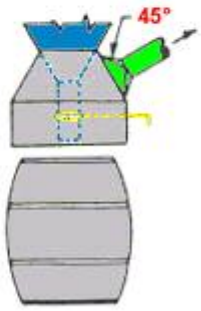
- Q = 100 cfm/sq ft barrel top min
- Duct velocity = 3500 minimum
- Entry loss = 0.25 vp + 1.78 slot vp
- Manual loading



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

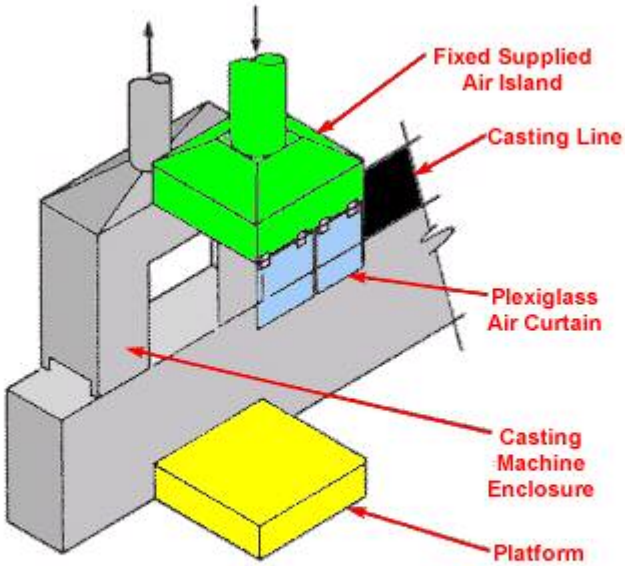


- Q = 50 cfm x drum dia (ft) for weighted lid
  150 cfm x drum dia (ft) for loose lid
- Duct velocity = 3500 fpm minimum
- Entry loss = 0.25 vp



- Q = 300 - 400 cfm
- Duct Velocity = 3500 min
- Entry loss = 0.25 vp

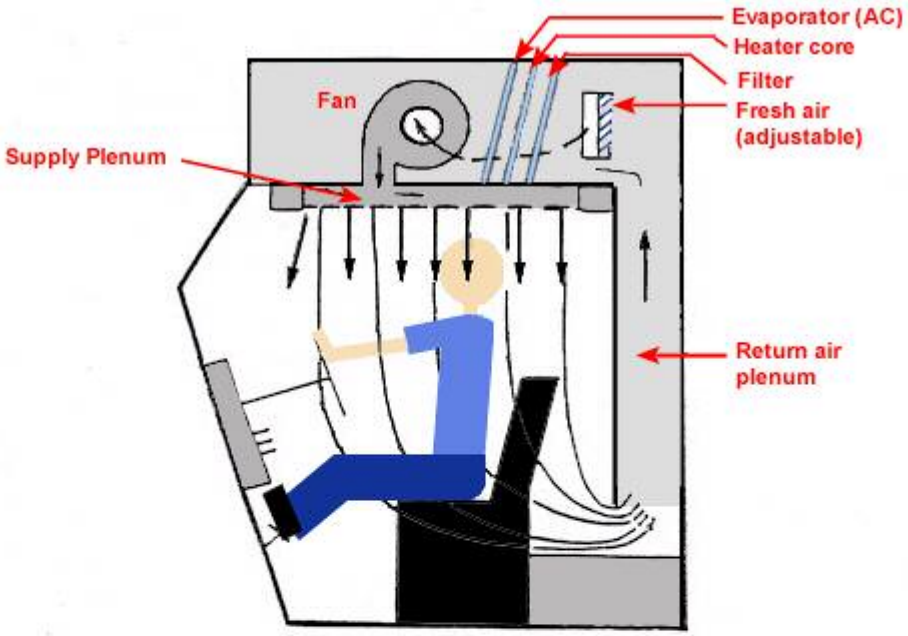
Fixed Supplied Air Island



Application Tips

- **Locate inlet in lead free area**
- **Temper inlet air - provide theromstat at work station**
- **Provide outlet nozzle as close to breathing zone as possible**

Filtered, Tempered, Supplied-Air Cab



DESIGN CHARACTERISTICS

Q = 100 scfm/sq ft of cab cross-sectional area.

v face = 100 fpm at breathing zone

sp reg = typically 5-6" w.g.

APPLICATION TIPS

Distribute air evenly across cab cross-section.

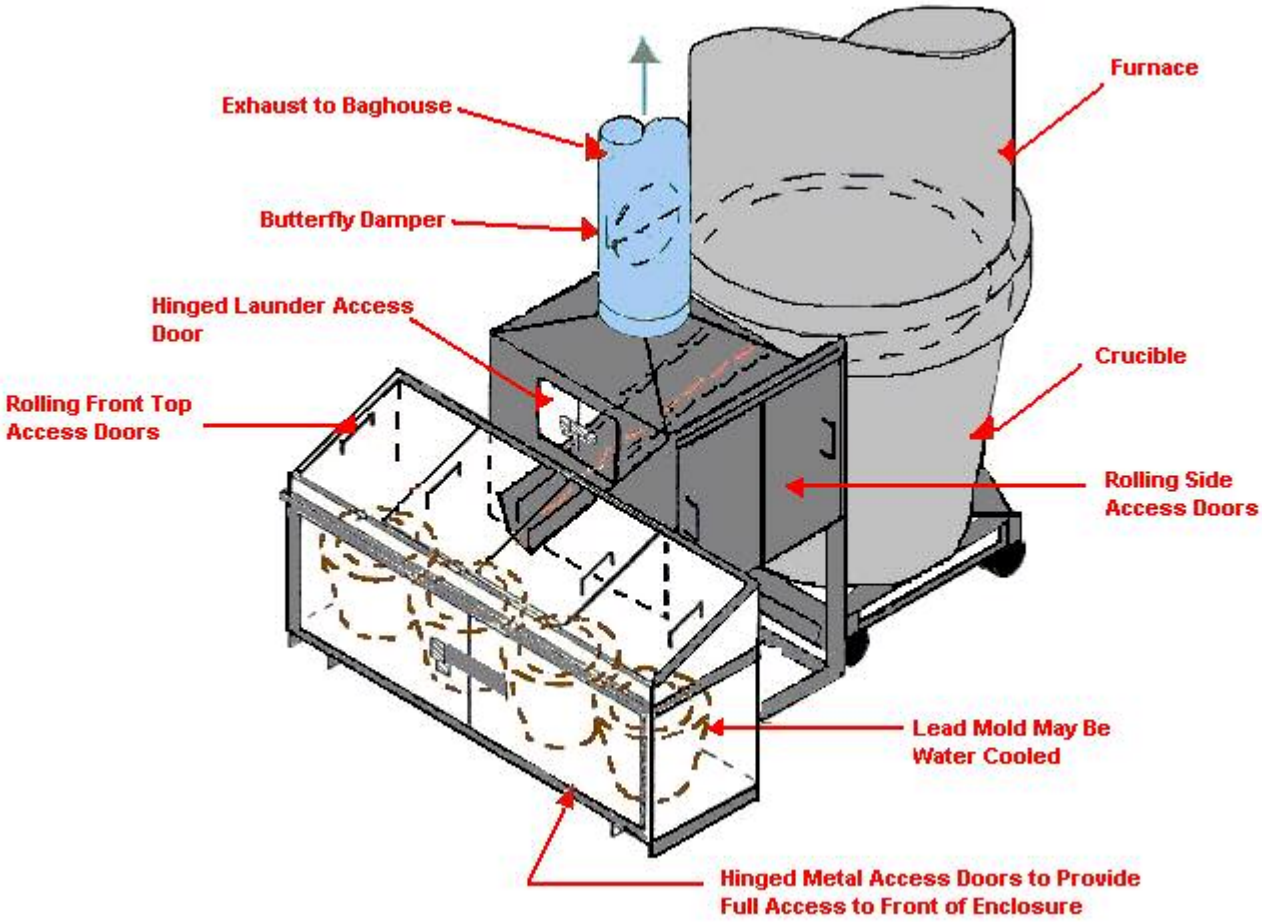
Provide temperature controls at operators station.

Provide for rapid filter change.

NIOSH articles:

Improved Cab Air Inlet Location Reduces Dust Levels and Air Filter Loading Rates Floor Heaters Can Increase Operator's Dust Exposure in Enclosed Cabs Sweeping Compound Application Reduces Dust From Soiled Floors Within Enclosed Operator Cabs

Enclosure Hooding - Furnace Lead Tap Controls



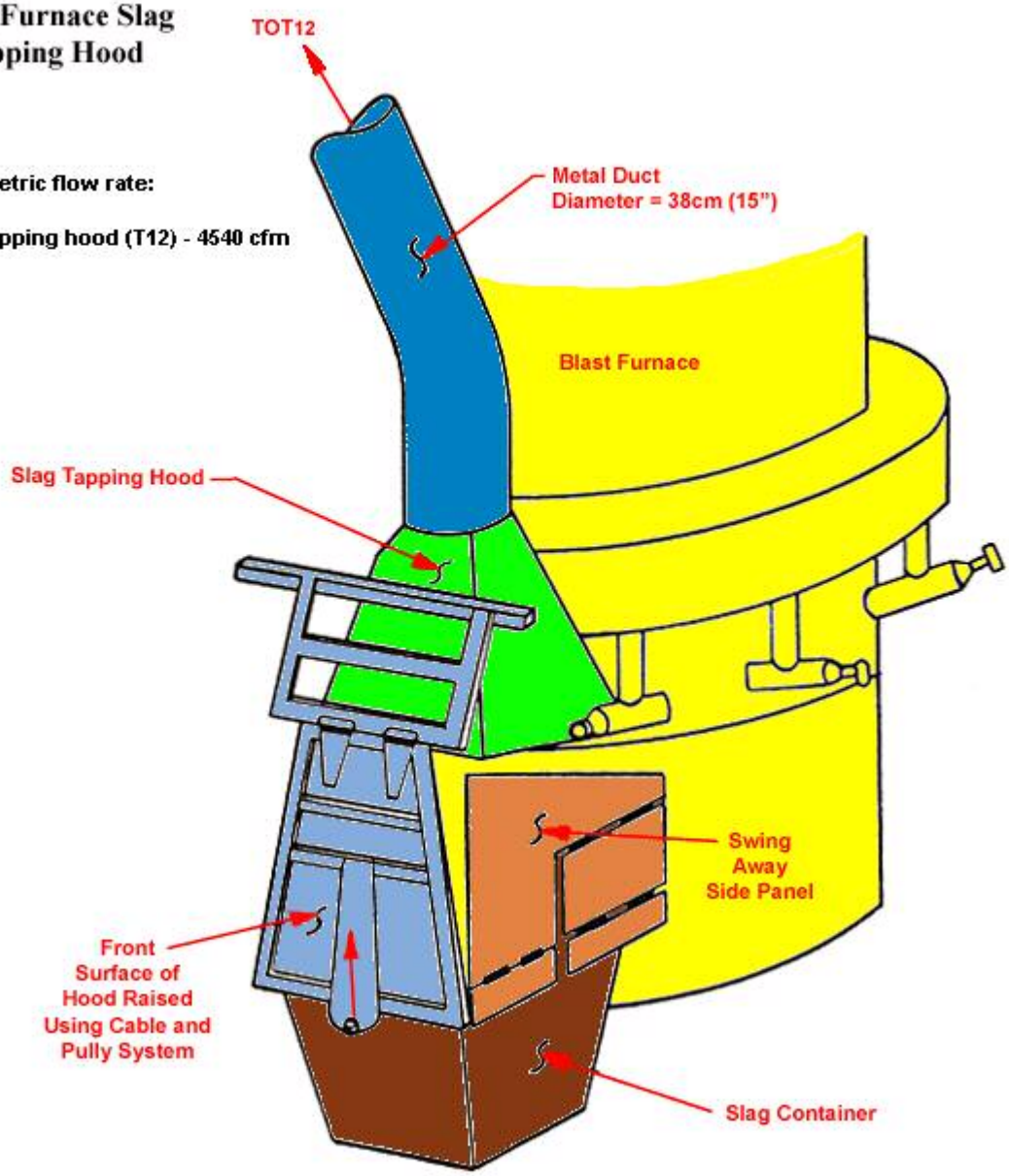
Design Characteristics

- Enclosure to provide capture velocities at opening of 350-500 FPM
- Transport velocity in ducts greater than or equal to 4000 FPM

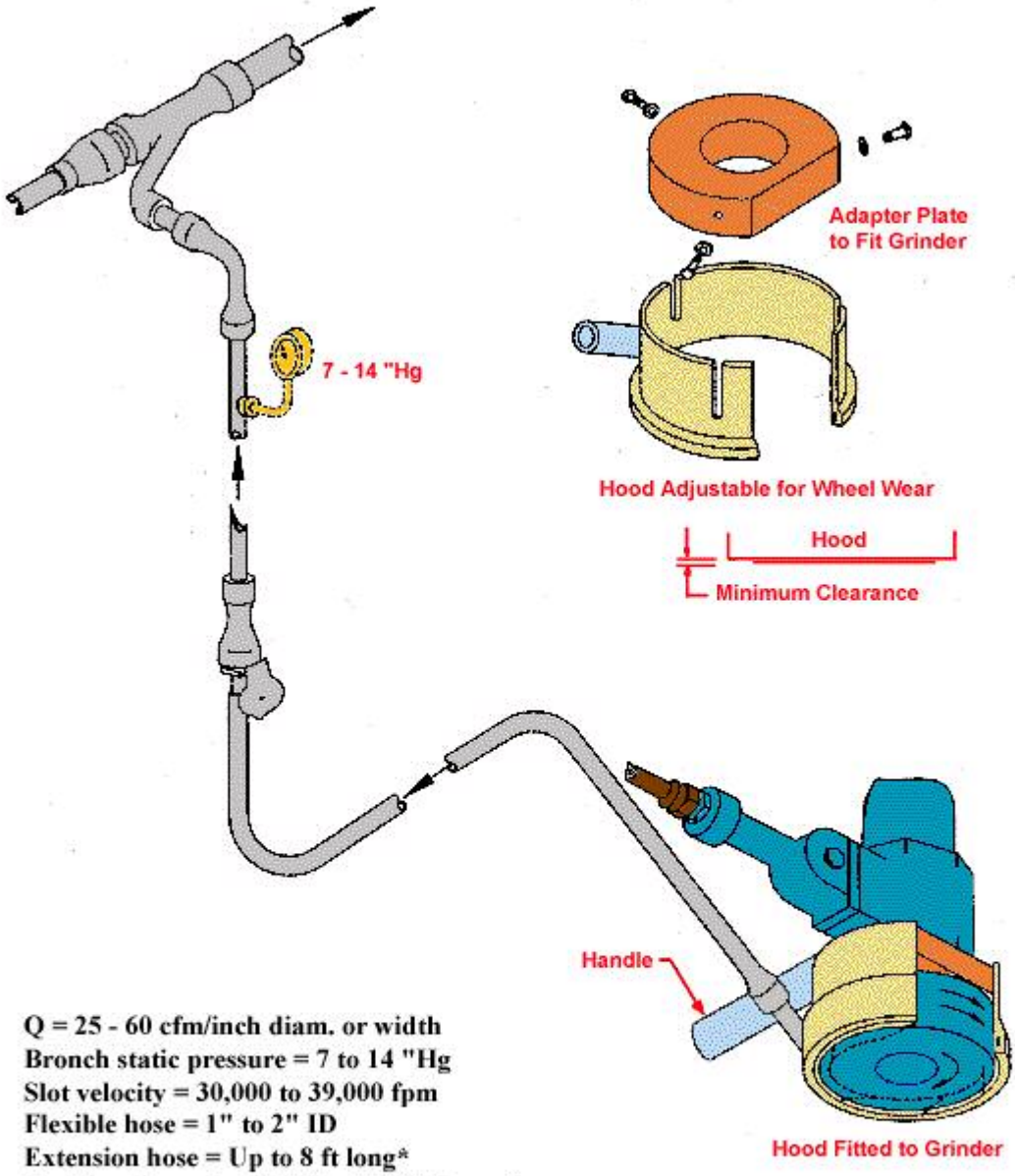
Blast Furnace Slag Tapping Hood

Volumetric flow rate:

Slag tapping hood (T12) - 4540 cfm



Hood for Cup Type Surface Grinder and Wire Brushes



Q = 25 - 60 cfm/inch diam. or width
Bronch static pressure = 7 to 14 "Hg
Slot velocity = 30,000 to 39,000 fpm
Flexible hose = 1" to 2" ID
Extension hose = Up to 8 ft long*
Peripheral speed = 6,000 to 12,000 linear fpm

***Hose lengths may be extended up to a maximum of 50 ft by using larger sizes between the tool hose and the tubing system.**

American Conference of Governmental Industrial Hygienists	
Date: 10-90	Figure VS-40-02

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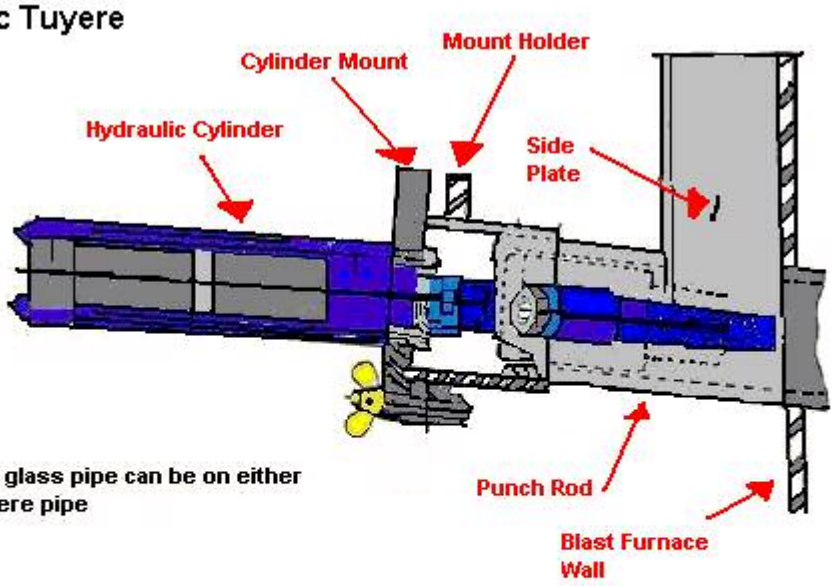
Hydraulic Tuyere Puncher



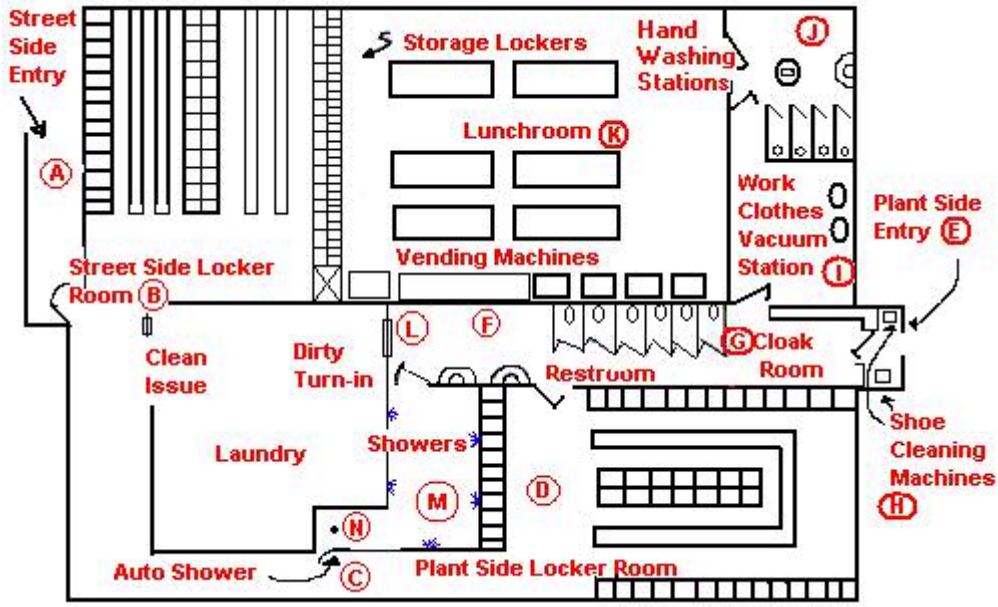
Note: Sight glass pipe can be on either side of tuyere pipe

Application Tips:

- Limited to compatible metallurgical conditions

- Moderate maintenance required

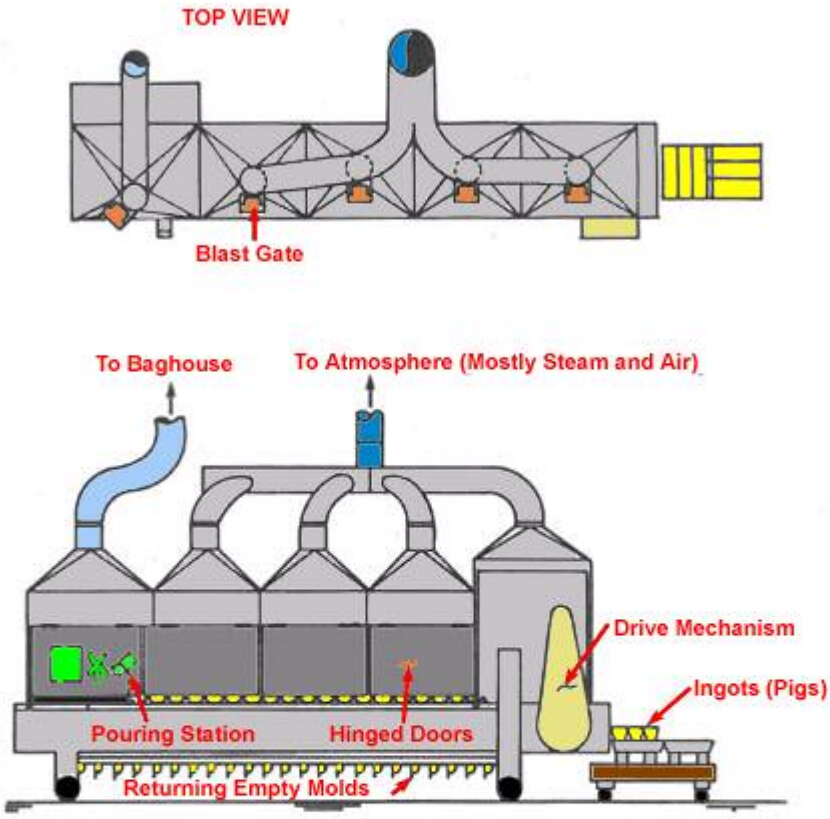
Two-Stage Hygiene Facility



Facility Function/Description

1. The facility can be entered from the street at only one point. (A)
2. Street clothes are removed and clean work clothes, hardhat, and respirator are issued and donned in the street side locker room. (B)
3. The employee passes through a one-way turnstile in order to get to the plant-side locker room. (C)
4. The employee dons work boots and other safety gear in the plant-side locker room where they are stored. (D)
5. There is only one entry to the plant. (E)
6. The restroom just inside the cloak room is readily accessible during working hours. (F)
7. The cloak room provides a place to store coats, hardhats, gloves and respirators during break periods. (G)
8. During lunch break the employee first cleans his boots at the shoe cleaning machines (H), leaves coat and equipment in the cloak room (G), vacuums off his clothes at the vacuum stations (I), proceeds to the hand washing station where he thoroughly washes his hands (J), and finally enters the lunch room. (K)
9. At the end of the shift the procedure is as follows: the employee cleans shoes (H), removes contaminated clothing in the plant side locker room (D), stores boots, etc. in plant-side lockers, turns in dirty work clothes, hardhat and respirator to laundry (L), and proceeds to the showers. (M) He then must pass through an automatic shower (N) to return to the street-side locker room (B), where he dresses and leaves the faculty. (A)

Ingot Casting
Local Exhaust Ventilation



Design Criteria

Casting Hood:

Q = 500 scfm/sq ft of equipment + 100 scfm/sq openings

$h_e = 0.5\ VP_{duct}$

$V_{transport} \geq 400$ fpm

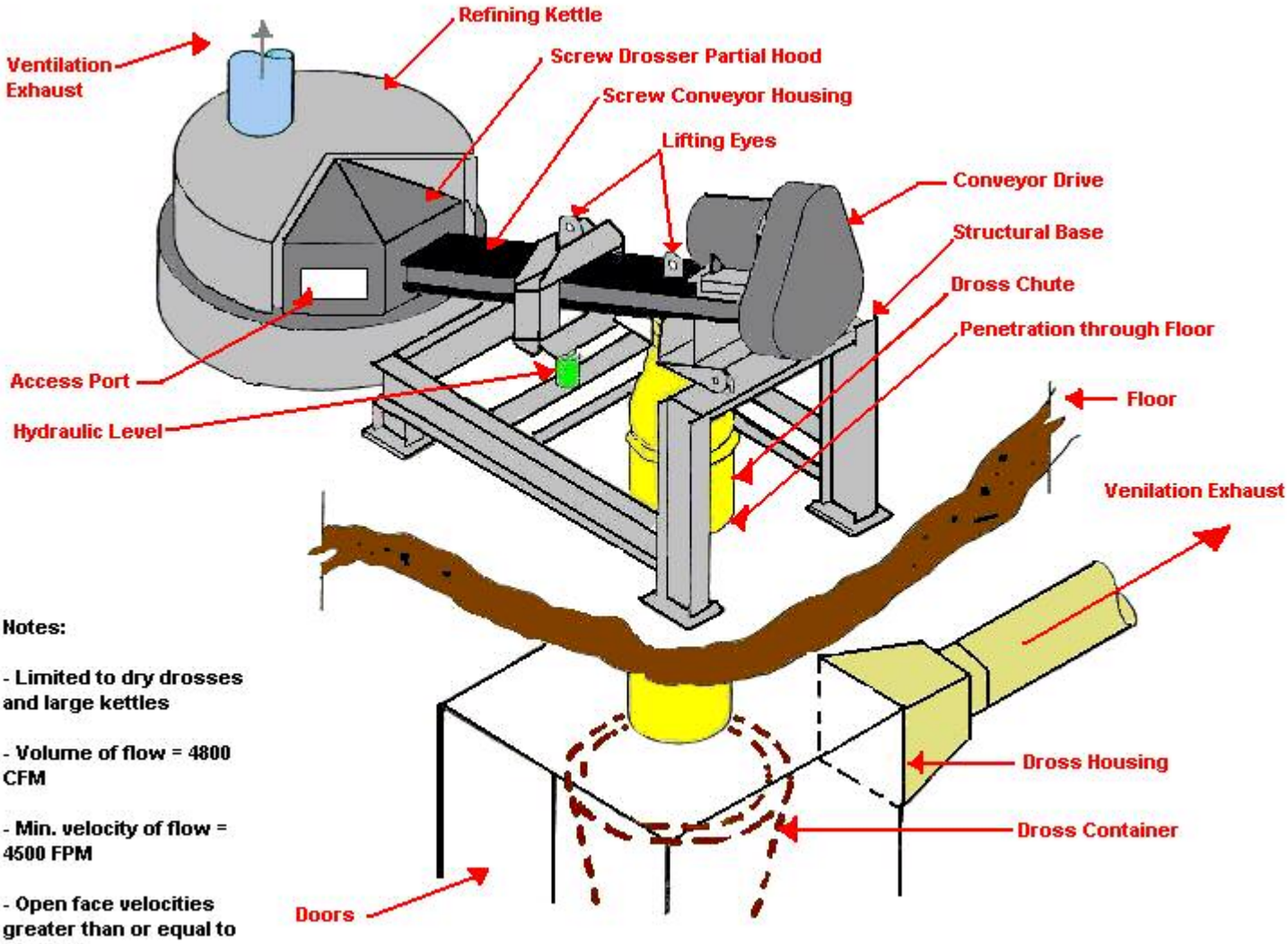
Cooling Hood:

Q = 100 scfm/sq ft openings + 500 scfm per gal H_2O used per minute

$h_e = 3.3\ VP$

$V_{duct} \geq 2000$ fpm

Mechanical Drossing
Tonolli Screw Drosser



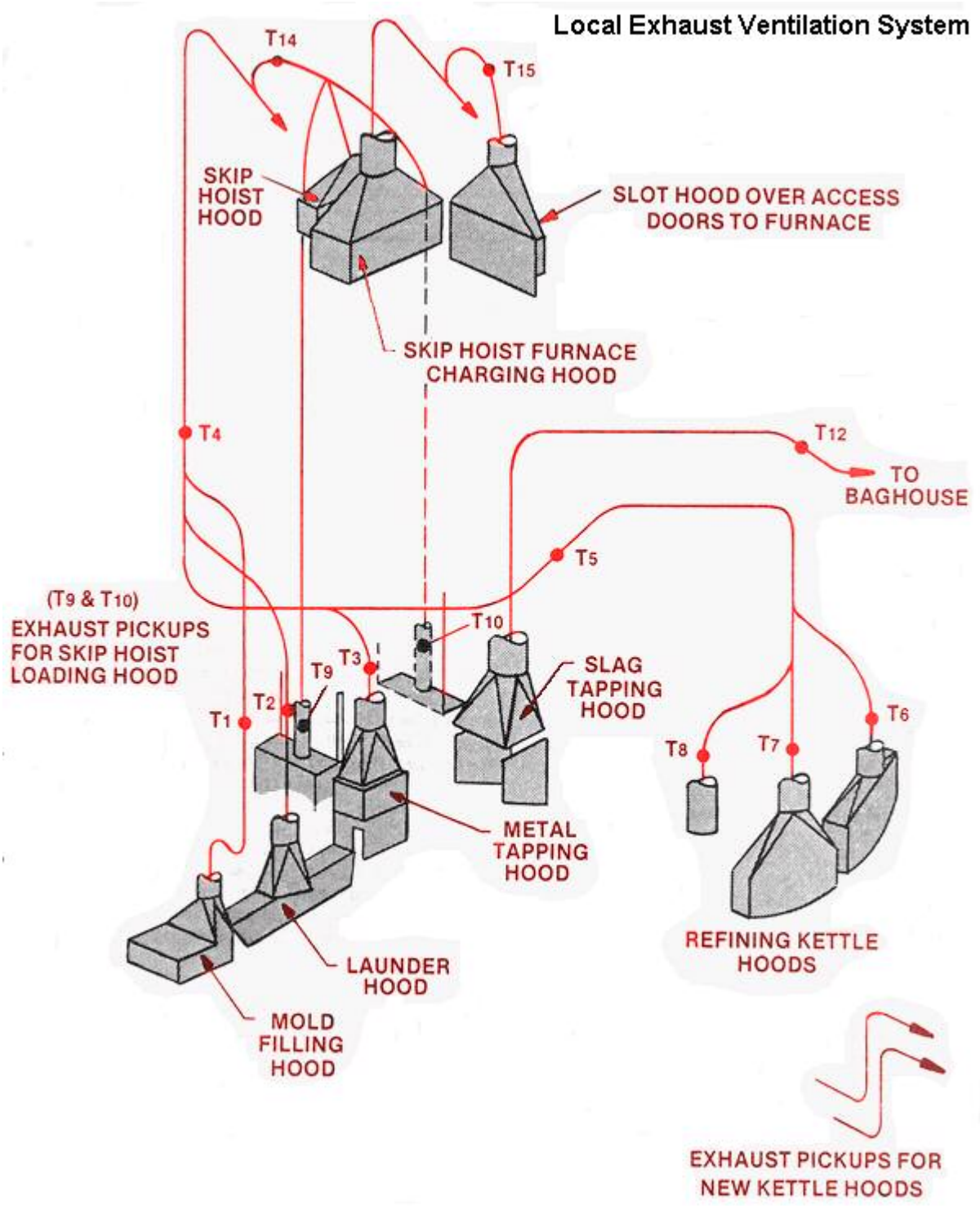
Notes:

- Limited to dry drosses and large kettles

- Volume of flow = 4800 CFM

- Min. velocity of flow = 4500 FPM

- Open face velocities greater than or equal to 250 FPM



Volumetric flow rate:

(T1) Mold filling hood - 1650 cfm

(T2) Launder hood - 2460 cfm

(T3) Metal tapping hood - 3660 cfm

(T5, T6, T7, T8) Refining kettle hoods - 4700 cfm

(T9, T10) Skip hoist furnace charging hood - 12100 cfm

(T12) Slag tapping hood - 4540 cfm

(T14) Skip hoist hoods (top and bottom) - 3930 cfm

(T15) Slot hood over furnace access doors - 1940 cfm

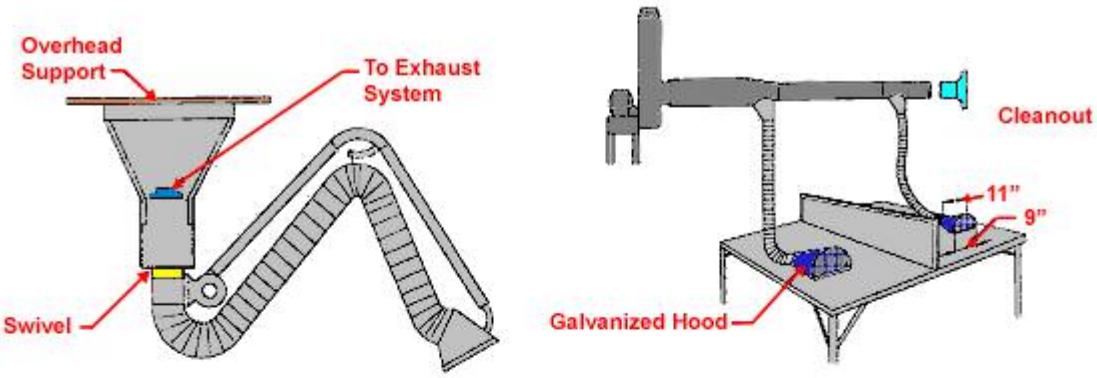
Exhaust pickups for new kettle hoods - 2940 cfm

Discharge from slag tapping baghouse - 5000 cfm

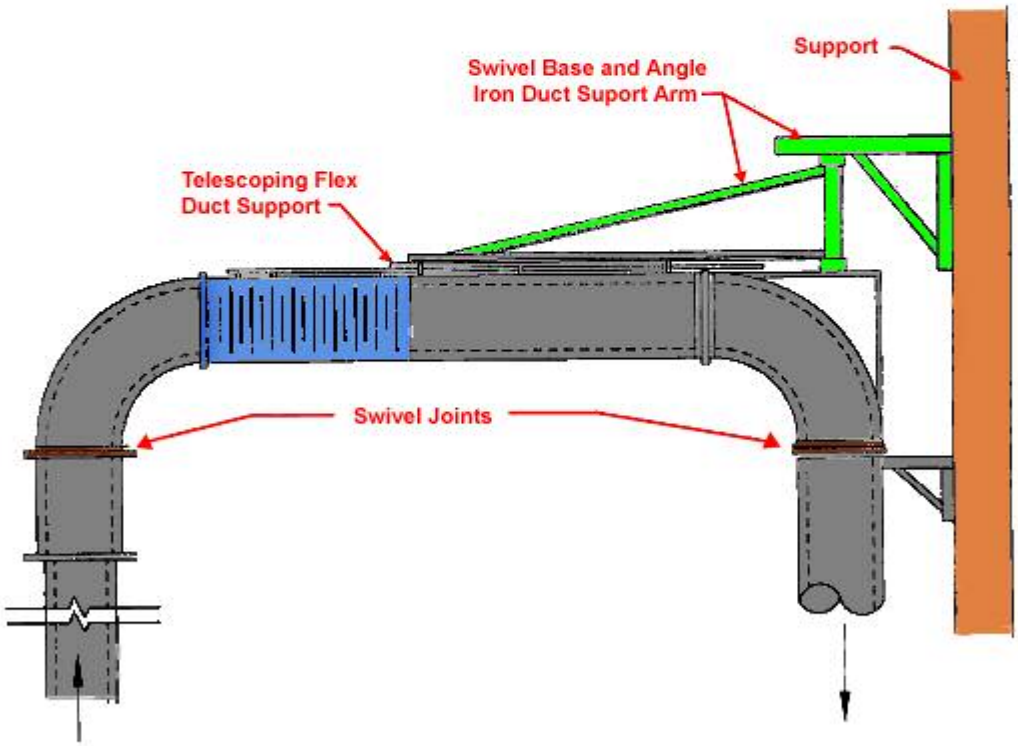
Inlet to main exhaust fan for smelter exhaust ventilation system - 41700 cfm

Proceedings of the Symposium on Occupational Health Hazard Control Technology in the Foundry and Secondary Non-Ferrous Smelting Industries, U.S. Department of Health and Human Services, NIOSH Publication No. 81-114 (1981).

Movable Exhaust Hoods



FLEXIBLE EXHAUST CONNECTIONS



American Conference of Governmental Industrial Hygienists	Date: 02-91
	Figure: VS-65-01

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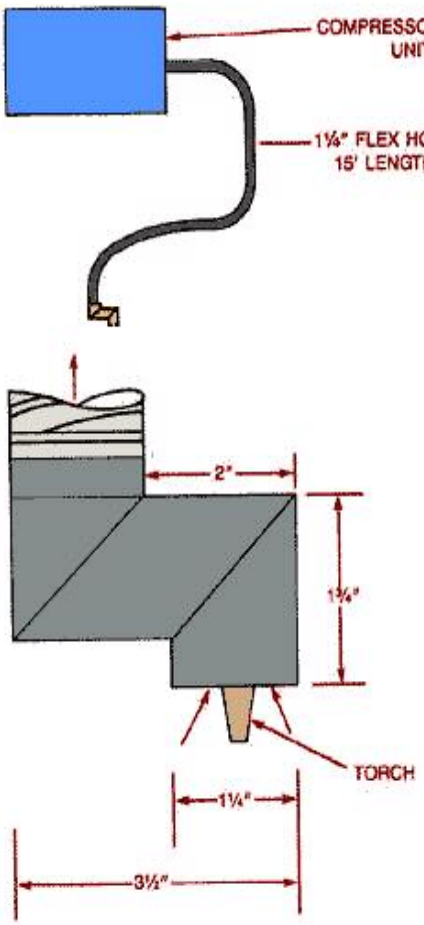
Portable Tool Exhaust
(High Velocity/Low Volume)



Design Criteria:

SP is greater than or equal to 72" W.G. (inlet)

Q=40 cfm

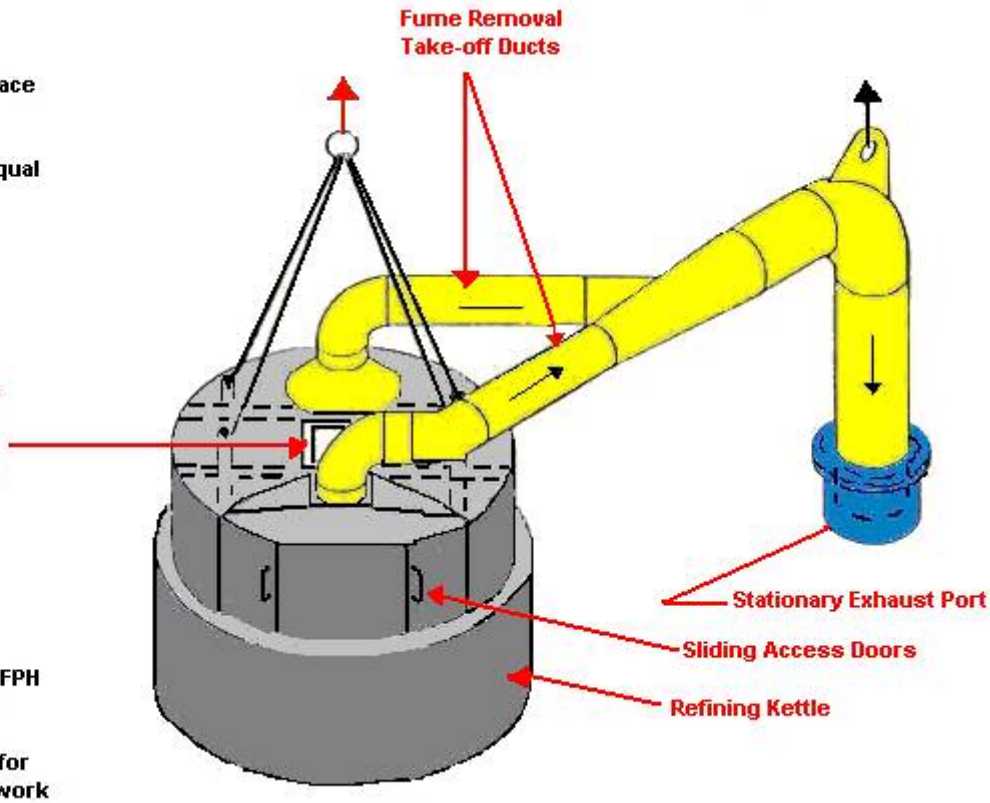
- **Use steel mold**
- **Source must be within 1" of hood**

Enclosure Hooding - Refining Kettle Emissions Control

Design Characteristics

- Volume flow rate of kettle surface area

- Dust Velocity greater than or equal to 4000FPM

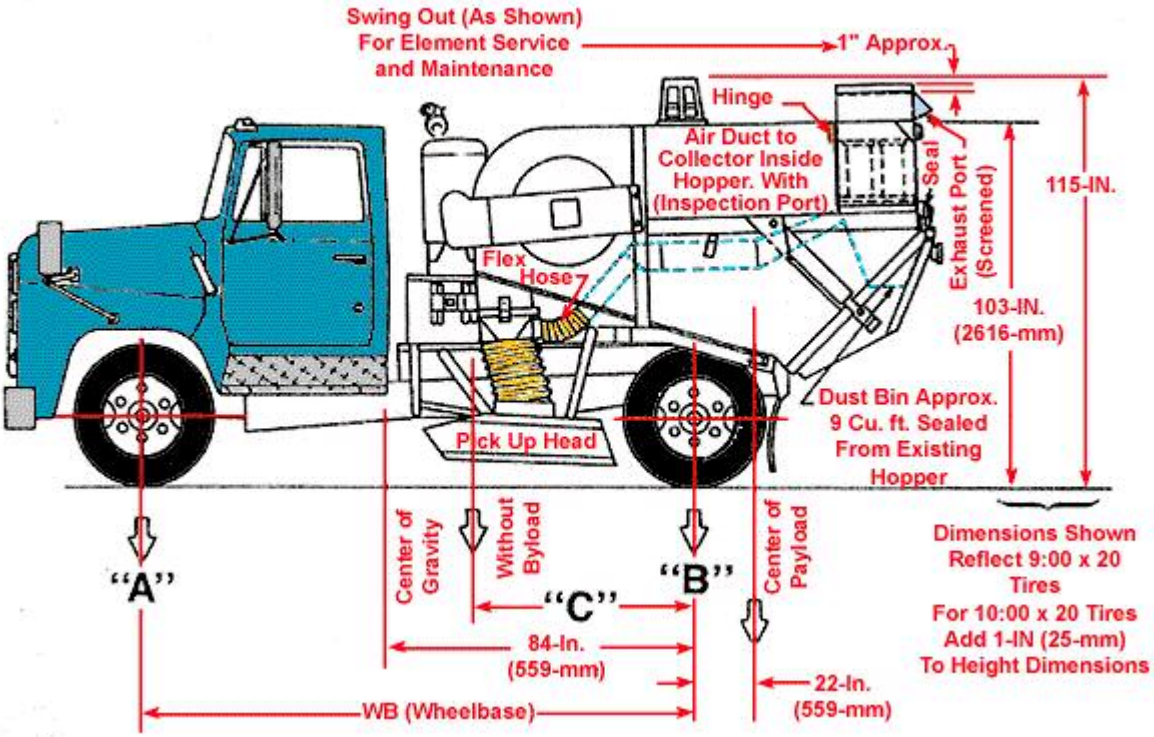


Construction Notes

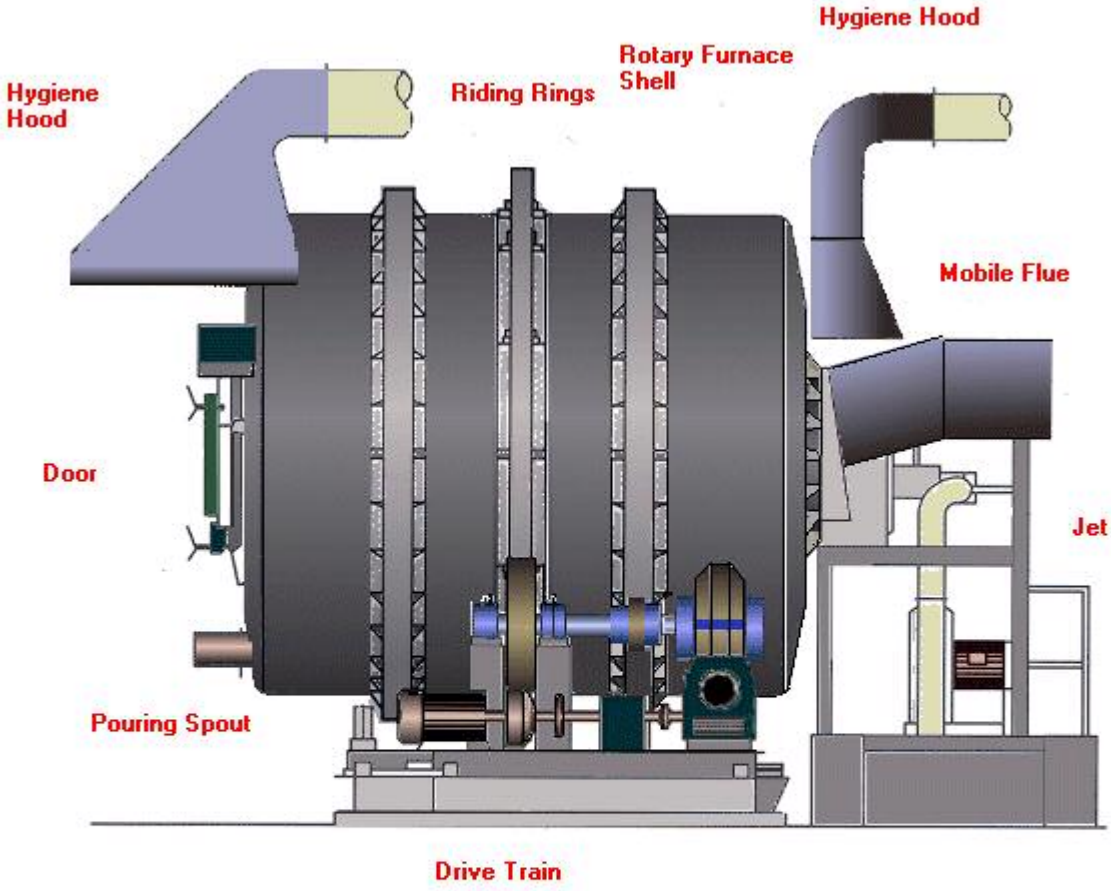
- Enclose to provide at least 250 FPH face velocity at all openings

- Provide adequate lifting points for hood assembly associated ductwork

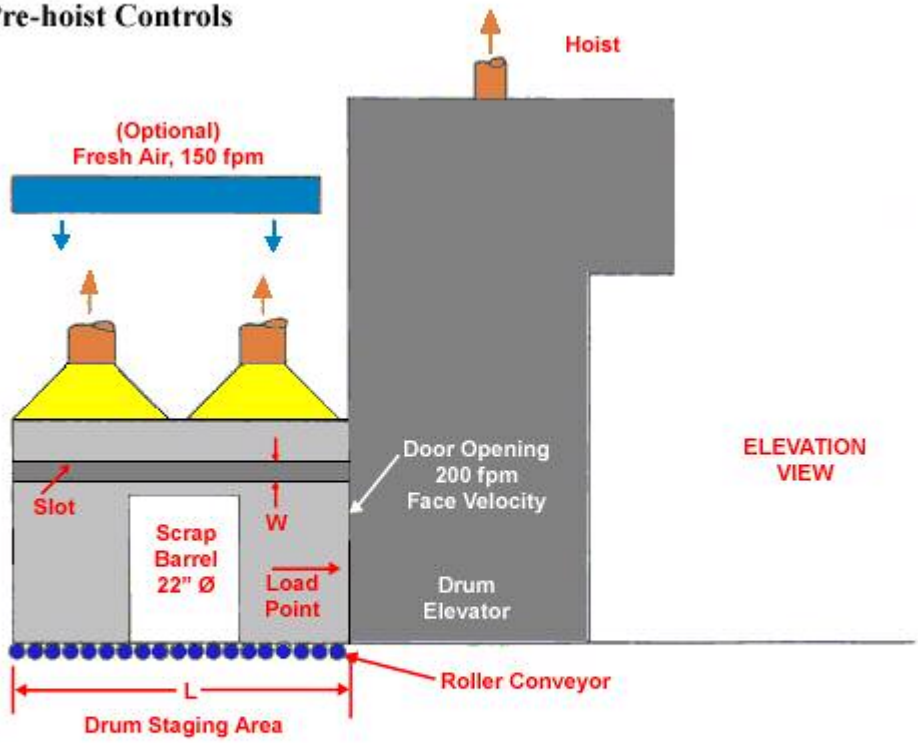
Regenerative Sweeper



Reverberatory Furnace



Scrap Barrel
Pre-hoist Controls



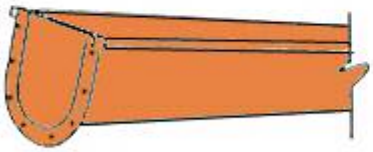
W = 0.25' (Typical)
V_{SLOT} = 2000 fpm
Q = 2000 · W · L
h_e = 1.78 VP_{SLOT} + 0.25 VP_{DUCT}

Conveyors -
Screw Conveyor Components

THE CONVEYOR SCREW imparts a smooth positive motion to the material as it rotates within the trough.

COUPLINGS AND SHAFT connect and transmit motion to subsequent screw conveyors. Held in place by self-locking Tem-U-Lac bolts.

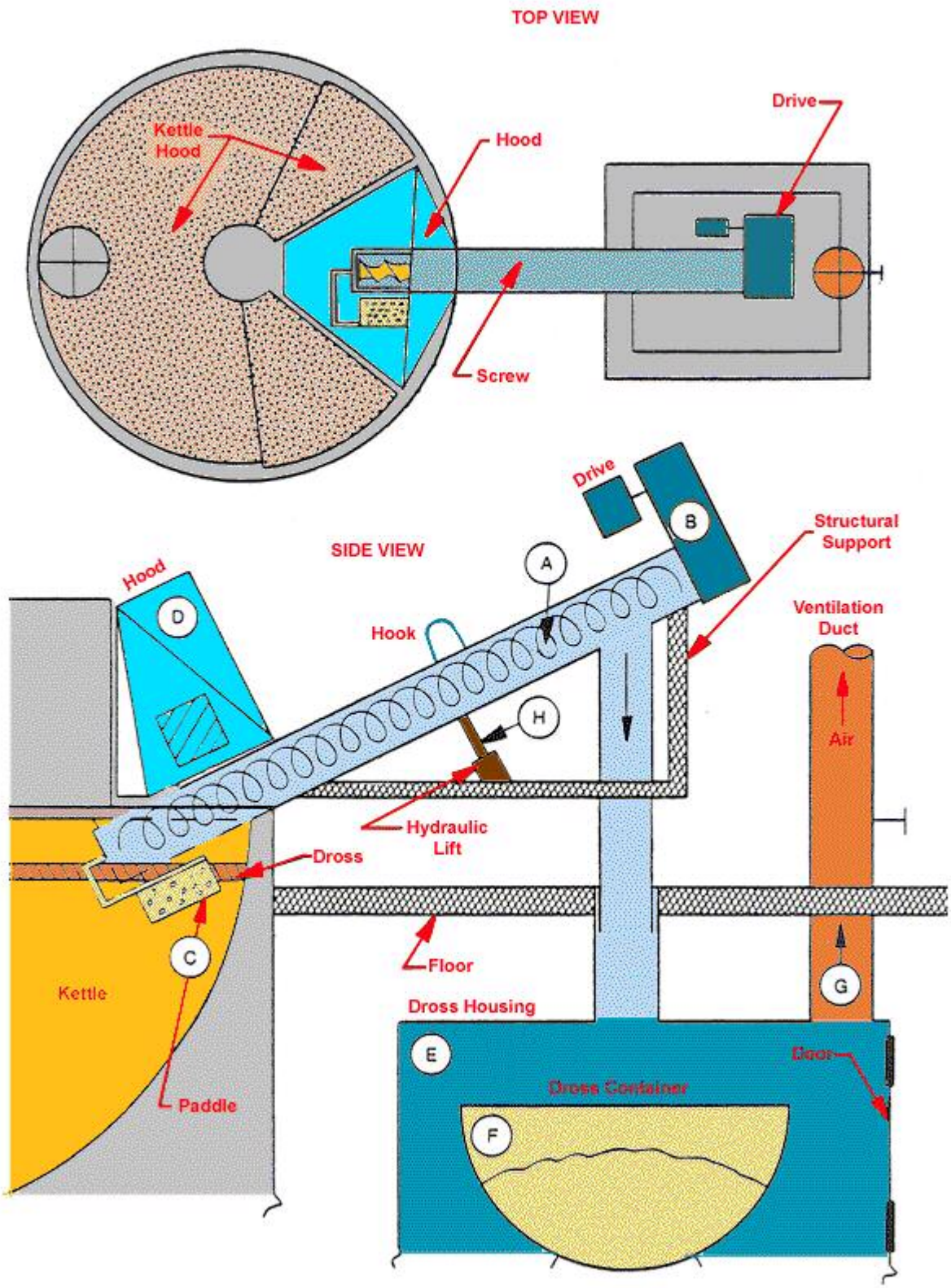
HANGERS provide support, maintain allignment and serve as bearing surfaces.



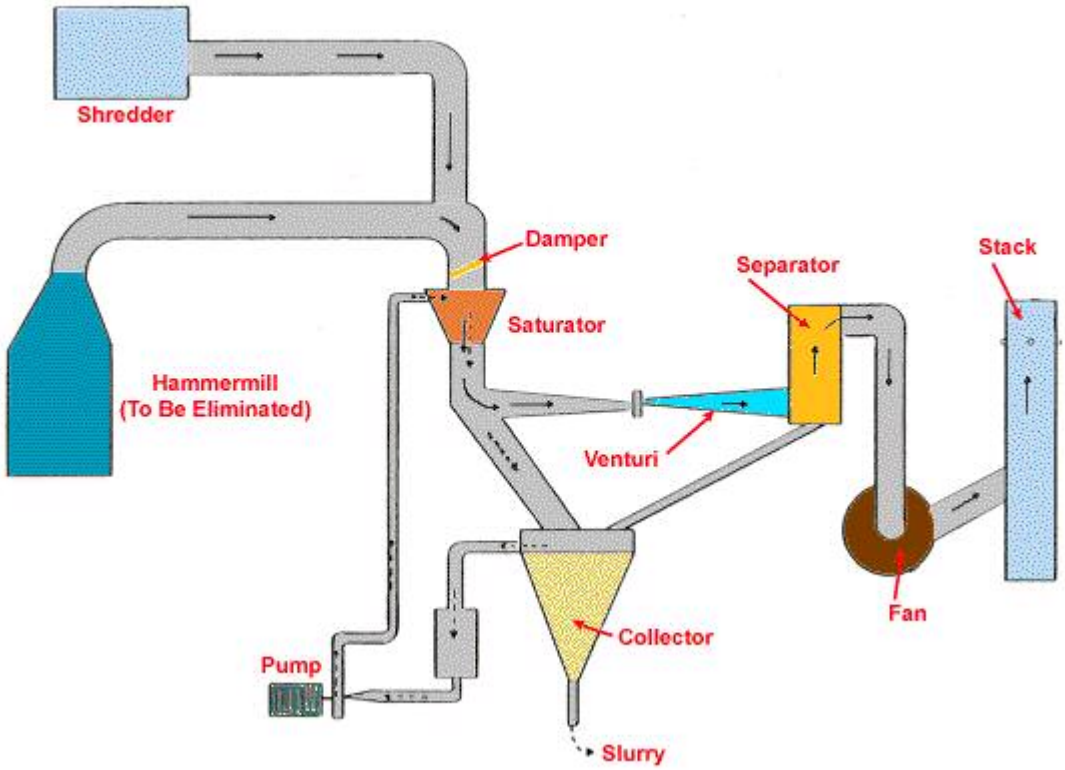
TROUGHS AND CONVEYORS completely enclose the material being conveyed and the rotating parts. Covers are availavle in various types and are secured to the trough by Spring, Screw, Tite-Seal or quick-acting Barron Clamps depending on the trough being used.

INLET AND DISCHARGE OPENINGS may be located wherever needed, discharge spouts may be without slides or fitted with either flat or curved slides. These slides may be operated by hand, rack and pinion gears, or by power.

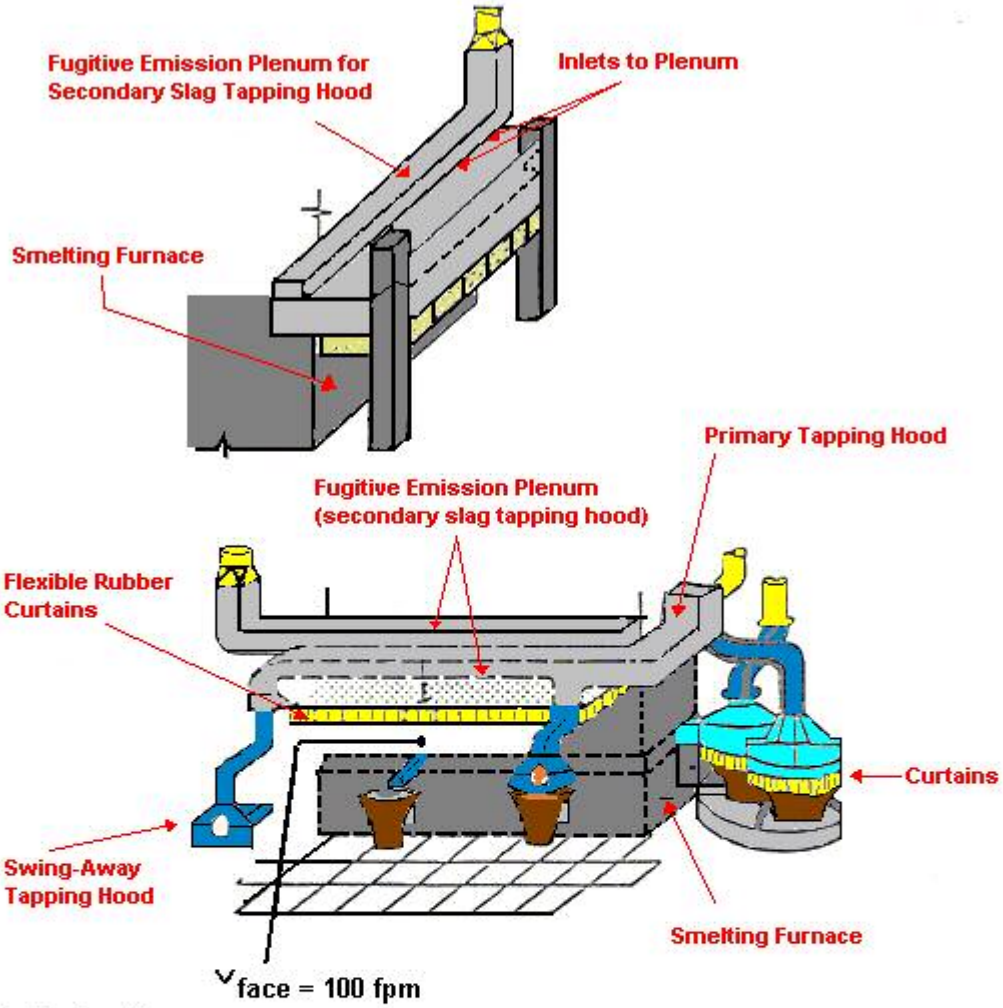
Screw Drossing



Scrubber


Shredder
Damper
Separator
Stack
Saturator
Hammermill
(To Be Eliminated)
Venturi
Fan
Collector
Pump
Slurry

Secondary Hoods for Fugitive Emission Control



Application Tips:

- Thouroughly characterize fugitive emissions prior to design

- Provide Make-up air

- Avoid the use of man-cooling fans

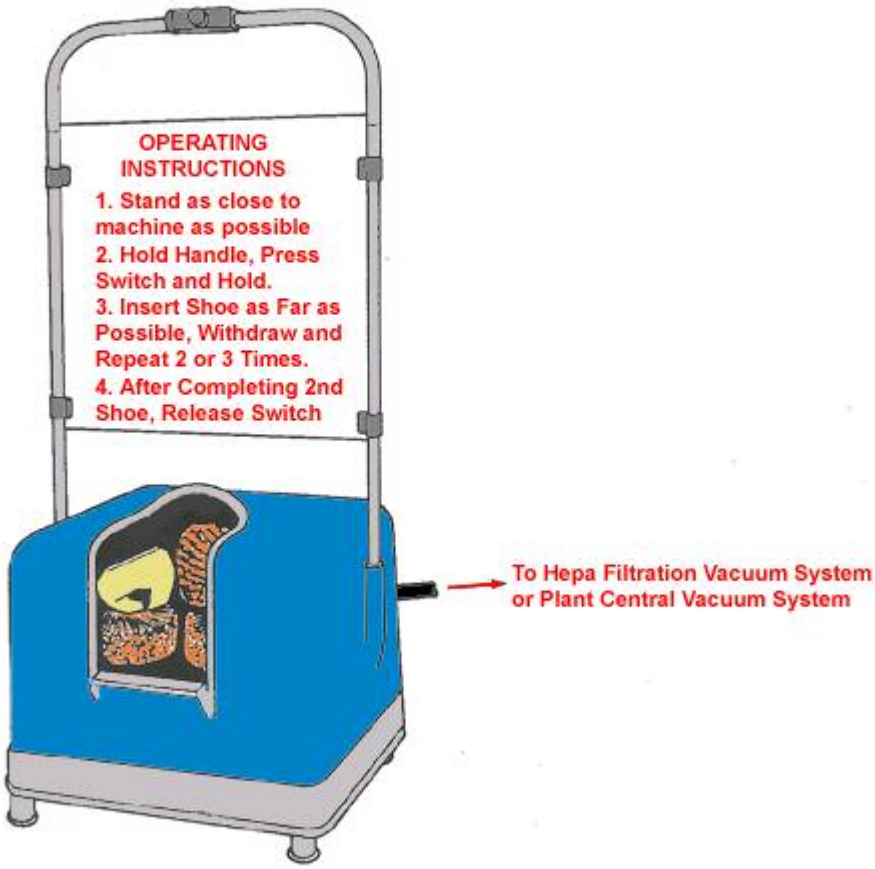
Design Characteristics:

Q= (Natural rising velocity at hood face = 100 fpm) times surface area of hood in sq. ft.

V is greater than or equal to 4000 fpm transport (horizontal runs)

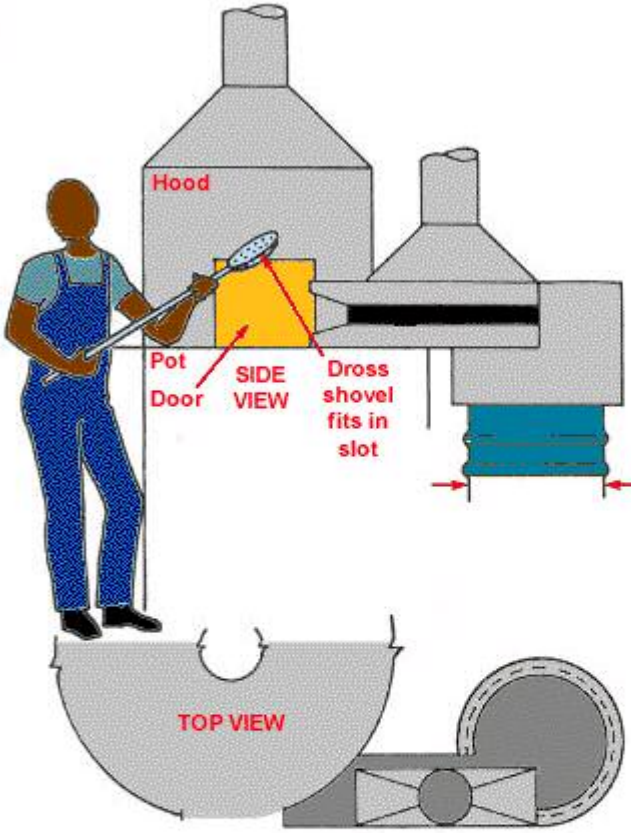
he = 2.2VP

Shoe Cleaning Machine



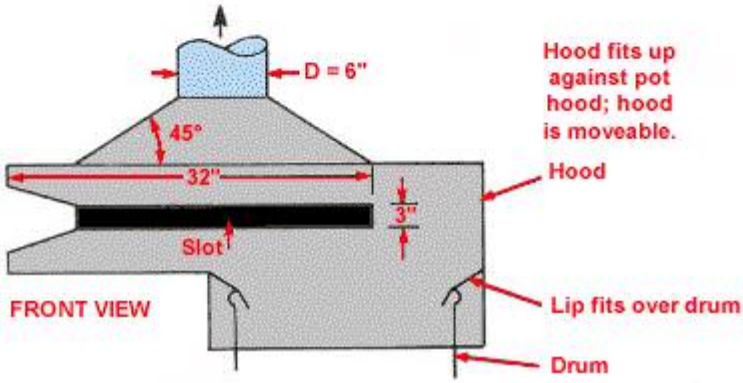
Provide exhaust ventilation, if necessary, to prevent brushes from throwing lead contaminants into operator's breathing zone.

Scrap Handling Remelt Pot and Slag/Dross/Skim Hood

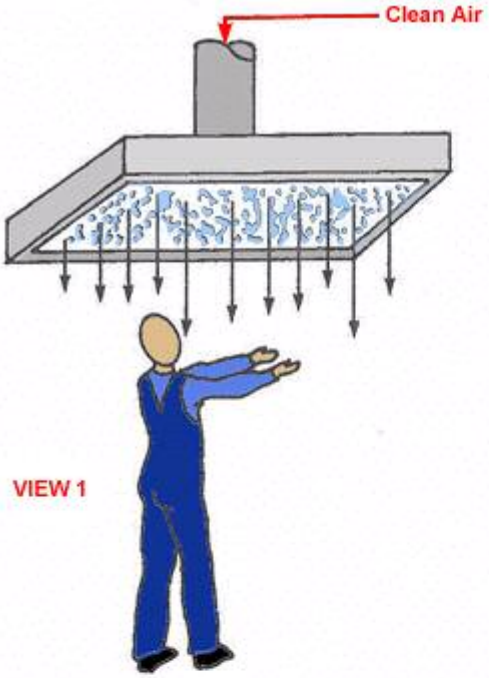


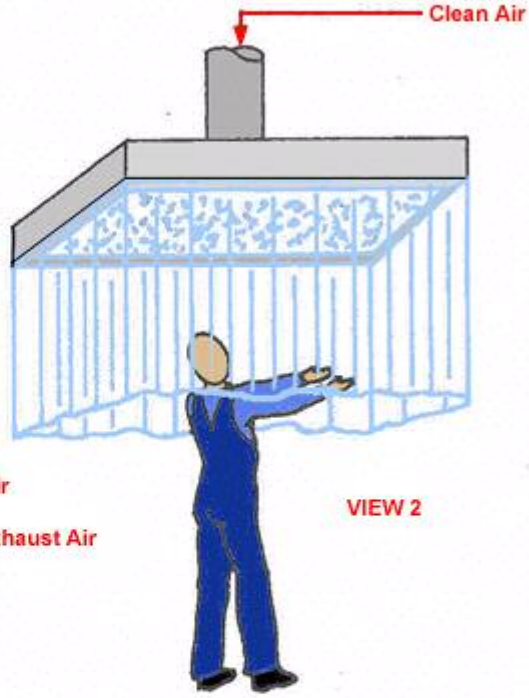
Design Criteria

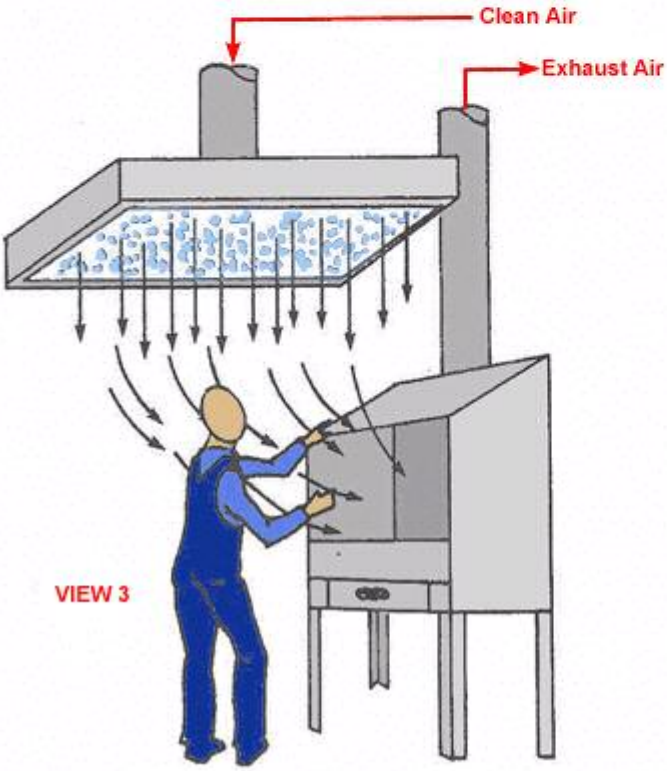
- V_{slot} = 1000 fpm
- Q = 1000 ctm
- V_{duct} = 4500 fpm
- he = 0.5 VP_{duct}



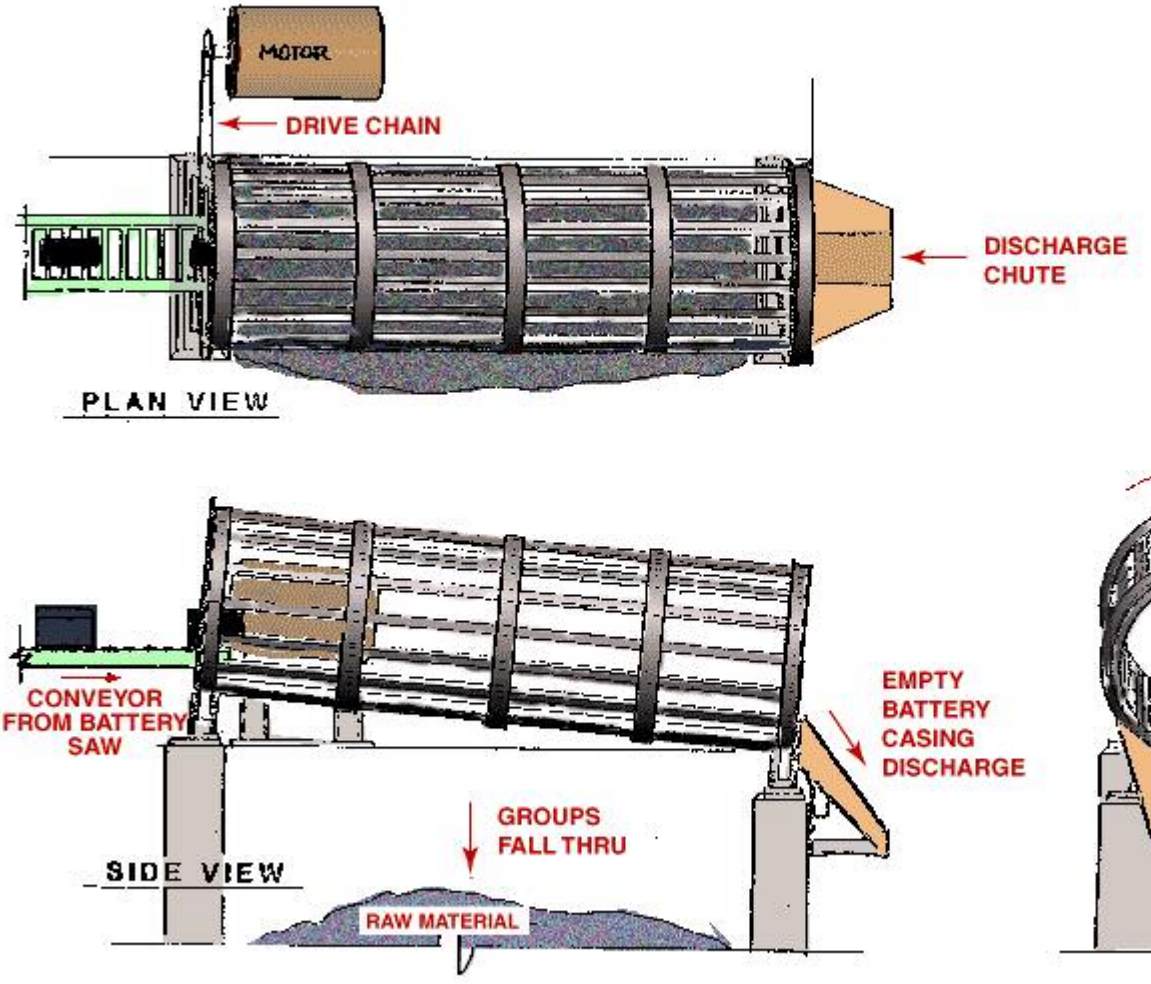
Supplied Air Island



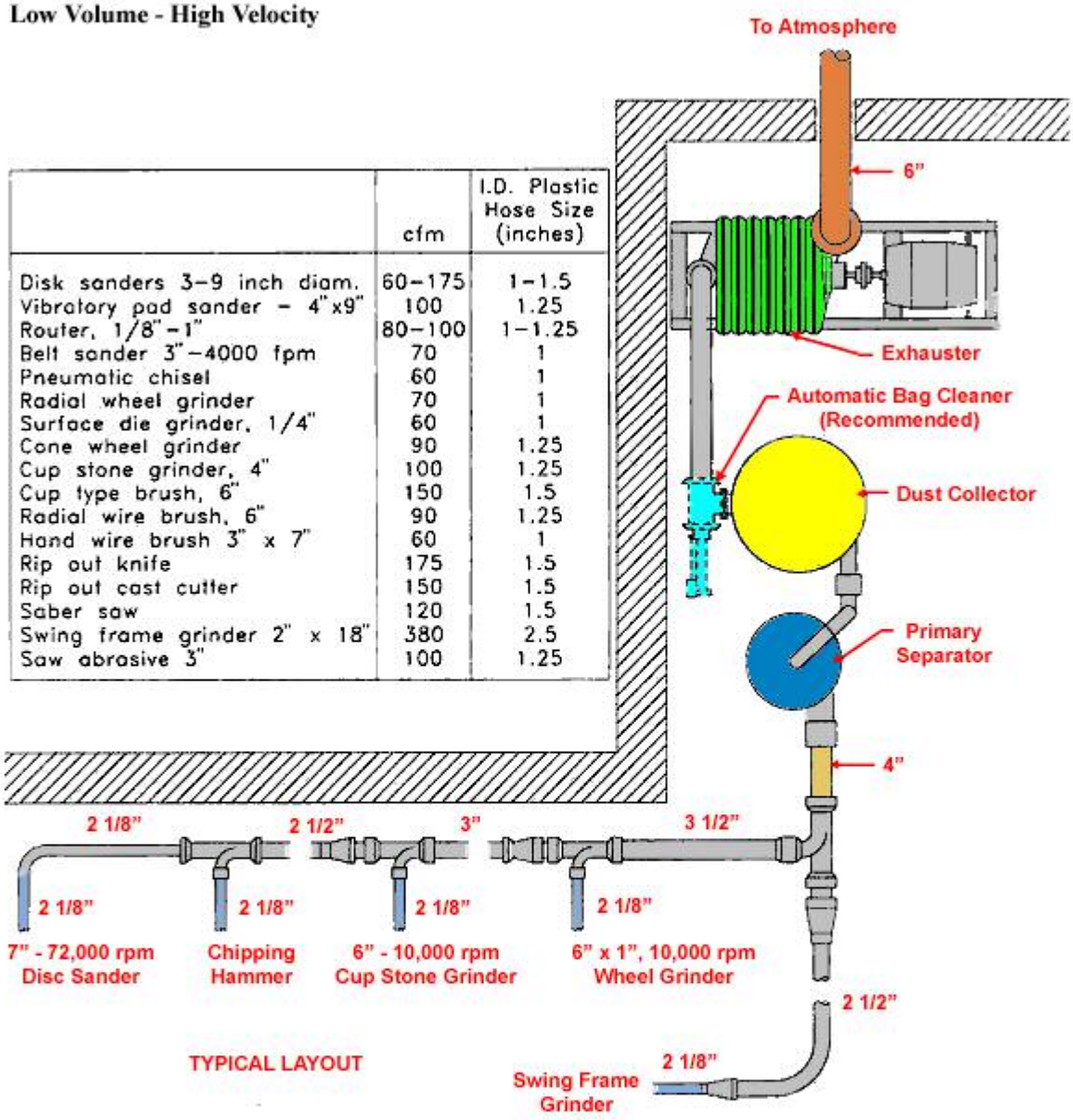




Tumbler


MOTOR
DRIVE CHAIN
DISCHARGE CHUTE
PLAN VIEW
CONVEYOR FROM BATTERY SAW
EMPTY BATTERY CASING DISCHARGE
GROUPS FALL THRU
SIDE VIEW
RAW MATERIAL
DRUM ROTATION
END VIEW

Typical System
Low Volume - High Velocity



	cfm	I.D. Plastic Hose Size (inches)
Disk sanders 3–9 inch diam.	60–175	1–1.5
Vibratory pad sander – 4"x9"	100	1.25
Router, 1/8"–1"	80–100	1–1.25
Belt sander 3"–4000 fpm	70	1
Pneumatic chisel	60	1
Radial wheel grinder	70	1
Surface die grinder, 1/4"	60	1
Cone wheel grinder	90	1.25
Cup stone grinder, 4"	100	1.25
Cup type brush, 6"	150	1.5
Radial wire brush, 6"	90	1.25
Hand wire brush 3" x 7"	60	1
Rip out knife	175	1.5
Rip out cast cutter	150	1.5
Saber saw	120	1.5
Swing frame grinder 2" x 18"	380	2.5
Saw abrasive 3"	100	1.25

American Conference of Governmental Industrial Hygienists	Date: 10 - 90
	Figure: VS - 40 - 20

System Notes

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

When system is used for vacuum cleaning of abrasive materials. Schedule No140 pipe and cast iron drainage fittings, or heavier, should be used in place of tubing.

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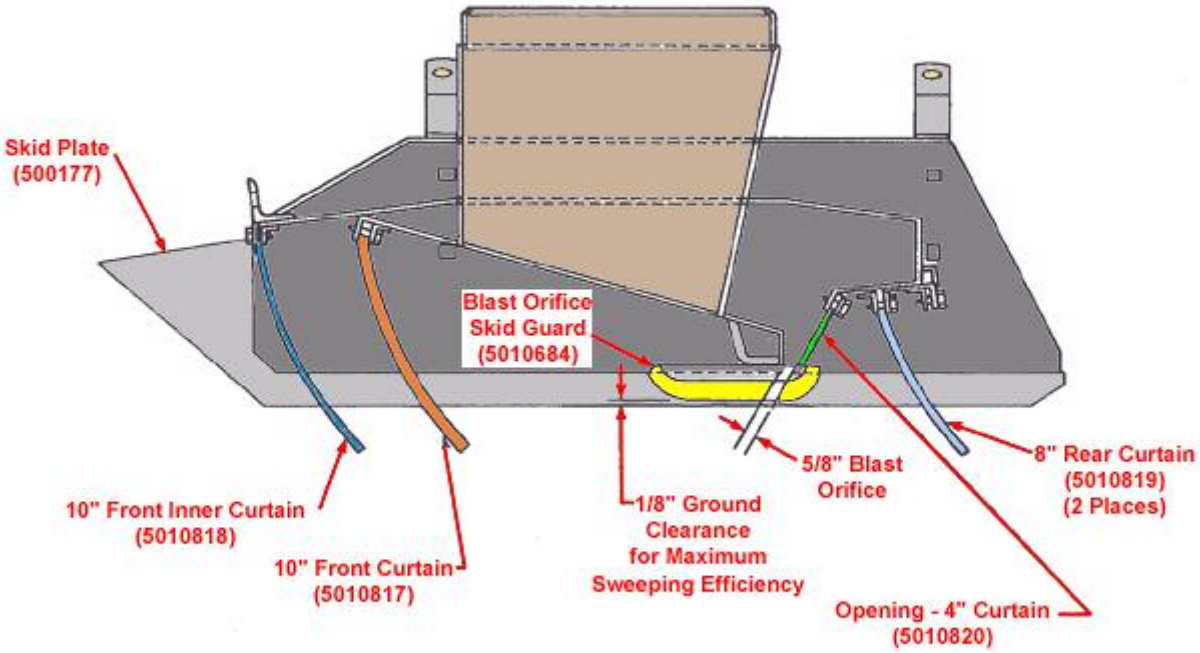
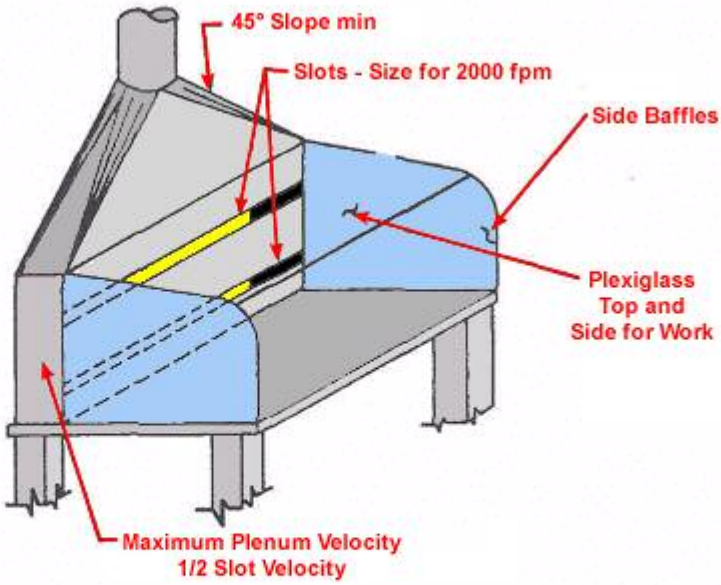
Vacuum Truck
Mobile Vacuum



CROSS SECTION

NOTE: Suction Baffle
(5010832) Not Shown

Workbench



Design Criteria

- Q = 350 cfm/lineal ft of hood
- Hood length = required working space
- Bench width = 24" maximum
- Duct velocity ≥ 4,500 fpm
- $h_e = 1.78\ VP_{slot} + 0.25\ VP_{duct}$

Lead > Secondary Lead Smelter eTool

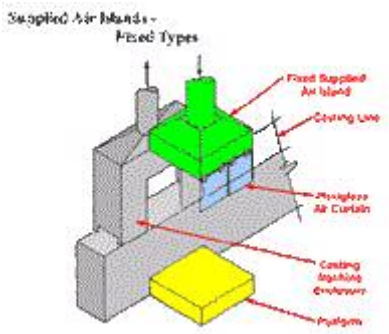
Engineering Controls > Supplied Air Island and Clean Air Rooms

There are two types of clean air systems that can be used for secondary lead smelting operations:

1. Supplied-Air Island (SAI)/Laminar Flow Systems
2. Clean Air Room

Both systems:

- Protect the worker from exposure to contaminated background air.
- Help propel dust produced at the workstation away from the operator's breathing zone.



View full size fixed supplied air island diagram

Supplied-Air Island (SAI)/Laminar Flow Systems

Supplied-air islands provide a zone of clean air at a workstation. The supplied air may come from outside the plant or the air may be filtered plant air.

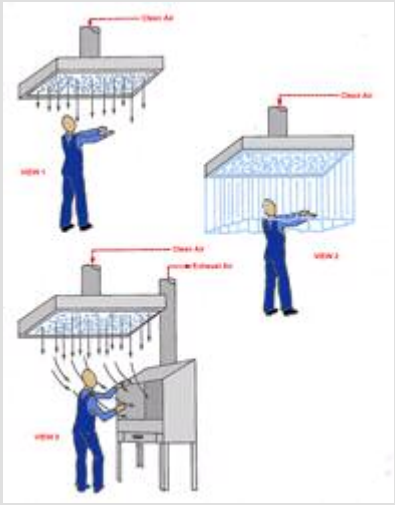
Supplied-air islands are especially useful in limiting lead exposure when:

- An employee remains in a stationary position at the workstation for long periods of time. The SAI provides an envelope of clean air to a worker. The clean air flows down over the worker which normally keeps factory air from entering the clean air core.
- A supply of fresh, clean air is available. Note: Outside air may not require cleaning and costs will be lower. If no outside source of clean air is available, intake air should be filtered).
- The air is tempered. Employees will not remain in an environment that is too hot or too cold. Note: If the air is not tempered employees will block off the air flow with cardboard or other material in the winter or try to increase the flow for cooling in the summer which could result in higher exposures.

Design Specifications:

The supplied-air island (SAI) should be designed to provide a laminar flow of fresh air through the employee's breathing zone at a low enough velocity so that additional airborne lead dust is not generated through reentrainment. The SAI height is typically 80 inches from the floor but is often restricted by overhead clearance limits and other equipment installed in the area. The air flow is

designed so that the velocity measured at the employee's breathing zone is 100-150 feet per minute. Higher velocity may stir up lead dust. SAIs can be used in conjunction with exhaust- ventilated work benches. In this case, the air should be balanced so that make-up air is provided equal to the amount of the exhaust air.



View full size supplied air island diagram

Clean Air Room

Using clean air rooms can effectively lower lead exposure. Some clean air rooms are used as lead-free environments where employees can remove their respirators. These rooms need to have positive pressure, be tempered, and have a filtered air system with a HEPA filter designed to remove 99.97 percent of lead dust greater than 0.3 micron in diameter. An ante room should be included to give employees a place to remove their protective equipment without spreading contamination in the clean air rooms.

Perform the following to ensure clean air rooms are free of lead contaminants:

- Vacuum enclosures and scrub with soap and water so lead dust does not collect on flat surfaces.
- Ensure the structural integrity of all enclosures is intact and under positive pressure at all times.
- Develop a preventive maintenance checklist that includes schedules for:
  - Replacing ventilation system filters
  - Replacing ventilation system hoses, clamps, and blower internal parts
  - Replacing window and door moldings
  - Checking and replacing air shower ventilation systems, including automatic doors, blower, nozzles, and lighting.
  - Monitoring intake and exhaust airflow to ensure that the rooms are under positive pressure at all times.

Lead > Secondary Lead Smelter eTool

Engineering Controls > Process Controls

Process control systems, which include artificial intelligence based on preset algorithms, are sometimes used for controlling lead smelter operations. Those systems can minimize system upsets, which may result in lead emissions. They provide graphical user interfaces (GUI) that show real-time information, such as when a process fails. The process control system can also store data that can be retrieved and manipulated, and provide automated reporting.

Process control system

Process Controls

The graphical user interface **(Fig. 1)** shows the process in real-time with user-friendly graphics. These graphics may be as simple as a block diagram or as complex as digital photographs. The user interface not only displays pictures of the process but can also use process data to show real-time or historical trends of process points. Alarms are provided to notify the operator when intervention is required.

Fig. 1. Graphical user interface

The programmable logic controller (PLC) is a local, stand-alone computer that is hard wired to process points such as limit switches and temperature probes. It runs logic based on information from input devices (e.g., switches, analog devices, or information received from the user interface) and compares it to a program in its memory. The PLC then makes decisions and provides commands to field devices (e.g., starting and stopping motors). If communication between the user interface and the PLC is lost, the PLC will run the process autonomously based on the last information received from the user interface and its programming.

The database is where all data collected from the user interface and PLCs is stored. This data can be used in a number of ways:

- It can be retrieved and trends analyzed to help identify how the process runs under certain conditions.
- It can be retrieved and put into report formats that can be shown on a computer screen, automatically printed out, or e-mailed to selected recipients.

In short, reports that were once collected and collated by hand can now be created automatically. This both saves time and decreases the likelihood for human error.

Process Control Examples

Waste water treatment chemical feed:

Chemicals are fed into a wastewater stream, which helps keep the stream at a pH of 10. A pH probe sends its readings to the PLC that monitors the process. The PLC then takes this reading and applies it to its logic tables to determine whether to add more chemicals, and if adding, how much to add. This keeps the waste stream at a pH of 10 and limits chemical wasting due to over feeding.

Furnace exhaust:

Instruments monitor furnace exhaust emissions and send their readings to the PLC. Decisions are then made by the PLC based on its logic tables:

- whether to add a chemical,
- open and close dampers,
- alarm the process control computer,
- or even send a message to the supervisor's pager.

This allows for a timely response by operations personnel to prevent unwanted releases from being vented to the atmosphere.

Occupational Safety & Health Administration
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