Lead > Secondary Lead Smelter eTool

Overexposure to lead is a leading cause of workplace illness in the lead industry. Employees working in secondary lead smelter plants are exposed to one of the highest lead exposure levels among all lead-related industries.

Smelting is the process of reducing reclaimed lead compounds to elemental lead and lead alloys in high-temperature furnaces.

Raw Materials Processing, Smelting, Refining and Casting, Environmental Controls, and Maintenance are operations conducted in a secondary lead smelter that may expose workers to lead.

Information on Engineering Controls and OSHA Lead Requirements is provided to assist in compliance with the OSHA Lead Standard.

Respiratory protection and medical surveillance are not addressed in this eTool. However, they are essential for controlling lead exposure levels and preventing lead-related disease when engineering controls do not reduce airborne lead levels below the permissible exposure limit. Please refer to respiratory protection and medical surveillance for more information.

The OSHA Lead Standard requires the employer to reduce employee exposure to the lowest feasible level through the use of engineering and work practice controls (1910.1025(e)(1). The engineering and work practice controls addressed in this eTool have been shown to reduce employee exposure and are provided to assist employers and employees in complying with the OSHA Lead Standard. It is the employer's responsibility to evaluate the sources of exposure and the specific controls for operations that are necessary to comply with the Lead Standard.

Disclaimer

eTools are "stand-alone", illustrated, Web-based training tools on occupational safety and health topics. As indicated in the disclaimer, eTools do not create new OSHA requirements. *Public Test Version for comments through June 2003.*

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Raw Materials Processing

Secondary lead smelter feed materials usually require processing before being charged into a smelting furnace. Handling and transporting lead-bearing materials may expose workers to lead-bearing dust during:

- Raw Material Receiving and Storage
- Battery Breaking
- Charge Preparation (drying)
- Material Handling and Transport

Included in the National Institute for Occupational Safety and Health publication *Mineral Processing Dust Control* is the Dust Control Handbook for Mineral Processing, US Department of Interior, Bureau of Mines (1987). This document contains valuable information in Chapter 2: Preventing Dust Formation.

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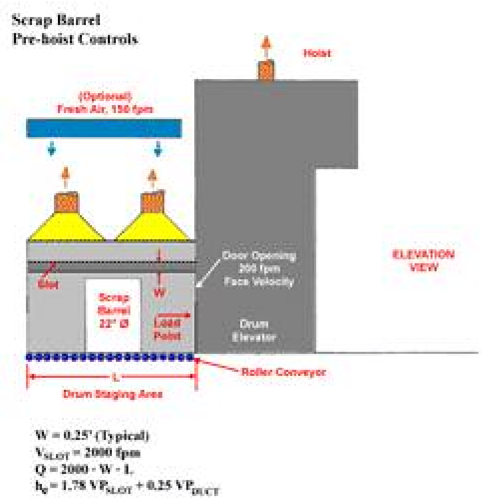
Raw Materials Processing > Raw Materials Receiving and Storage

Used batteries are usually received in palletized containers and can either be stored or transferred to conveyors for shredding. These are normally low-exposure operations.

Lead-bearing scrap from other operations (such as battery manufacturing plant scrap, dross from lead refining, and scrap metallic lead) should be covered during transfer and stored in an enclosed, ventilated area until the charge preparation phase begins.

Workers may be exposed to lead dust during receiving and storage of lead-bearing materials.

- Materials Receiving and Storage
- Lead-bearing Scrap



Click for larger view of scrap barrel diagram

Materials Receiving and Storage

Potential Sources of Exposure:

- Lead dust from scrap materials can become airborne during handling and transportation of materials **(Fig. 1)**.
- Emissions may occur during dumping and transporting materials to storage areas.
- Settled lead dust on surfaces and equipment may become airborne due to vehicle traffic and cross-drafts.

Fig.1. Material handling and transport with front end loader

Possible Engineering and Work Practice Controls:

- Provide vehicles with enclosed cabs that have positive-pressure, HEPA filtered air. **(Fig. 2)**.
  Tempered Air Cab Diagram

- Install full enclosure of bins containing lead-bearing materials.
  - Scrap Barrel Diagram

Fig.2. Enclosed cab front end loader with filtered air system

- Maintain raw material storage and handling areas under a negative-pressure enclosure to prevent contamination of adjacent work areas. **(Fig. 3)**.
  - Dust Control Handbook: Enclosures
- Minimize the height of free fall of materials dumped into storage bins.
  - Dust Control Handbook: Storage Bins and Hoppers

Fig. 3. Enclosed raw material storage

- Maintain positive-pressure, filtered air systems on mobile equipment to ensure effective operation. Check and change air filters regularly as part of an effective scheduled preventative maintenance program.
- Remain inside the vehicle and keep doors and windows shut during operation.
- Vacuum the inside of mobile equipment frequently.
- Reduce vehicle speeds to minimize the stirring up of settled dust.

Fig. 4. Sweeper for paved roads

- Wash vehicles to prevent spread of contamination when exiting storage areas.
- Pave all roadways to facilitate housekeeping. **(Fig. 4)**.
- Keep all roadways wet to minimize dust generation.
- Wet down raw materials storage to suppress dust generation.
- Install roll-up doors on bin charging decks to permit access for trucks and container dumping.
- If it is determined through source identification sampling that lead dust is coming from mobile equipment or is coming from adjacent areas, reevaluate material handling patterns and work practices and isolate the area through barriers and provide ventilation as needed.

Lead Bearing Scrap

Secondary lead smelters purchase a variety of materials as feed materials for the refining process. These materials include: battery manufacturing plant scrap, lead dross, metallic lead such as linotype and cable shielding, and tetra ethyl lead (TEL) residues **(Fig. 5)**. These materials may be charged directly into smelting furnaces or mixed with other charge materials.

Fig. 5. Tetra ethyl lead (TEL) storage

Lead-bearing scrap does not normally require processing prior to being charged to the furnace. Hazards involved are the same as receiving and storage and transport of raw materials.

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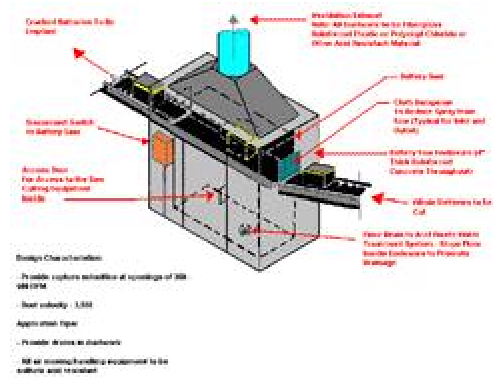
Lead > Secondary Lead Smelter eTool

Raw Materials Processing > Battery Breaking and Separating

The most common raw material at a secondary lead smelter is used automotive batteries. Batteries are typically unloaded by hand from trailers, conveyors, or from pallets. The batteries are then prepared for smelting by draining the acid and separating the plates, rubber, plastic containers, and sludge.

This section discusses the primary sources of lead exposure and controls that minimize lead exposure during the battery breaking and separating process.



Click for larger view of battery saw diagram

- Automotive Battery Breaking
  - Video Exposure Monitoring: Crusher Feed
- Industrial Battery Breaking
- Battery Separating
  - Manual Battery Separating
  - Tumbler Battery Separating
  - Sink/Float Process

Note: Exposure to corrosive acids can lead to serious burns and injuries. Required personal protective equipment must take acid exposure into account. Eye washes and emergency flushing facilities must also be provided.

Automotive Battery Breaking

The four most common processes for breaking automotive batteries are:

- High speed saw
- Slow speed saw
- Shear
- Whole battery crushing

The use of saws and shears involves cutting the tops off of the batteries, then dumping the contents of the battery. The whole battery crushing process involves crushing the entire battery in a crusher, shredder or hammermill, and separating the components by gravity separation.

Potential Sources of Exposure:

- The operation of battery saws, shears, crushers (hammermills), and shredders may release mists containing lead, which may dry and release lead dust if disturbed.
- Shredded or crushed battery components may fall to the ground and release lead-containing materials.

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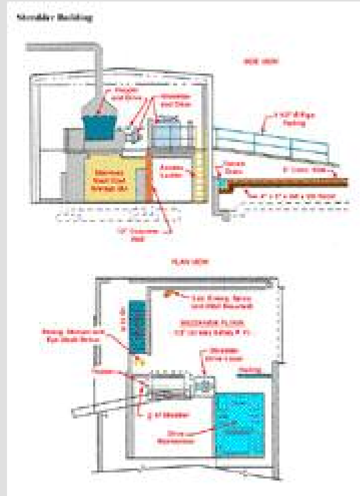
- Vibrating equipment with lead- contaminated surfaces may cause reentrainment of lead dust.

Possible Engineering and Work Control Practices:



Click for larger view of shredder diagram

- Provide properly designed local exhaust hoods with local exhaust ventilation for saws, shears, shredders, and crushers (hammermills) to control lead emissions. **(Fig. 1)**.
  - Dust Control Handbook: Crushers

  Battery Saw Diagram
  Battery Shredder

- Provide enclosure and local exhaust ventilation for shredded battery conveyor and transfer points.
  - Dust Control Handbook: Belt Conveyors

  Conveyor Belt Ventilation Diagram

- Provide a supplied air island or a temperature-controlled, positive-pressure, filtered supplied clean air room.

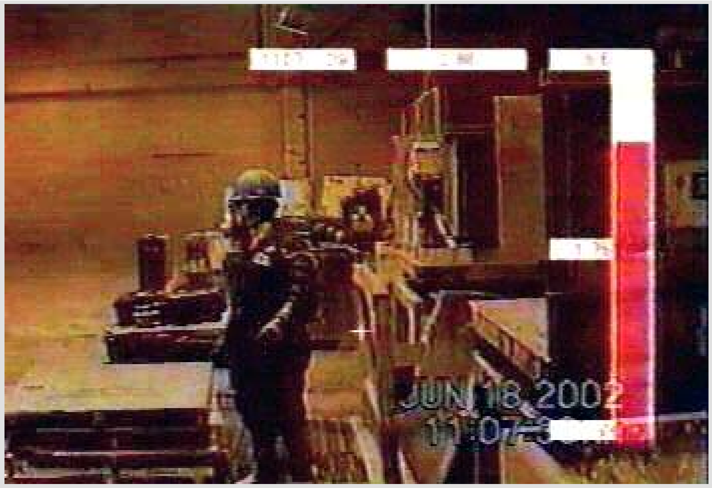
  Supplied Air Island Diagram

Fig.1. Enclosed and exhaust ventilated hammermill

- Automate the process with slow speed saws to cut off the tops of batteries. Slow speed saws emit less lead dust and acid mist than high speed saws.
- Provide curtains or shields on battery-breaking equipment to contain mists and liquid droplets containing lead particulate.
- Use wet suppression techniques to control exposure levels during cutting and sawing operations.
- Provide adequate make-up air.
- If it is determined through source identification sampling that lead dust is coming from mobile equipment or is coming from adjacent areas, reevaluate material handling patterns and work practices and isolate the area through barriers and provide ventilation as needed.

Video Exposure Monitoring: Crusher Feed

With video exposure monitoring (VEM), worker exposures to lead are monitored and recorded with a direct reading instrument. At the same time, workplace activities are recorded on a videotape. The right hand bar indicates changes in total dust concentrations over time.



Low Bandwidth Video

Dial up Modem, ISDN

High Bandwidth Video

LAN, DSL, T1, T3

As the employee charges battery feed material to a battery crusher, the increasing red bar indicates that employee exposure may be from settled dust becoming airborne after dropping the pallet; or acid mist and particulate may be escaping the ventilated battery crusher. Additional area samples may be collected at the inlet to the crusher and adjacent to the pallet to determine which is the predominate source.

Note: This example illustrates the level and duration of exposure to total dust and is used to show how VEM can be used for determining sources of employee exposure. Other sources of employee lead exposure can be determined by using VEM sampling for a full work shift.

Industrial Battery Breaking

Industrial batteries, used to power mobile electric equipment or for other industrial uses, are periodically purchased for raw material by most secondary smelters. Many of these batteries have steel cases which require removal by cutting the case open with a cutting torch, a hand-held gas powered saw, or other equipment that can separate the case from its contents **(Fig. 2)**.

Fig. 2. Industrial battery being broken

Potential Sources of Exposure:

- For manual cutting or breaking operations, acid mist containing lead may be emitted which may dry and release lead dust if disturbed.
- Automated operations using crushers may release lead containing mist that may dry and release lead dust if disturbed.
- Vibrating equipment with lead contaminated surfaces may cause reentrainment of lead dust.
- Cutting industrial battery cases open with a torch may result in exposures to airborne lead.

Possible Engineering and Work Control Practices:

- Provide side draft ventilation and a turntable at the cutting station to control any mist being generated.

  ▶ Work Bench Diagram

- Provide properly designed local exhaust hoods with local exhaust ventilation for crushers to control lead emissions.
  - Dust Control Handbook: Crushers

  ▶ Battery Shredder

- Provide enclosure and local exhaust ventilation for shredded battery conveyor and transfer points.
  - Dust Control Handbook: Belt Conveyors

  ▶ Conveyor Belt Ventilation Diagram

- Provide a supplied air island or a temperature-controlled, positive-pressure, filtered supplied clean air room.

  ▶ Supplied Air Island Diagram

- Provide an automatic or semi-automatic means for opening battery cases.

- Provide curtains or shields on battery breaking equipment to contain mist and liquid droplets containing lead particulate.

- Provide adequate make-up air.

- Use wet suppression techniques to prevent lead from drying on equipment surfaces.

- If it is determined through source identification sampling that lead dust is coming from mobile equipment or is coming from adjacent areas, reevaluate material handling patterns and work practices and isolate the area through barriers and provide ventilation as needed.

Automotive Battery Separating

After the automotive batteries have been "broken", the lead-bearing material must be separated from the case material. The three most widely used techniques for accomplishing this task are:

- Manual
- Tumbler
- Sink/Float Process

Manual

The "manual" technique is not used by many secondary lead smelters. After the battery passes through the saw or shear, an employee manually dumps the "groups" or lead-bearing material into a pile and places the case and top of the battery into another pile or conveyance system.

Potential Sources of Exposure:

- Splashes of lead-laden liquid may dry on equipment and adjacent surfaces and become airborne through reentrainment or physical disturbance.
- Lead-laden acid mist may be created from the physical dumping of batteries.
- Acid mist may be generated by the saw or shear, which is located in close proximity to the dumping station.

Potential Engineering and Work Practice Controls:

- Provide enclosure and local exhaust ventilation for conveyor loading and discharge points to maintain adequate capture velocity.
  Conveyor Belt Loading Diagram
- Provide enclosure and local exhaust ventilation for conveyor.
  Conveyor Belt Ventilation Diagram
- Provide supplied air island or temperature-controlled, positive-pressure, filtered supplied air control room.
  Supplied Air Island Diagram
- Vacuum surfaces using HEPA filtered portable or central vacuum systems.
  Central Vacuum System
- Provide barriers and shields to stop splashes of mists and liquid droplets containing lead particulate.
- Wash down building walls and fixed equipment with water.
- Provide additional dilution or make-up air ventilation.

Tumbler

A "tumbler" is a device in which batteries are placed after the tops have been sawed or sheared off to separate the battery plates from the cases. Ribs inside the tumbler dump the groups as it slowly rotates. Groups fall through the slots in the tumbler while the cases are conveyed to the far end and are collected as they exit. Plastic and rubber battery cases and tops are further processed after being separated from the lead-bearing material **(Fig. 3)**.

Fig. 3. Enclosed and exhaust ventilated tumbler and duct work

Potential Sources of Exposure:

- Splashes of lead-laden liquid may dry on equipment and adjacent surfaces and become airborne through reentrainment or physical disturbance.

Possible Engineering and Work Practice Controls:

- Provide enclosure and local exhaust ventilation for tumbler and loading and discharge points **(Fig. 3)**.
  Tumbler Diagram

- Provide enclosure and local exhaust ventilation for discharge points of adjacent crushers which may contribute to employee exposure.
  Conveyor Belt Loading Diagram

- Provide supplied air island or temperature-controlled, positive-pressure, filtered supplied air control room.
  Supplied Air Island Diagram

- Vacuum surfaces using HEPA filtered portable or central vacuum systems.
  Central Vacuum System

- Provide additional dilution or make-up air ventilation.

- Wash down building walls and fixed equipment with water.

Sink/Float Process

The "sink/float process" is used by the majority of secondary smelters **(Fig. 4)**. The "sink/float process" is typically combined with the hammermill or crushing process for battery breaking. Battery pieces, both lead-bearing and cases, are placed in a series of tanks filled with water. Lead-bearing material sinks to the bottom of the tanks and is removed by screw conveyor or drag chain while the case material floats and is skimmed off the tank's surface **(Fig. 5)**. This operation should not lead to significant employee exposure.

Fig. 4. View of sink/float system

If employees are exposed above the OSHA PEL, additional air sampling should be performed to determine sources of exposure.

Fig. 5. Screw conveyors removing lead bearing material from a tank in the sink/float process

Potential Source of Exposure:

- Splashes of lead-laden liquid may dry on equipment and adjacent surfaces and become airborne through reentrainment or physical disturbance.

Potential Engineering and Work Practice Control:

- Wash down building walls and fixed equipment with water.

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Raw Materials Processing > Charge Preparation/Drying

Charge preparation is the process of blending the stored lead scrap and the lead from batteries to the proper metallurgical requirements so it can be charged to the furnace.

Before raw material can be charged to a reverberatory furnace, it must be dried to zero percent moisture. When the reverberatory furnace is charged with feed of consistent moisture content, upset conditions (puffs and explosions) are reduced.

Hazards exist during the charge preparation/drying phase that may expose workers to lead-bearing dusts.

- Charge Preparation
- Drying

Note: Drying is not done by all secondary lead smelters prior to the smelting operation.

Charge Preparation

Potential Sources of Exposure:

- Lead dust may be reentrained from the road or floor as vehicles move about the charge prep area. **(Fig. 1)**.
- Lead dust may become airborne during the transport and mixing of lead bearing materials when using mobile equipment.
- Dust may be generated at conveyor loading or transfer points during charge prep.

Fig. 1. Charge material in containment area

Possible Engineering and Work Practice Controls:

- Provide vehicles with enclosed cabs that have positive pressure, HEPA-filtered air.
  - Tempered Air Cab Diagram
- Keep all surfaces wet and clean through the use of water supply systems and central vacuum cleaners.
  - Central Vacuum System Diagram
- Provide ventilated enclosures for mixing feed materials.
  - Dust Control Handbook: Enclosures
- Maintain positive-pressure, filtered air systems on mobile equipment to ensure effective operation. Check and change air filters regularly as part of an effective scheduled preventative maintenance program.

- Remain inside the vehicle and keep doors and windows shut during mobile equipment operation in contaminated areas.
- Reduce vehicle speeds to minimize the reentrainment of settled dust.
- Vacuum the inside of mobile equipment frequently.
- Pave all surfaces to facilitate housekeeping.
- Wet down materials and surfaces to suppress dust generation. **(Fig. 2)**.
- If it is determined that lead dust is coming from mobile equipment or is being blown from adjacent areas, evaluate material handling patterns and area isolation.
- Refer to Feed Material Handling and Transport for possible conveyor transport controls.

Fig. 2. Wetting surfaces to suppress dust generation

Drying

The dryer is a rotating vessel, usually gas fired, where the charge material is added at one end and travels the length of the dryer, then discharged on the other end onto a belt conveyor and discharged to the furnace.

Potential Sources of Exposure:

- Lead dust may be generated:
  - At the discharge end of dryers.
  - At the transfer points to the ram feeder or reverberatory furnace.
- The dryer may leak lead-bearing dust due to inadequate exhaust ventilation.
- Fugitive emissions may come from charge preparation.
- Lead dust may be reentrained from the road or floor as vehicles move about the drying area.
- Lead dust may become airborne during the transport and loading of lead bearing materials when using mobile equipment.

Possible Engineering and Work Practice Controls:

- Use process controls to prevent dryer operation without adequate exhaust ventilation.
- Provide local exhaust ventilation at the discharge end of the dryer.
  - Dust Control Handbook: Dryers
- Provide local exhaust ventilation at the reverberatory furnace charge hole.

- Develop a written schedule of inspections and audit checklist for dryer operators.
- Cleanup surfaces of equipment and floors during every shift, vacuuming whenever possible.
- Maintain positive-pressure, filtered-air system on mobile equipment to ensure effective operation. Check and change air filters regularly as part of an effective scheduled preventative maintenance program.
- Remain inside the vehicle and keep doors and windows shut during mobile equipment operation in contaminated areas.
- Reduce vehicle speeds to minimize the reentrainment of settled dust.
- Vacuum the inside of mobile equipment frequently.

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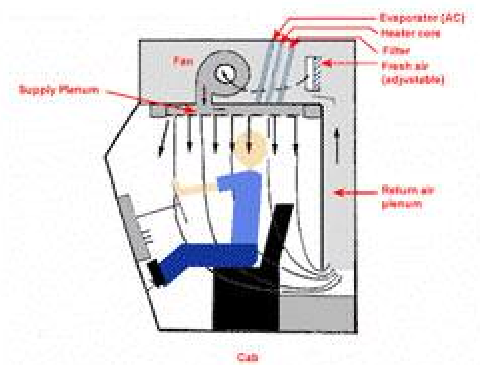
Raw Materials Processing > Handling and Transport

Handling and transportation of feed materials is an essential part of the secondary lead smelting process. Material is primarily transported through the use of mobile equipment (forklifts, front-end loaders). Proper operator training, prudent work practices, and good housekeeping are key in minimizing lead emissions during mobile equipment operation. Conversely, careless equipment operation coupled with inadequate housekeeping can lead to serious lead exposure throughout the plant.



Click for larger view of air cab diagram

- Mobile Equipment
- Video Exposure Monitoring: Material Transport

Certain material transporting operations call for mechanical conveyance. Some common mechanical conveyance methods used in secondary lead smelters include:

- Belt Conveyors
- Screw Conveyors
- Bucket Elevators and Drag Chains/Lines

Mobile Equipment

Potential Sources of Exposure:

- Lead dust from feed materials can become airborne during handling and transport **(Fig. 1)**.
- Settled lead dust on surfaces and equipment may become airborne by vehicle traffic and wind.
- Dust may be generated while mixing feed materials outside ventilated areas prior to charging.

Fig. 1. Forklift transporting materials

Possible Engineering and Work Practice Controls:

- Provide vehicles with enclosed cabs that have positive-pressure, HEPA-filtered air.
  Tempered Air Cab Diagram
- Keep all surfaces wet and clean through the use of water supply systems and

central vacuum cleaners.

Central Vacuum System Diagram

- Maintain positive-pressure, HEPA-filtered air system on mobile equipment to ensure effective operation. Check and change air filters regularly as part of an effective scheduled preventative maintenance program.
- Remain inside the vehicle and keep doors and windows shut during mobile equipment operation in contaminated areas.
- Reduce vehicle speeds to minimize the stirring up of settled dust.
- Vacuum the inside of mobile equipment frequently.
- Pave all roadways to facilitate housekeeping.
- Wet down raw materials storage to suppress the dust generation.
- If it is determined that lead dust is coming from mobile equipment or is coming from adjacent areas, evaluate material handling patterns and practices and area isolation.

Video Exposure Monitoring: Material Transport

With video exposure monitoring (VEM), worker exposures to lead are monitored and recorded with a direct reading instrument. At the same time, workplace activities are recorded on a videotape. The right hand bar indicates changes in total dust concentrations over time.

As the employee moves slag from the furnace to the slag pot cooling area with a front-end loader, the increasing red bar indicates that employee exposure may be from the stirring up of settled lead dust from the floor or possibly fugitive emissions from the furnace.

Low Bandwidth Video

Dial up Modem, ISDN

High Bandwidth Video

LAN, DSL, T1, T3

Note: This example illustrates the level and duration of exposure to total dust and is used to show how VEM can be used for determining sources of employee exposure. Other sources of employee lead exposure can be determined by using VEM sampling for a full work shift.

Belt Conveyors

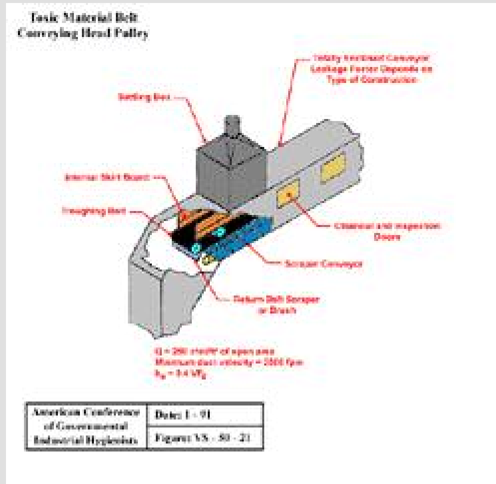
Belt conveying systems can be used to transport furnace feed material from storage to battery shredders and the furnace charging area.

Potential Source of Exposure:

- Lead dust may be emitted from open conveyor systems:
    - At the receiving end
    - At the discharge end
    - At the underside of conveyor
    - From spillage along the conveyor belt

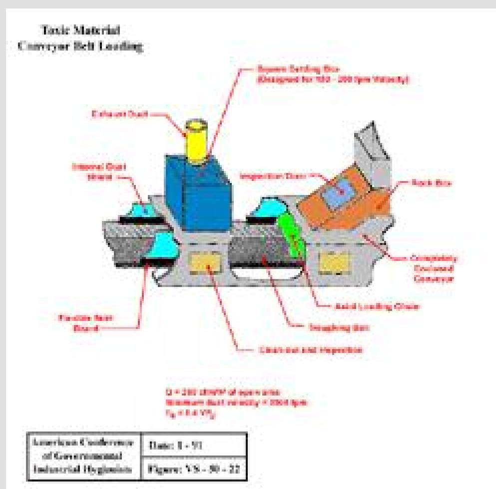
Possible Engineering and Work Practice Controls:

- Provide an enclosed conveying system, such as a screw conveyor, in place of a chain-drag or open conveyor belt where possible.
    - Dust Control Handbook: Screw Conveyors
- Totally enclose and exhaust ventilate the conveyor from loading to transfer points.
  ▶ Conveyor Belt Ventilation Diagram
  ▶ Belt Conveying Head Pulley Diagram



Click for larger view of belt conveying head pulley diagram

- Provide an exhaust ventilated enclosure at the conveyor loading and unloading points to minimize dust emissions.
  ▶ Conveyor Belt Loading Diagram



Click for larger view of conveyor belt loading diagram

- Provide a trough belt and conveyor skirting to minimize spillage.
    - Dust Control Handbook: Belt Conveyors
- Provide a baffle to ensure the unloading of conveyor at transfer point.
- Provide a belt scraper at the discharge end to dislodge dust particles that may adhere to the belt surface.
- Provide access doors to conveyor and transfer point enclosures to facilitate maintenance, wash down, and other activities.
- Use top-hinging doors for inspection to prevent spillage of leaded material.
- Provide drains and sumps in conveyor trench to collect wash water and mud.
- Provide hose bibs for manually washing the conveyor equipment.
- Wet down materials to suppress dust generation.

Screw Conveyors

Screw conveyors are commonly used in the secondary lead smelting industry to transport flue dust from the baghouse to an agglomeration furnace or a storage area **(Fig. 2)**.

Potential Sources of Exposure:

- Lead dust may be emitted from leaking screw conveyors and at furnace discharge points.

Possible Engineering and Work Practice Controls:

- Enclose screw conveyor systems that transport leaded materials.
  - Dust Control Handbook: Screw Conveyors

  ▶ Screw Conveyor Components
- Enclose and exhaust ventilate screw conveyor transfer points.
  - Dust Control Handbook: Transfer Chutes
- Maintain cover gaskets and repair leaks immediately.

Fig. 2. Screw conveyor

Note: The screw conveyor can not be used for charging smelting furnaces.

Bucket Elevators and Drag Chains/Lines

Commercially available bucket elevators and drag chains may be used in conjunction with some material handling operations.

Potential Sources of Exposure:

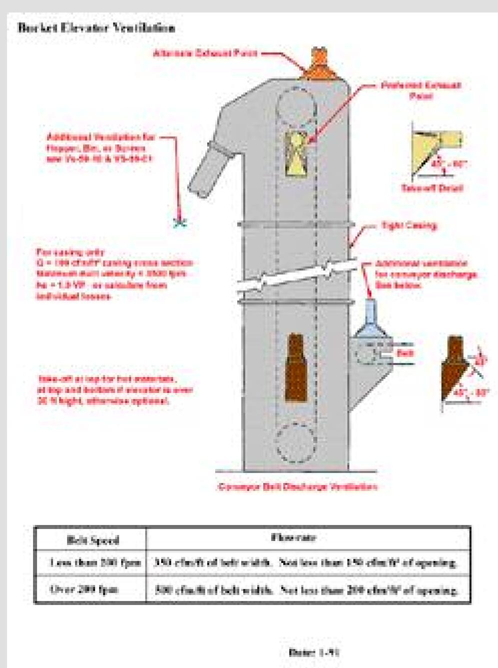
- Leaded materials may leak from the feed or discharge end of the elevator.

Possible Engineering and Work Practice Controls:

- Provide a properly-designed and exhaust-ventilated bucket elevator.

  ▶ Bucket Elevator Ventilation Diagram

  ▶ Bin and Hopper Ventilation Diagram
- Minimize dust generation when feeding the bucket elevator by keeping the height of the material free-fall to a minimum and by gently loading material into the bucket elevator.
  - Dust Control Handbook: Bucket Elevators



Click for larger view of bucket elevator ventilation diagram

- Enclose and exhaust ventilate the chutes between the elevator discharge and the receiving furnace.
  - Dust Control Handbook: Transfer Chutes
- Repair any holes or openings in the casings of the bucket elevator or chutes.

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Smelting

The smelting process is a major source of lead fume emissions. Smelting involves the reduction of lead-bearing scrap into metallic lead in a furnace. Each furnace is designed and operated to produce a certain lead product. The following furnaces are the most common types of smelting furnaces used in the industry:

- Blast Furnace
- Reverberatory Furnace

Lead tap at reverberatory furnace

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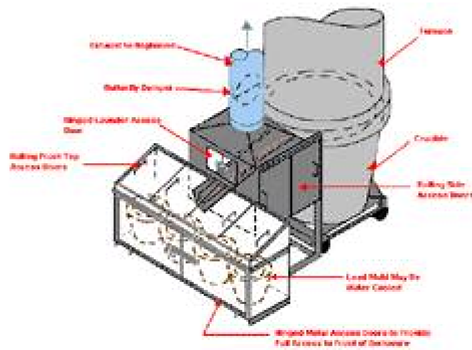
Smelting > Blast Furnace

Blast furnaces are designed and operated to produce a hard (high alloy content) lead product. Blast furnaces emit high levels of lead fume during the the following processes:

- Charging
- Tapping
- Tuyere Punching

- Cross-sectional view of blast furnace
- Additional blast furnace images



Click for larger view of blast furnace lead tap controls diagram

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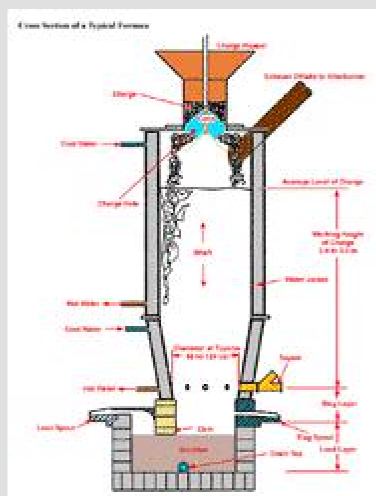
Charging

Potential Sources of Exposure:

- Spillage or emissions may occur at blast furnace feed conveyor transfer points and charging points.
- Spillage of lead-containing dust may occur if bucket elevators, conveyors, or skip hoists are overfilled.
- Lead fume and dust may be emitted from the blast furnace if the charge level is too low.



Click for larger view of blast furnace diagram

Possible Engineering and Work Practice Controls:

- Maintain raw material storage and handling areas under negative pressure to prevent contamination of adjacent work areas.
- Prevent puffing by providing and maintaining process controls to ensure that the proper amount of charge material is in the thimble on the top of the furnace.
- Provide hooding with sufficient exhaust ventilation at furnace feed conveyor loading and charge points to capture dusts and fumes which may be emitted.
- Provide hooding with sufficient exhaust ventilation to capture dusts which may be generated when charging the furnace.

- Do not overfill bucket elevators, conveyors, or skip hoists.

- Maintain positive-pressure, HEPA filtered air systems on mobile equipment to ensure effective operation. Check and change air filters regularly as part of an effective scheduled preventative maintenance program.

- Vacuum any spills immediately with a HEPA filtered vacuum system. Water should not be used in the smelting area for dust suppression due to the possibility of oxide fires and the mixing of water and molten lead.

Tapping

Blast furnace tapping operations involve removing the slag and then tapping molten lead from the furnace into molds or ladles. Some smelters tap metal directly into a holding kettle which keeps the metal molten for refining. The other smelters cast the furnace metal into blocks and allow the blocks to solidify.

Slag tap with enclosure hooding and local exhaust ventilation

Potential Sources of Exposure:

- Lead fumes may be emitted at the lead or slag tapping plugs during removal of the tapping plug or while lancing the tapping plug.

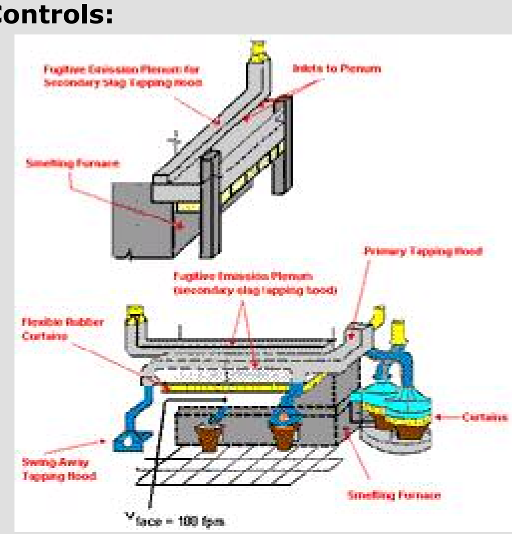
- Emissions may occur while pouring lead or slag at the tapping launder, mold, ladle, or refining kettle.

- Lead dust may become airborne due to disturbance of settled dust in the smelting area.

- Emissions may occur from ladles containing slag or molten lead.

- Spilled slag or molten lead may emit lead fumes.

Possible Engineering and Work Practice Controls:



Click for larger view of secondary exhaust hood diagram

- Provide local exhaust ventilation at the lead and slag tap, launders, molds, ladles, and refining kettles.
  Blast Furnace Lead Tap Controls Diagram
  Blast Furnace Slag Tap Controls Diagram

- Allow lead and slag pots to remain under the exhaust hood until crusted to minimize fume emissions.
  Secondary Exhaust Hood Diagram

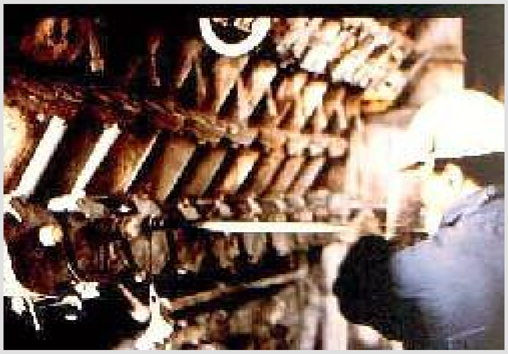
- Provide a supplied air island at lead and slag tapping stations.
  Supplied Air Island Diagram

- Provide local exhaust ventilation for staged slag pots if necessary.

Moveable Exhaust Hood Diagram

Tuyere Punching

Blast air for the combustion process enters the blast furnace through "tuyeres." The tuyeres occasionally begin to fill with accretions and must be physically punched, usually with a steel rod, to keep them unobstructed. The conventional method used for this task is to remove the cover of the tuyeres and insert the steel rod. After the accretions have been "punched," the cover is replaced.



Manual tuyere punching

Recently smelters have been able to adapt an "off-the-shelf" automatic tuyere puncher that has greatly reduced employee lead exposure. However, even with the automatic system there are occasions when the tuyere pipe has to be cleared by using a jackhammer or rod.

Potential Sources of Exposure:

- Significant lead fume emissions may come from the furnace during manual punching.

Possible Engineering and Work Practice Controls:

- Provide automatic tuyere punching.
  Hydraulic Tuyere Punch Diagram
- Use notched, rotating tuyere covers to minimize tuyere opening during punching.
- Stand to the side of the tuyere when opening the cover during the tuyere punching operation.
- Provide a rod of sufficient length to minimize operator exposure.

Automatic tuyere puncher

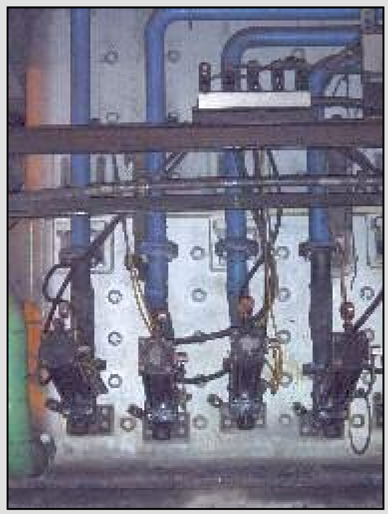
- Provide a viewing port on the tuyere cover so that plugging can be observed without removing the cover.

Additional Images


Lifting recently cast lead blocks from mold


Slag side of blast furnace


Local exhaust ventilation at lead tap


Automatic tuyere punch


Liquid lead cooling in molds


Lead flowing into mold

Lead > Secondary Lead Smelter eTool

eTool Home

Raw Materials Processing

Smelting

Blast Furnace

Reverberatory Furnace

Refining and Casting

Environmental Controls

Maintenance

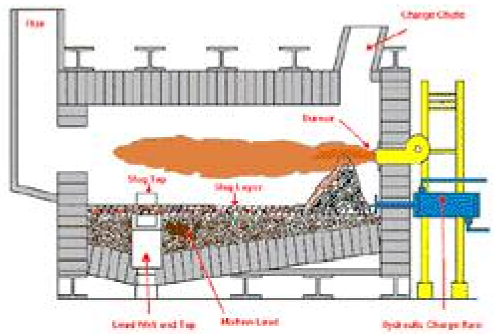
Engineering Controls

OSHA Lead Requirements ...

Smelting > Reverberatory Furnace

Reverberatory furnaces are designed and operated to produce a soft, nearly pure lead product. Reverberatory furnaces emit high levels of lead fume during the following processes:

- Charging
- Tapping Lead and Slag



Click for larger view of reverberatory furnace

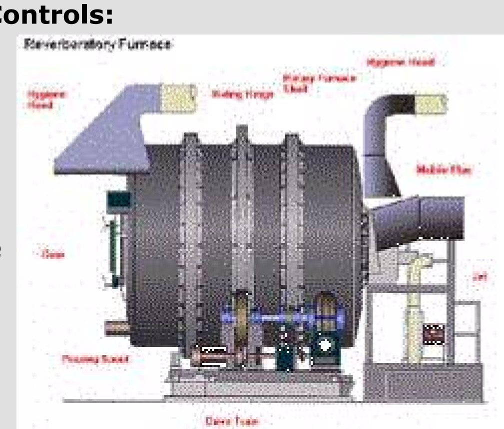
Charging

Potential Sources of Exposure:

Reverberatory furnace tap hole hood

- Spillage or emissions may occur at feed conveyor transfer and charging points of the reverberatory furnace.
- Emissions may occur through leaks in refractory material, which allow lead dust and fumes to escape.
- Lead fume and dust may be emitted from the reverberatory furnace if the furnace is run at positive pressure or if bridging occurs during charging wet materials.

Possible Engineering and Work Practice Controls:



Click for larger view of reverberatory furnace diagram

- Enclose and provide exhaust ventilation for the reverberatory furnace.
- Provide hooding with sufficient exhaust ventilation to capture dust that may be generated by filling or emptying charge material conveyors.
  - Conveyor Belt Ventilation Diagram
- Maintain positive-pressure, HEPA filtered air system on mobile equipment to ensure effective operation. Check and change air filters regularly as part of an effective scheduled preventative maintenance program.
  - Tempered Air Cab Diagram

- Maintain raw material storage and handling areas under negative pressure to prevent contamination of adjacent furnace areas.
- Provide process controls to maintain sufficient negative air pressure on the furnace during charging to prevent puffing.
- Do not overfill conveyors and ram feeders.
- Vacuum any spills immediately with a HEPA filtered vacuum system. Water should not be used for dust suppression in the smelting area due to the possibility of oxide fires and the mixing of water and molten lead.

Tapping

Reverberatory furnace tapping operations involve pouring the molten lead and slag from the furnace into molds or ladles. Some smelters tap metal directly into a holding kettle, which keeps the metal molten for refining. Other smelters cast the furnace metal into blocks and allow the blocks to solidify.


Reverberatory furnace lead tap with local exhaust ventilation

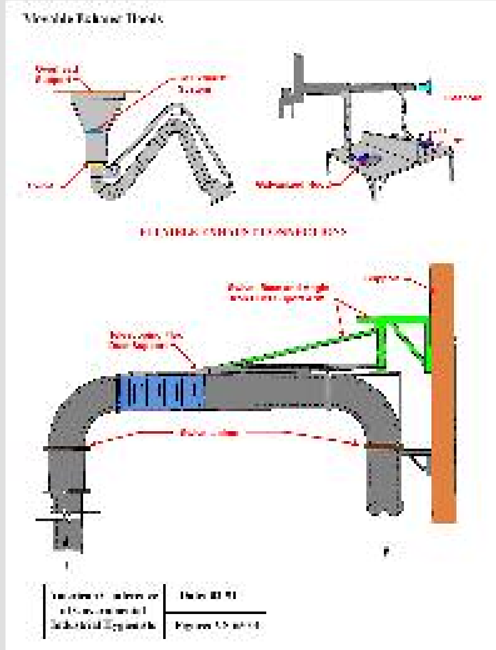
Potential Sources of Exposure:

- Lead fumes may be emitted at the lead or slag tapping plugs during removal of the tapping plug or while lancing the tapping plug.
- Pouring lead or slag into the tapping launder, mold, ladle or refining kettle may emit fumes.
- Lead dust may become airborne due to the disturbance of settled dust in the smelting area.
- Ladles containing slag or molten lead may emit fumes.
- Spilled slag or molten lead may emit lead fumes.

Possible Engineering and Work Practice Controls:

- Provide local exhaust ventilation at the lead and slag tap, launders, molds, ladles, and refining kettles.
- Allow lead and slag pots to remain under the exhaust hood until crusted to minimize the emission of fume.
  ▶ Secondary Exhaust Hood Diagram
- Provide supplied air island at lead and slag tapping stations.
  ▶ Supplied Air Island Diagram
- Provide local exhaust ventilation for staged slag pots if necessary.
  ▶ Moveable Exhaust Hood Diagram
- Reline or repair refractory as necessary

to minimize lead fume leakage from furnace.



Click for larger view of moveable exhaust hood diagram

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Lead > Secondary Lead Smelter eTool

Refining and Casting

Crude lead produced during smelting operations is remelted in cast iron kettles and refined by the addition of reagents, such as sulfur and caustic soda. The purified lead is then cast into molds or ingots.

Significant lead emissions can occur from poorly controlled refining, casting, and drossing operations.

- Refining
- Casting
- Drossing

Casting pigs

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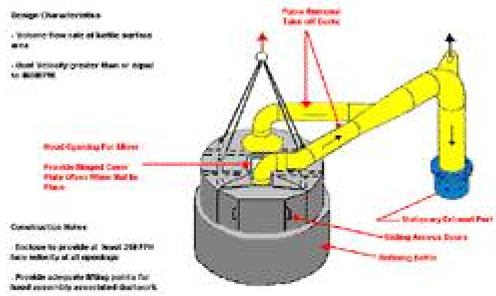
Lead > Secondary Lead Smelter eTool

Refining and Casting > Refining

Typically, metal from the smelting furnace is melted in an indirect-fired kettle or pot and the trace elements are combined to produce the desired alloy. Employees may be exposed to lead fume and particulate during the refining process.



Click for larger view of refining kettle diagram

Refining

Potential Sources of Exposure:

- Lead particulate may become airborne due to updrafts created by thermal rise from the surface of the refining kettle during preheating and cleaning.
- Lead fumes or particulate may be emitted from the surface of the molten lead during the transfer of lead to the kettle and from the kettle during melting, adding refining agents, and stirring of molten alloy.
- Lead emissions may occur while drossing lead kettles.
- Settled dust may be reentrained due to vibrating equipment and vehicular traffic in the area.

Engineering and Work Practice Controls:

- Provide exhaust ventilated enclosure for refining kettles **(Fig. 1)**.
  Refining Kettle Diagram
- Enclose and exhaust ventilate all launders **(Fig. 2)**.
  Controls for Lead Tapping and Pouring
- Pump rather than pour molten lead when possible.
- Keep molten lead temperatures to a minimum to reduce lead fume generation.
- Provide local exhaust ventilation hoods and ductwork that does not

Fig. 1. Removing pump from enclosed refining kettle

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interfere with the use of overhead cranes.

- Provide roll back access doors to allow the addition of refining agents.
- Provide a supplied air island near the refining kettle.
  Supplied Air Island Diagram

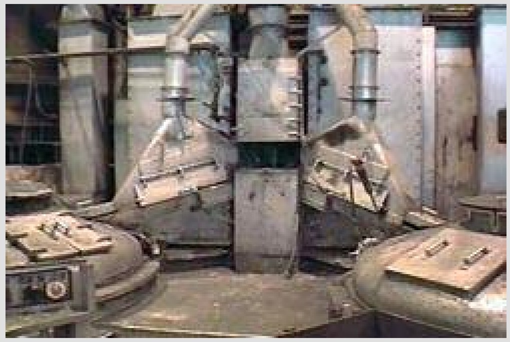

Fig. 2. Ventilated lead launders to refining kettles

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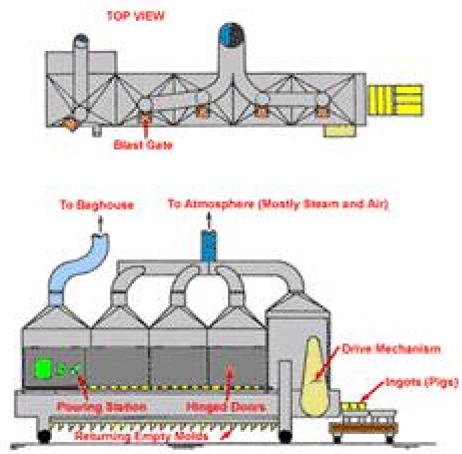
Lead > Secondary Lead Smelter eTool

Refining and Casting > Casting

Molten, refined, or alloyed lead is pumped via heated pipes from kettles to a casting reservoir, or casting wheel, which directs a measured amount of lead into steel or cast iron molds. Hand operations include drossing and stacking cooled castings. Castings typically consist of "pigs" (up to 80 pounds) and blocks (up to 2000 pounds) **(Fig. 1)**. Employees may be exposed to lead fumes emitted from the molten lead during the casting and drossing operations.



Click for larger view of pig/ingot casting diagram

- Block Casting
- Pig Casting

Block Casting

Potential Sources of Exposure:

Fig 1. Block casts

- Lead fumes may be emitted during heating and cleaning of lead transfer pipes and pumps.
- Lead fumes may be emitted during the heating of lead reservoir and casting equipment.
- Lead fumes may be emitted during the pouring and cooling of lead castings.
- Lead fumes may be emitted during the drossing of lead oxides from the reservoir and casting surfaces.
- Spillage and emissions of lead fumes and dust may occur during the handling, transport, and storage of drosses.
- Lead fumes and dust may be emitted during mold casting line cleaning, heating, and maintenance.
- Lead dust may be generated during the application of mold release agents.
- Lead dust may be reentrained by mobile traffic moving through the area.

Possible Engineering and Work Practice Controls:

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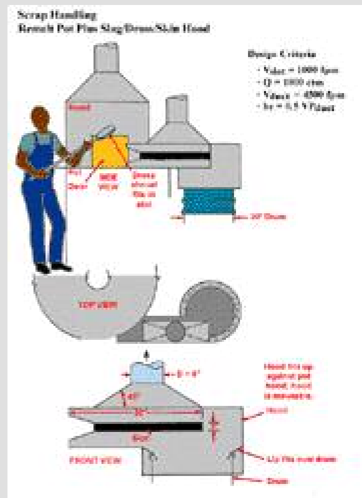
- Provide local exhaust ventilation for the castings and molds while pouring molten lead.
  - Controls for Lead Tapping and Pouring
- Provide a supplied air island at the operator work station.
  - Supplied Air Island Diagram
- Use automatic drossing machines when feasible.
  - Mechanical Drossing Diagram
- Dross into an exhaust ventilated container.
  - Dross Hood Diagram
- Enclose and exhaust ventilate all launders.
- Keep molten lead temperature below 1000° F to minimize lead fumes and particulate emissions during lead transfer and drossing of castings and molds.
- Eliminate or minimize the use of a torch for equipment cleanup and spilled lead or dross.
- If a torch must be used, provide portable local exhaust ventilation or a ventilated torch.
  - Portable Tool Exhaust Diagram



Click for larger view of lead pot and dross hood

Pig Casting

Potential Sources of Exposure:

Fig. 2. Manual drossing of pigs

- Lead fumes may be emitted during heating and cleaning of lead transfer pipes and pumps.
- Lead fumes may be emitted while heating the lead reservoir and casting equipment.
- Emissions may occur during the pouring and cooling of lead castings.
- Lead fumes and dust may be emitted during the drossing of lead oxides from the reservoir and casting surfaces **(Fig. 2)**.
- Spillage and emissions of lead fumes and dust may occur during the handling, transportation, and storage of drosses.
- Lead fumes and dust may be emitted during mold and casting line cleaning, heating, and maintenance.
- Lead dust may be generated during the application of mold-release agents.

- Lead dust may be reentrained by mobile traffic moving through the area.

Possible Engineering Controls

- Provide local exhaust ventilation for the castings and molds while pouring molten lead **(Figs. 3 & 4)**.
  Ingot/Pig Casting Diagram

Fig. 3. Automatic casting machine with local exhaust ventilation

- Provide a supplied air island at the operator work station.
  Supplied Air Island Diagram
- Use automatic drossing machines when feasible.
  Mechanical Drossing Diagram
- Dross into an exhaust ventilated container.
  Dross Hood Diagram
- Enclose and exhaust ventilate all launders.
  Controls for Lead Tapping and Molding

Fig. 4. Enclosed and exhaust ventilated star caster

- Keep molten lead temperature below 1000°F to decrease lead fumes and particulate emissions during lead transfer and drossing of lead oxides from the reservoir and casting surfaces.
- Eliminate or minimize the use of a torch for cleanup of spilled lead metal or dross.
- If a torch must be used, provide portable local exhaust ventilation or a ventilated torch.
  Portable Tool Exhaust Diagram

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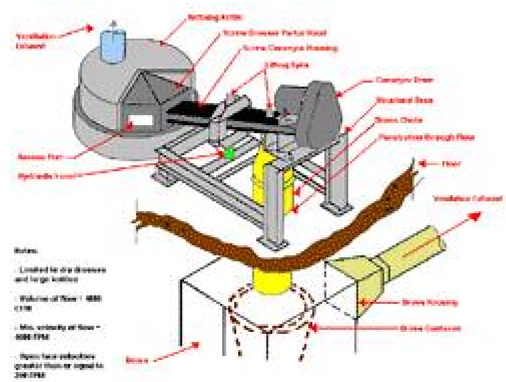
Lead > Secondary Lead Smelter eTool

Refining and Casting > Drossing

During drossing operations, dross is skimmed to the rim of the kettle and manually shoveled or "spooned" into a container. Mechanical drossing methods, such as vacuum drossing, are used by some secondary lead smelters. Significant levels of lead fume and dust may be released during drossing.

- Drossing
- Video Exposure Monitoring: Manual Drossing



Click for larger view of mechanical drossing diagram

Drossing

Potential Sources of Exposure:

Fig. 1. Manual removal of dross may expose workers to lead dust and fume

- Lead dust and fume may be emitted during manual or vacuum dross removal **(Fig. 1)**.
- Lead dust may be emitted when depositing dross into a waste container.
- Emissions may be released while charging dross to the storage bin via pneumatic conveyance system.
- Lead dust may be spilled and emitted while handling, transporting, and storing dross.

Possible Engineering and Work Practice Controls:

- Eliminate or minimize the use of manual drossing. Use automated dross machines where ever possible **(Fig. 2)**.
  ▶ Mechanical Drossing Diagram
- Provide an exhaust ventilated barrel or bin in which dross can be deposited before transfer to the storage area.
  ▶ Dross Hood Diagram

- Provide portable local exhaust ventilation or enclosure to control emissions from dross which is manually deposited in ladles **(Fig. 3)**.
  Moveable Exhaust Hood Diagram

- Provide enclosure and exhaust ventilation for dross storage.
  Dross Storage Diagram

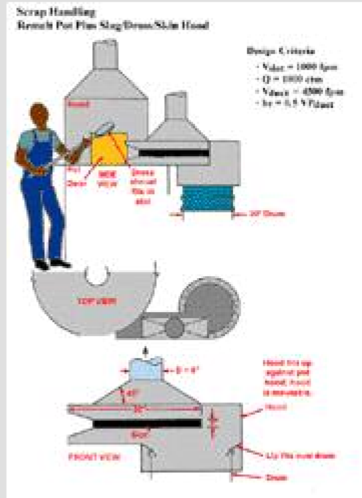
- Use a drossing shovel, which allows molten lead to drain prior to removal of dross.

- Use local exhaust ventilation at drossing access locations.

- Do not overfill dross containers.

- Eliminate or minimize the use of a torch for dross cleanup.

- If a torch must be used provide portable local exhaust ventilation or a ventilated torch.
  Portable Tool Exhaust Diagram



Click for larger view of dross pot hood diagram

Fig. 2. Portable dross hood with flexible duct attachment port

Fig. 3. Mechanical dross vacuum

Video Exposure Monitoring: Manual Dross Removal

With video exposure monitoring (VEM), worker exposures to lead are monitored and recorded with a direct reading instrument. At the same time, work place activities are recorded on a video tape. The right hand bar indicates changes in total dust concentrations over time.

As the employee skims dross (oxide and other impurities) from the kettle, the increasing red bar indicates that the local exhaust ventilation is inadequate to effectively capture lead dust generated during the transfer of dross from the kettle to the ventilated dross receiving vessel.

Low Bandwidth Video
Dial up Modem, ISDN

High Bandwidth Video
LAN, DSL, T1, T3

Note: This example illustrates the level and duration of exposure to total dust and is used to show how VEM can be used for determining sources of employee exposure. Other sources of employee lead exposure can be determined by using VEM sampling for a full work shift.

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Lead > Secondary Lead Smelter eTool

Environmental Controls

Employees may be exposed to lead while servicing and maintaining environmental controls.

- Waste Water Treatment
- Dust Collection Systems

Baghouse

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Dust Collection Systems

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Lead > Secondary Lead Smelter eTool

Environmental Controls > Waste Water Treatment

Normally, employees are not exposed to hazardous levels of airborne lead contaminants during the service and maintenance of waste water treatment systems. However, during the handling of lead-bearing wastes, sludges, and filters employees may come in contact with lead-containing wastes.


Waste water

Waste Water Treatment

Potential Sources of Exposure:

- Liquid lead waste may splash on equipment and become airborne if it dries and becomes disturbed.
- Employees may contact leaded waste products during removal and transport of recovered lead.


Fig. 1. Waste water treatment area

Possible Engineering and Work Practice Controls:

- Ensure that appropriate PPE is provided and used when handling leaded materials.
- Transfer recovered lead in covered or closed containers.
- Clean up spills and water mists, when necessary, to prevent leaded materials from drying.

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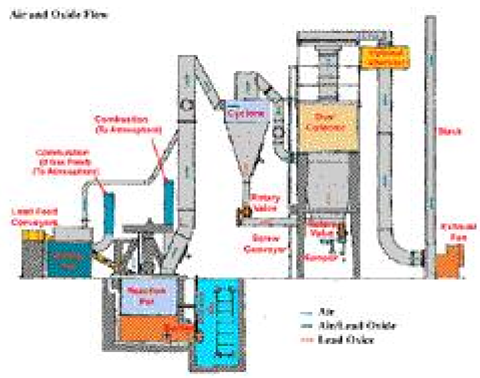
Lead > Secondary Lead Smelter eTool

Environmental Controls > Dust Collection Systems

Flue gases from furnaces and air from ventilation systems are vented to cyclones, scrubbers, baghouses, etc. for particulate removal. Flue dust must be removed from the separator (air pollution control equipment) and transported to storage, recycle streams, or to off-plant receivers. Dust collection systems can be a significant source of lead exposure if not properly operated, cleaned, and maintained.

- Dust Collection Systems
- Flue Dust Agglomeration Furnace



Click for larger view of air and oxide flow diagram

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Dust Collection Systems

Potential Sources of Exposure:

- Employees have a high potential of overexposure to lead dust during cleaning and maintenance of dust collection systems (cyclones and baghouses) **(Fig. 1)**.
- Employees have a high potential of overexposure to lead dust during handling and transporting of materials removed from dust collection systems (cyclones and baghouses).

Fig. 1. Dust collection system

- Employees have a high potential overexposure to lead dust due to improperly maintained dust collection systems.

Possible Engineering & Work Practice Controls:

- Screw or pneumatically convey flue dust back to the process.
  Scrubber Diagram
- Provide vehicles with enclosed cabs that have positive-pressure, HEPA filtered air.
  Tempered Air Cab Diagram
- Enclose or cover containers used to transport lead from dust collection systems.
- When working on or entering ventilation or dust-control equipment for

- maintenance or cleaning, implement proper permit required confined space entry and energy-control procedures.
- Always provide appropriate personal protection equipment.
- Ensure that dust-control equipment is designed, operated, and maintained properly on a scheduled basis to prevent breakdown and release of lead to the ambient environment.

Flue Dust Agglomeration Furnace

Potential Sources of Exposure:

- Lead dust and fumes may be emitted from agglomeration flue gases that contain lead.
- Lead fumes may be emitted at the slag tap, when pouring slag to the casting machine, during transfer of slag, or from cooling slag.
- Lead dust may be emitted from disturbed settled particulate.

Possible Engineering & Work Practice Controls:

- Provide local exhaust ventilation that controls lead emissions at the slag port, launder, and receiving kettles.
- Enclose and exhaust ventilate the slag casting line and slag dumping station.
- Provide two agglomerating furnaces.
  ▶ Agglomeration Furnace Diagram
- Use enclosed screw conveyors to deliver dust to the furnace.
  ▶ Screw Conveyor Components
- Provide curtains and baffles, if necessary, to prevent cross-drafts.
- Ensure that access doors to agglomeration furnaces are closed.

Click for larger view of agglomeration furnace

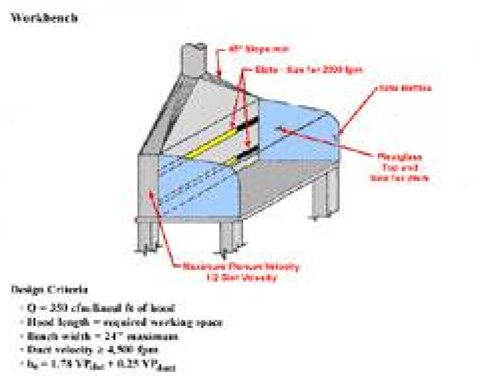
- Provide a swing-away section of the furnace flue to facilitate flue cleaning directly above the furnace.
- Provide vehicles with enclosed cabs that have positive-pressure, HEPA filtered air.
  ▶ Tempered Air Cab Diagram

Lead > Secondary Lead Smelter eTool

Maintenance

Maintenance personnel are at risk of exposure to lead fume and dust during maintenance operations involving equipment that is contaminated with lead. There are recommended engineering and work practice controls to minimize employee exposure for the following:

- Maintaining or moving contaminated equipment
- Shops



Click for larger view of workbench diagram

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Maintaining or Moving Contaminated Equipment

Potential Source of Exposure:

- Maintenance shop personnel may be exposed to lead dust when servicing and handling equipment that is contaminated with lead.

Possible Engineering & Work Practice Controls:

- Decontaminate equipment prior to servicing by vacuum, water spray, or mechanical removal such as scraping or brushing in conjunction with local exhaust ventilation.

Shops

Potential Source of Exposure:

- Exposure to lead may occur when working on contaminated equipment in the maintenance shop **(Fig. 1)**.

Possible Engineering & Work Practice Controls:

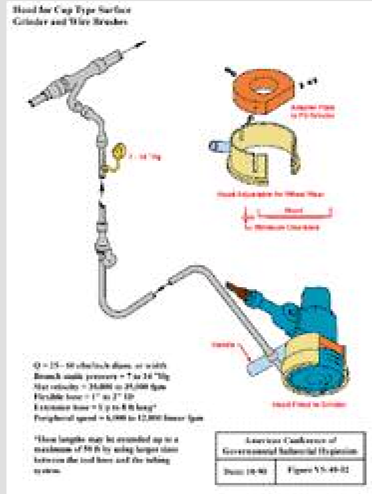
- Provide exhaust ventilated work areas or portable local exhaust ventilation.
  - Moveable Exhaust Hood Diagram
  - Work Bench Diagram

Fig. 1. Maintenance shop

- Decontaminate equipment using vacuum, water spray or mechanical removal such as scraping or brushing in conjunction with local exhaust ventilation.

- Provide low volume/high velocity ventilated hand tools.

  Typical System Low Volume/High Velocity Diagram
  Hood for Cup Type Surface Grinder and Wire Brushes



Click for larger view of surface grinder and wire brush hood diagram

- Provide supplied air islands at work stations.
  Supplied Air Island Diagram

- Provide wash-up sink for employees in the shop.

- Keep surfaces as free as practicable of lead contamination.

- Ensure that all shop vacuums are equipped with HEPA filters capable of removing lead.

- Empty vacuums in a manner that minimizes the reentry of lead into the shop.

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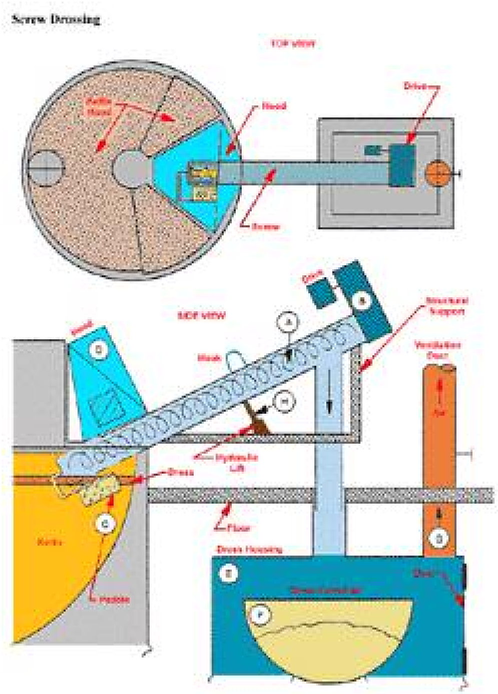
Lead > Secondary Lead Smelter eTool

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

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Scope	Definitions	Additional References	User Guide	Credits

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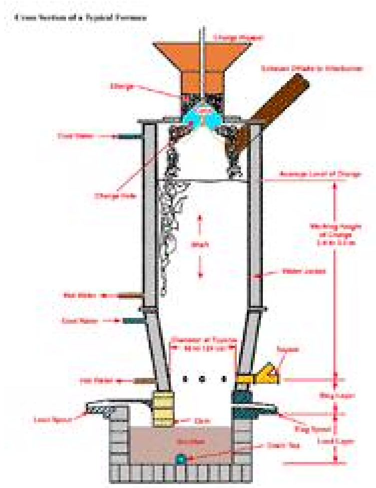
Engineering Controls > Local Exhaust Ventilation Diagrams

- 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

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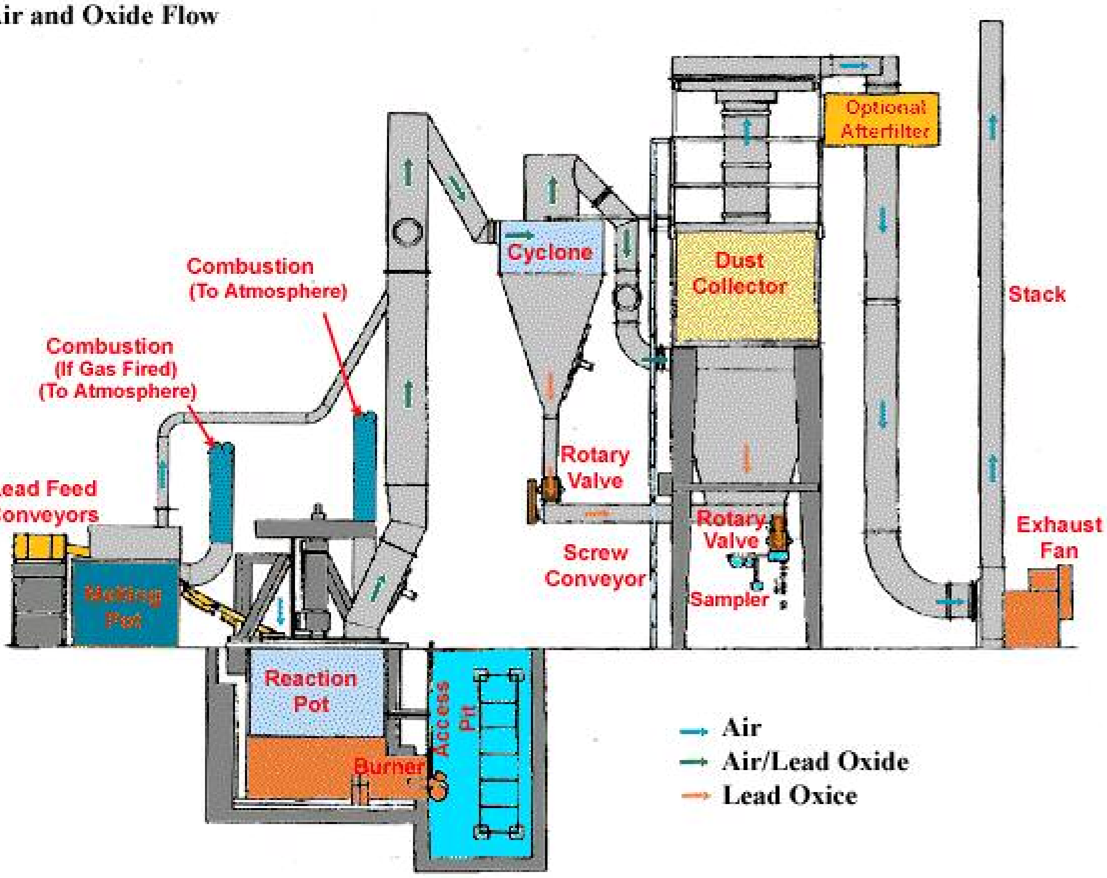
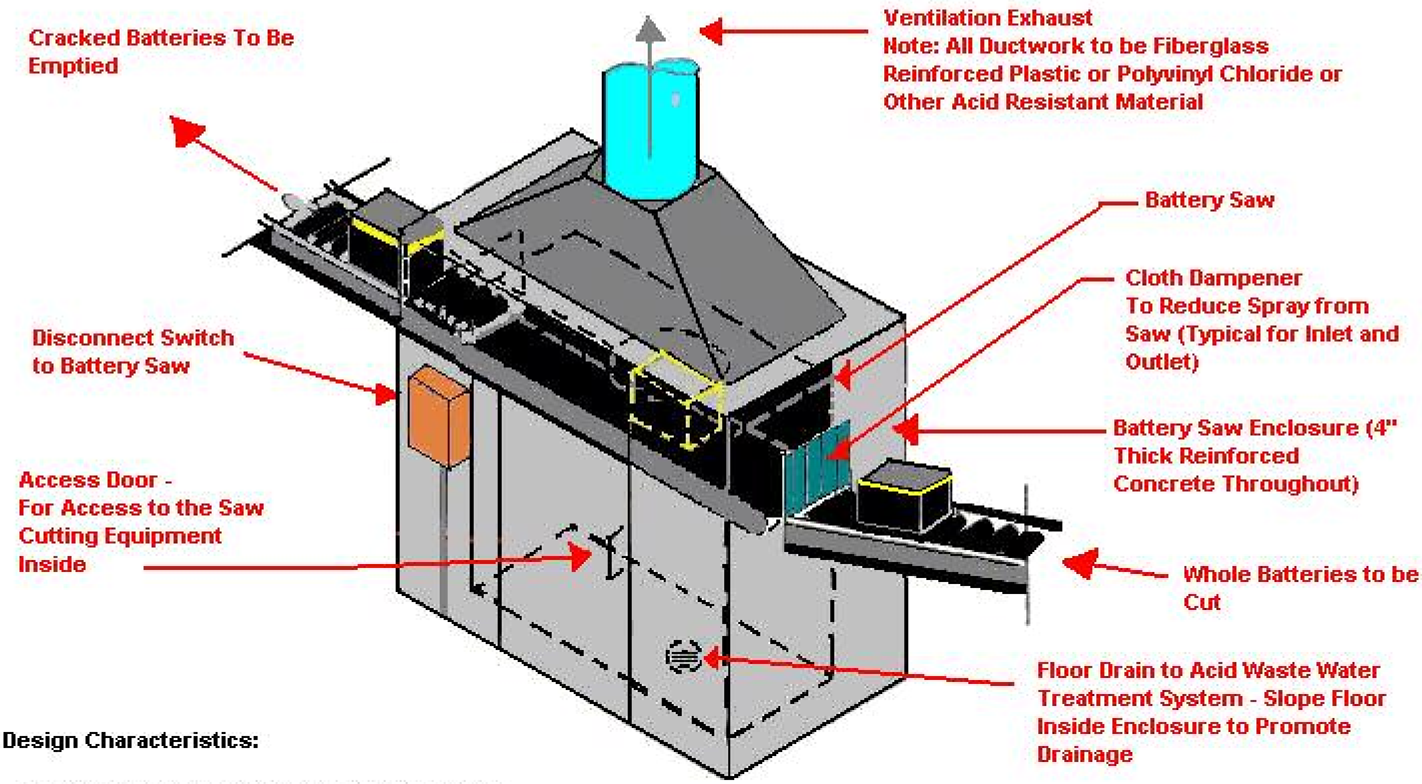
Air and Oxide Flow



Enclosure Hooding - Battery Saw Emission Control



Design Characteristics:

- Provide capture velocities at openings of 350 - 500 FPM

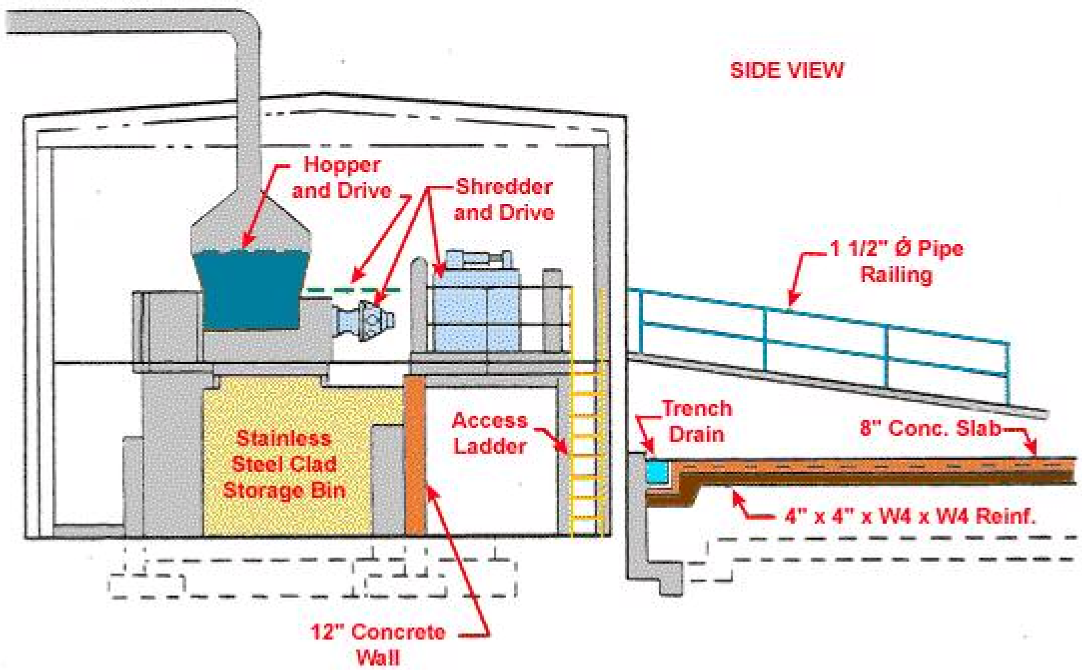
- Duct velocity - 3,500

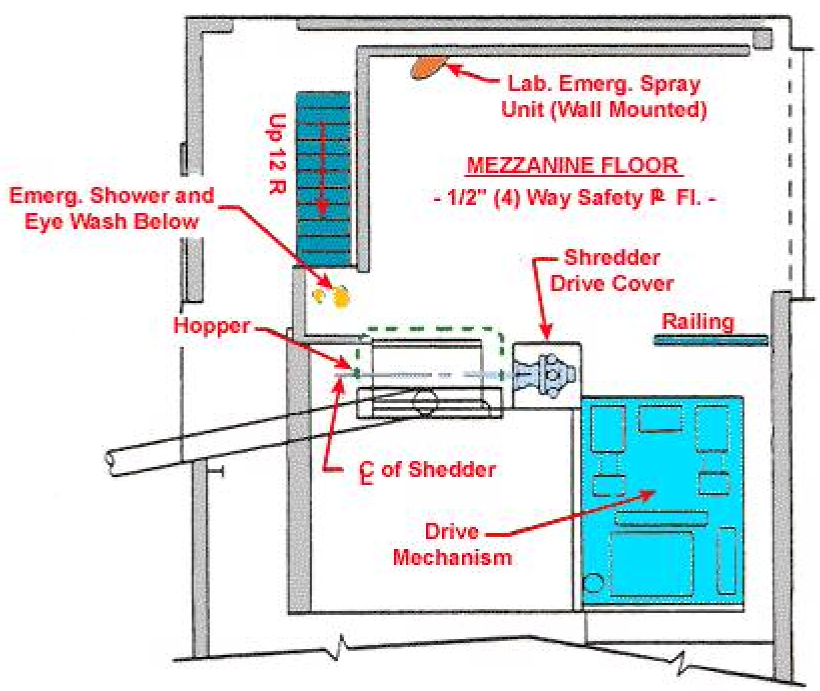
Application Tips:

- Provide drains in ductwork

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

Shredder Building





Battery Shredding and Emission Control

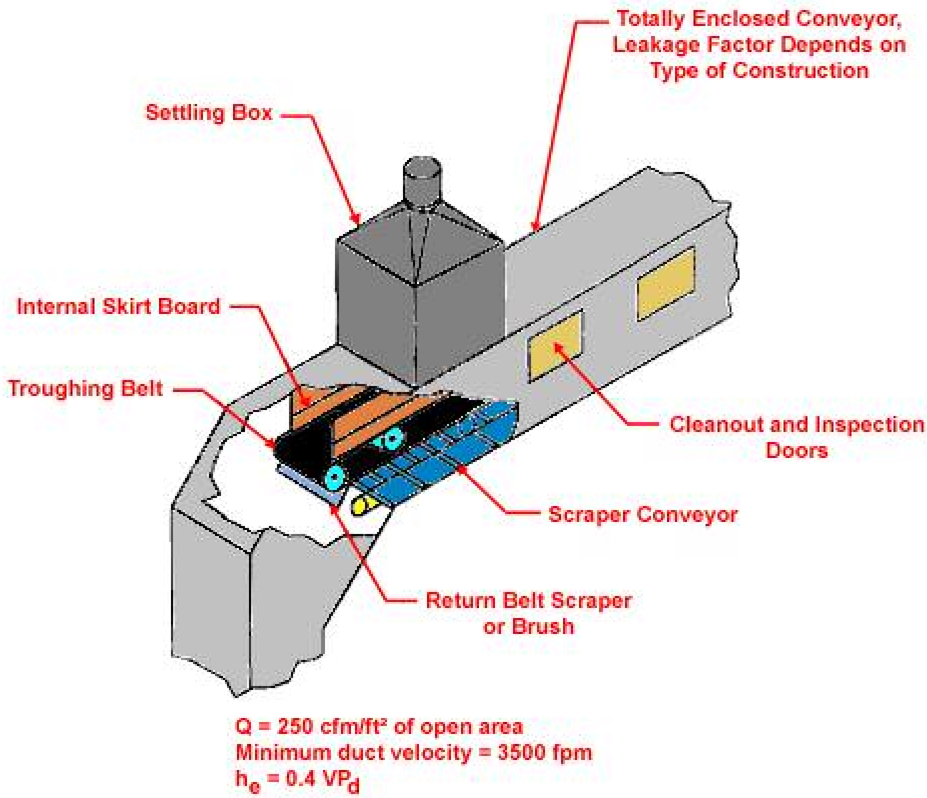
Application Tips:

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

Design Characteristics:

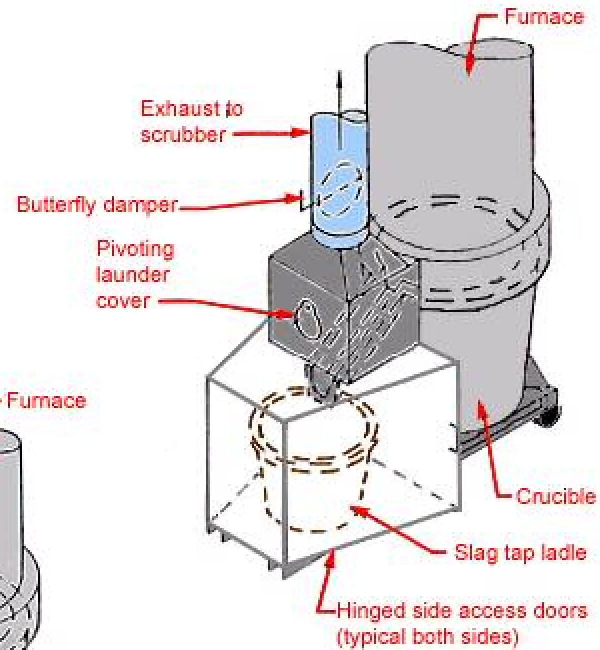
Q = 350 cfm/sq. ft. hood opening

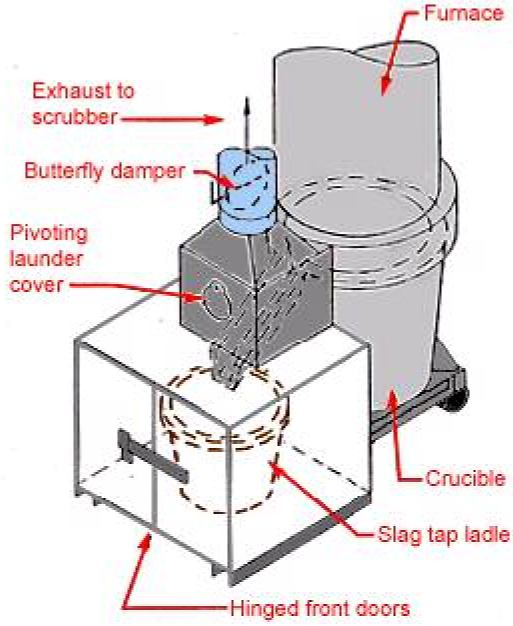
Toxic Material Belt Conveying Head Pulley



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

Enclosure Hooding - Blast
Furnace Slag Tapping Controls

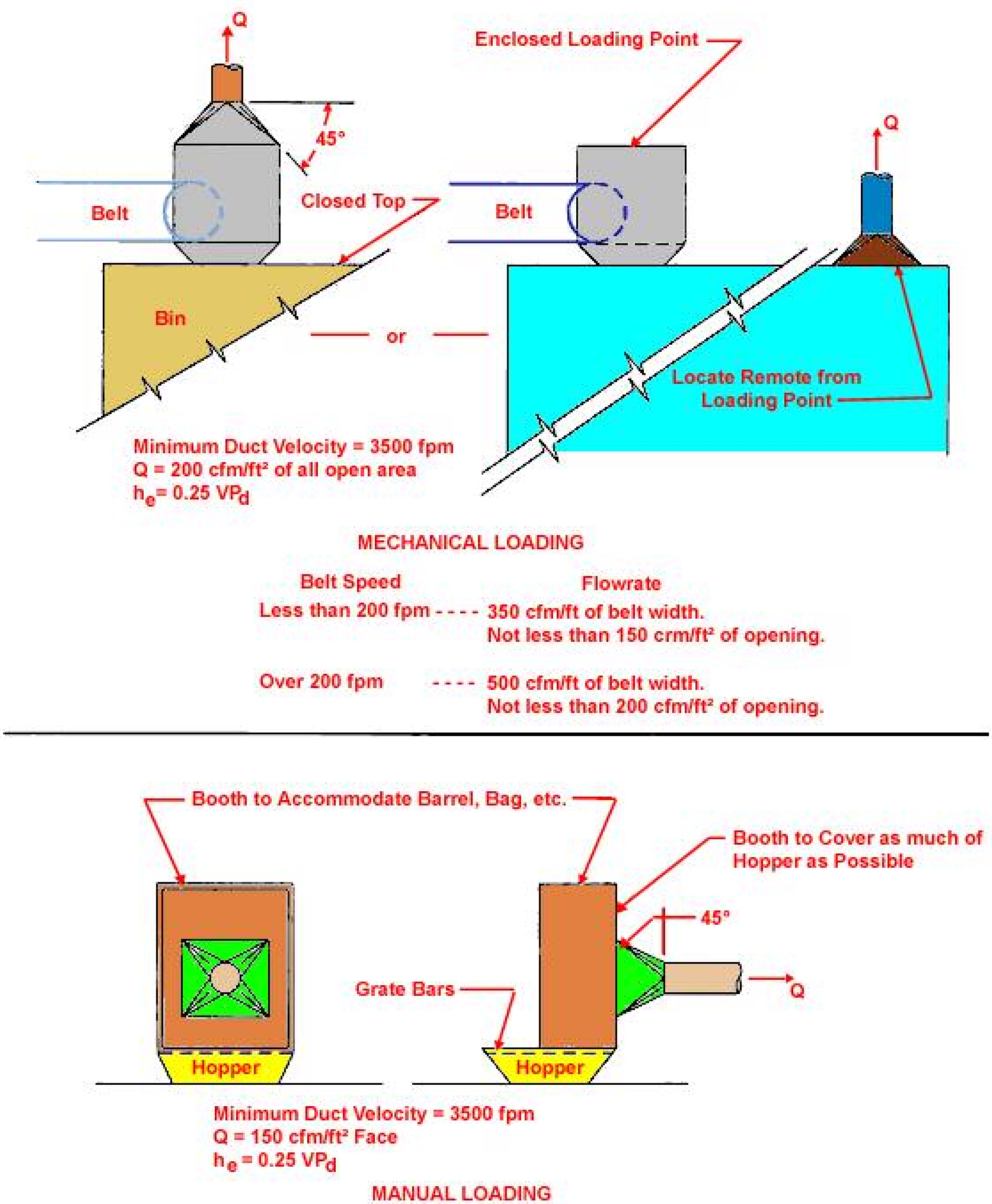




Design Characteristics

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

Bin and Hopper Ventilation



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

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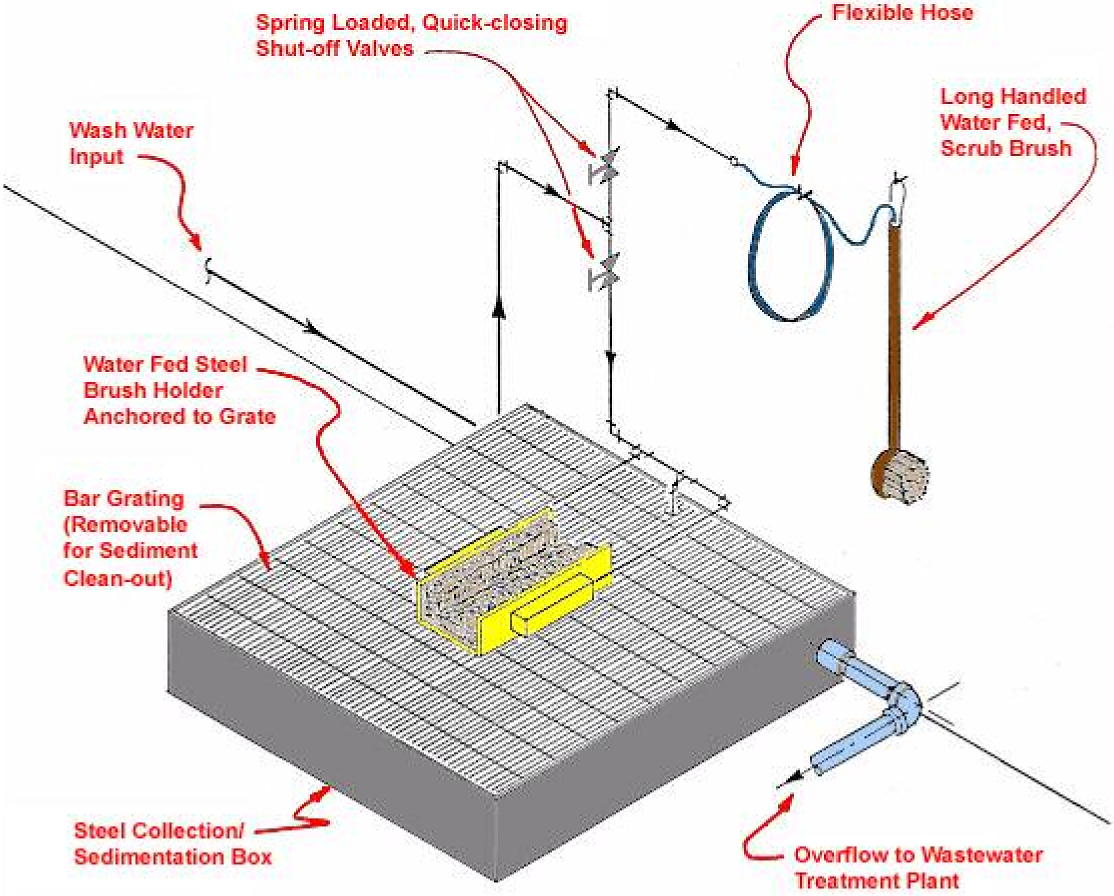
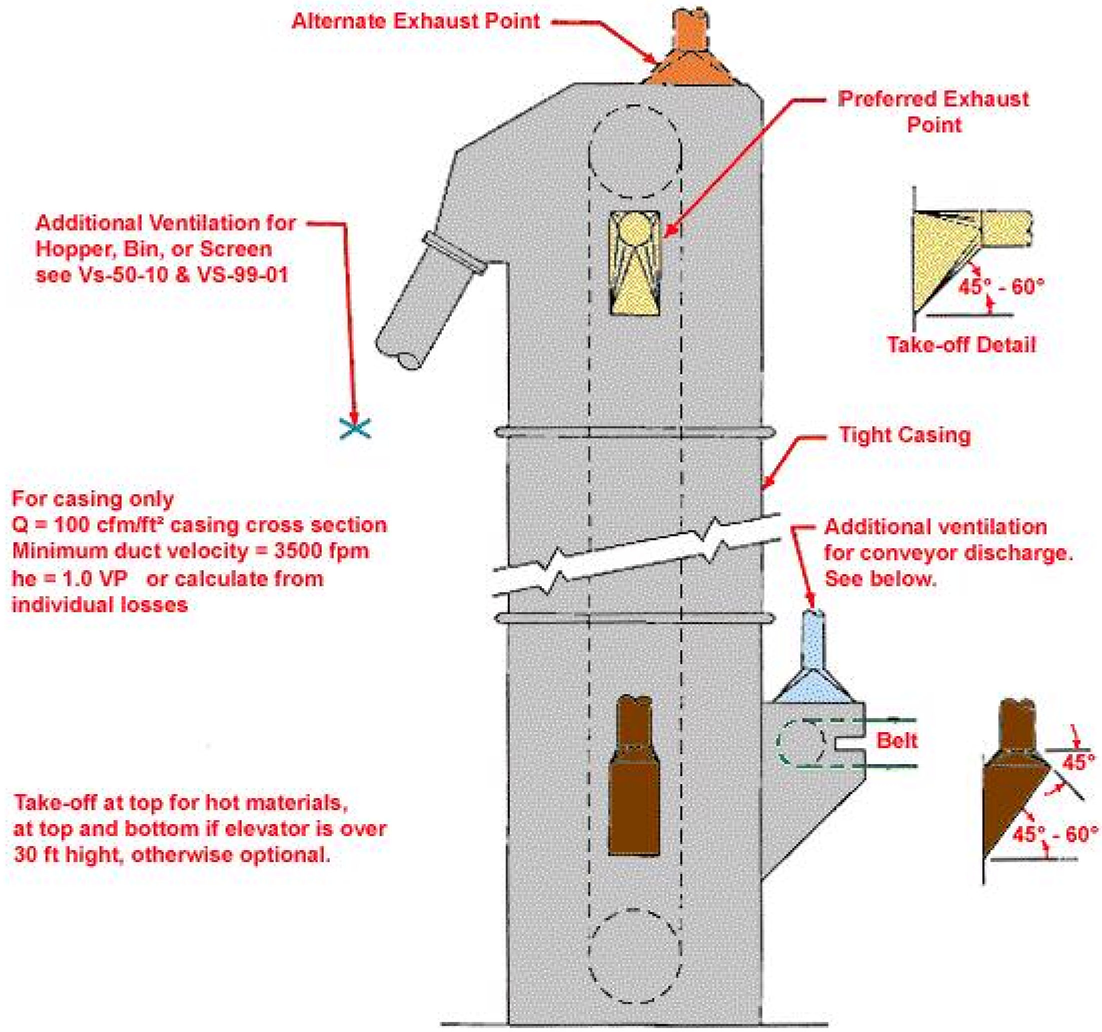
Boot Wash Station



Bucket Elevator Ventilation

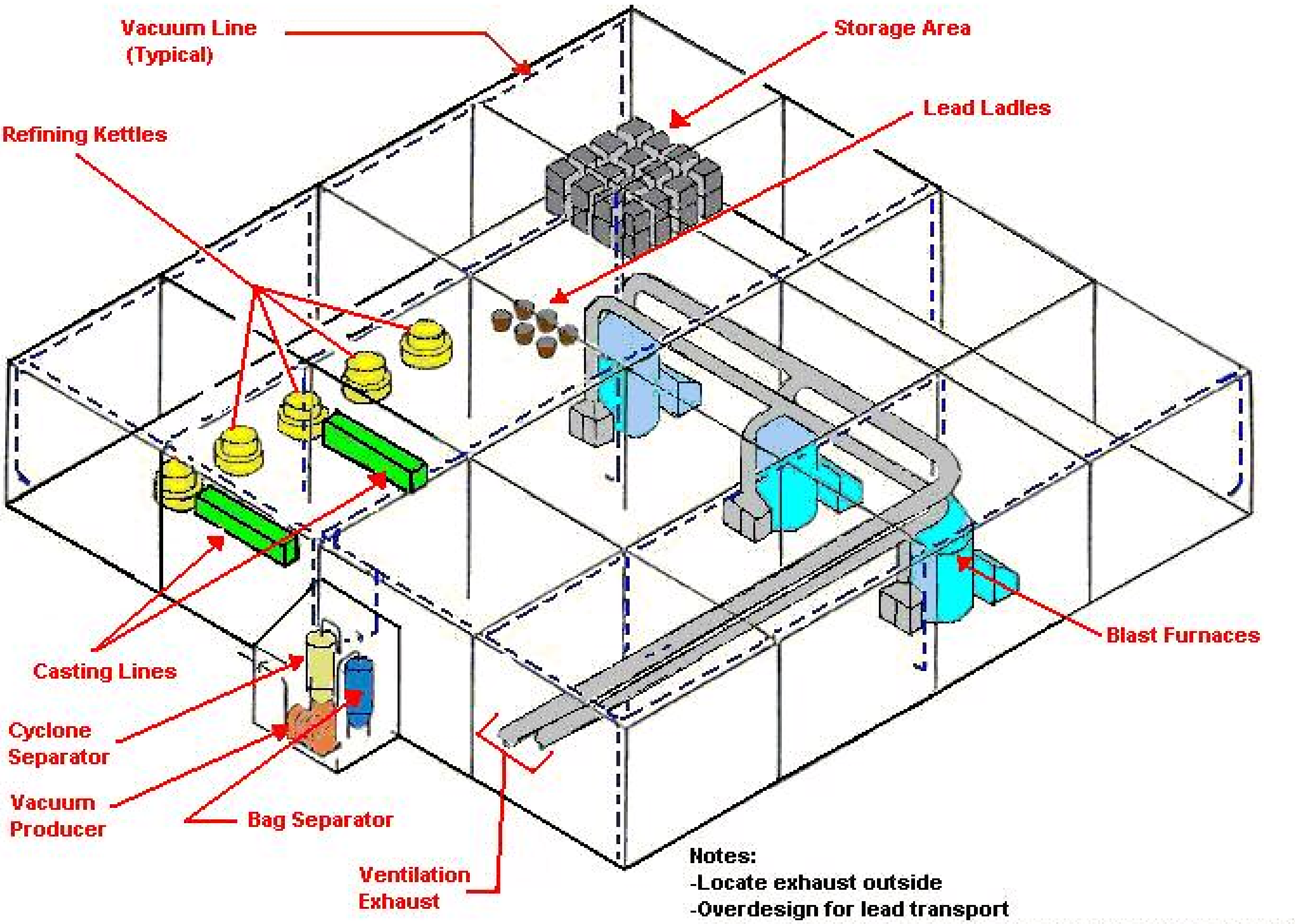


Conveyor Belt Discharge Ventilation

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.

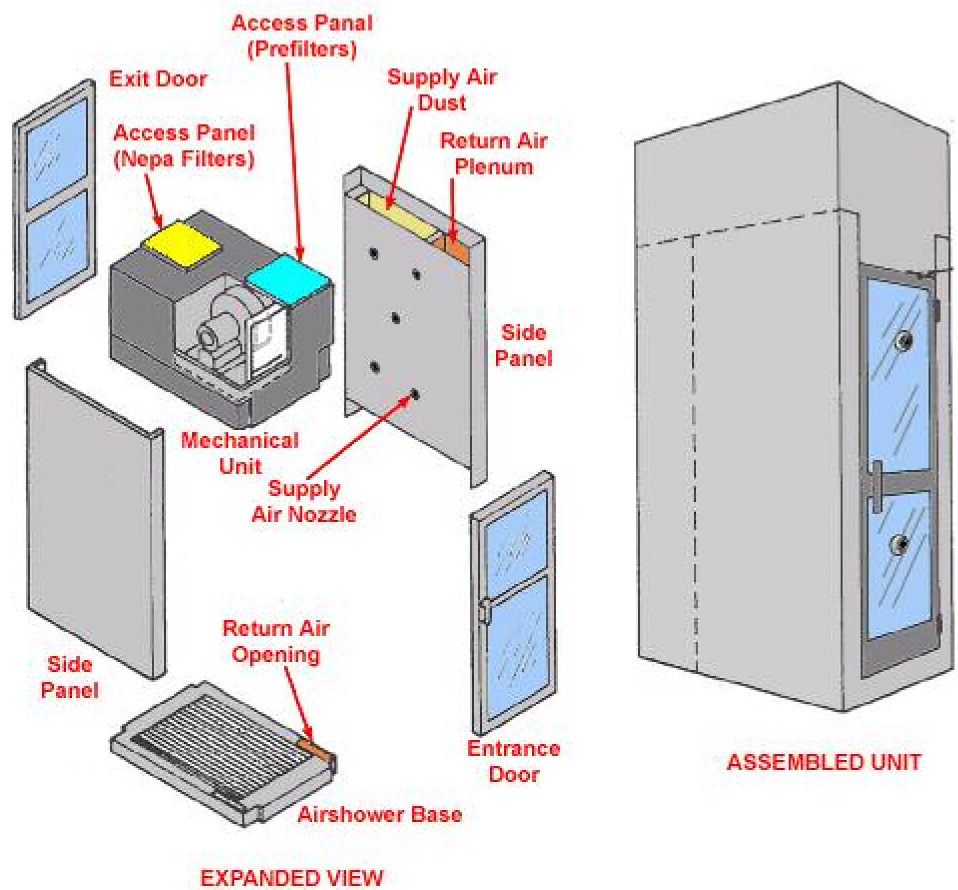
Date: 1-91

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



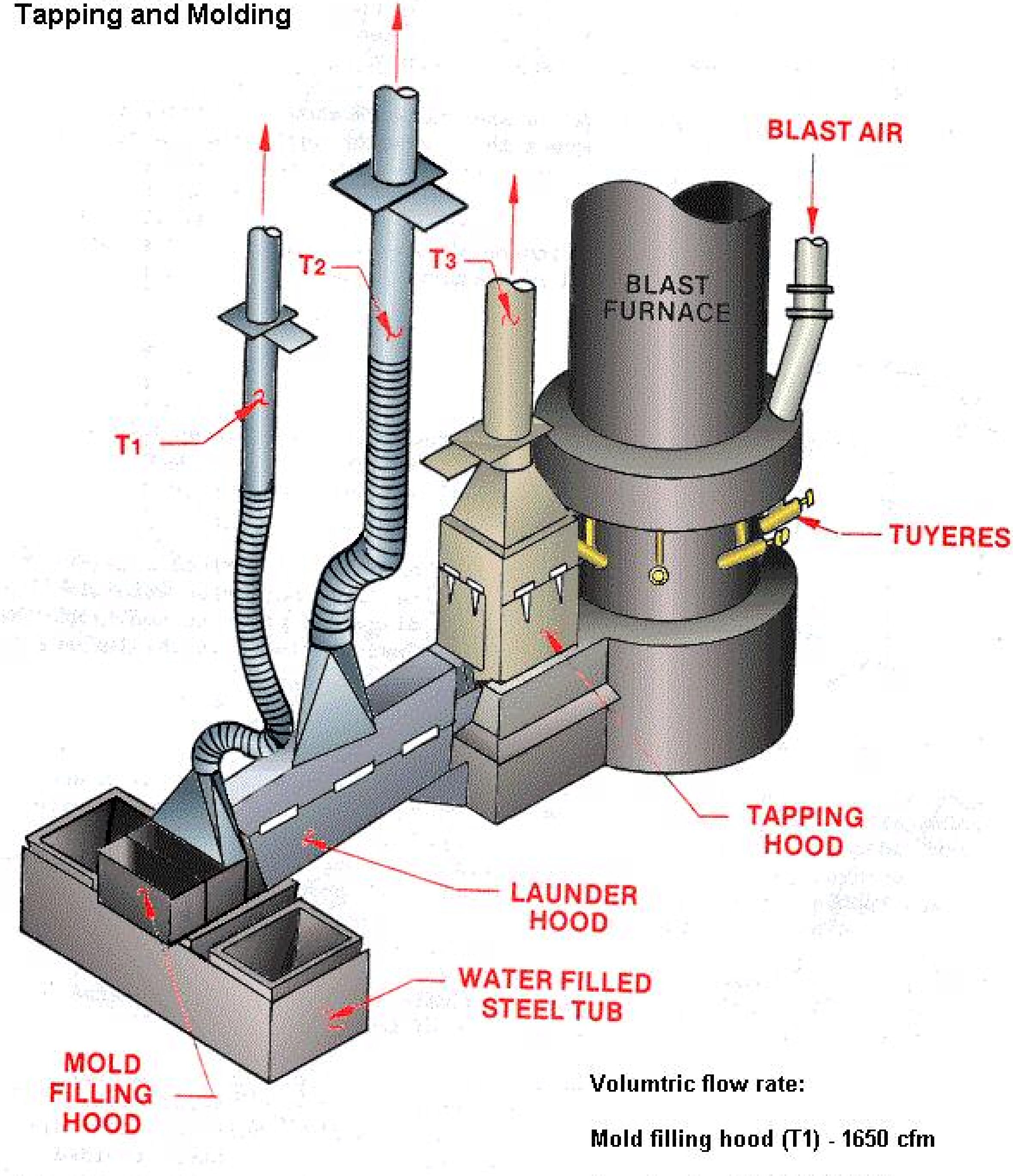
Design Characteristics

· 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.

Controls for Lead Tapping and Molding



Volumtric flow rate:

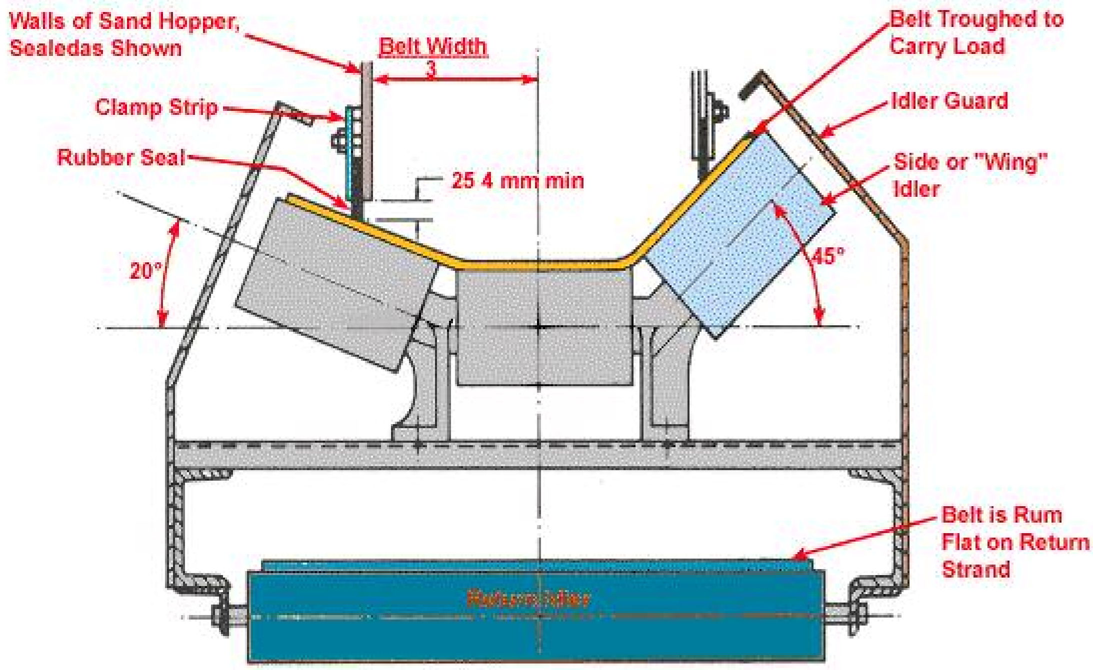
Mold filling hood (T1) - 1650 cfm

Launder hood (T2) - 2460 cfm

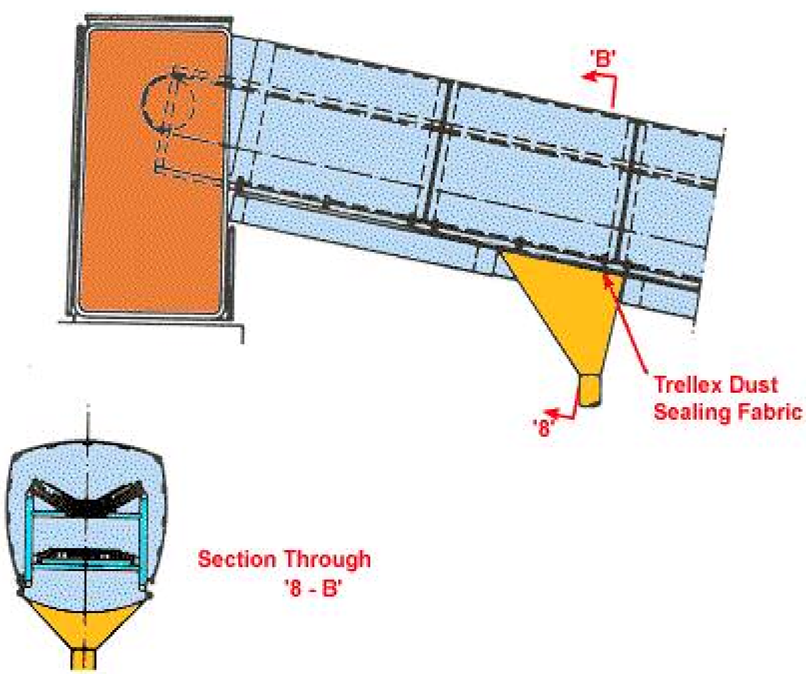
Metal tapping hood (T3) - 3660 cfm

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).

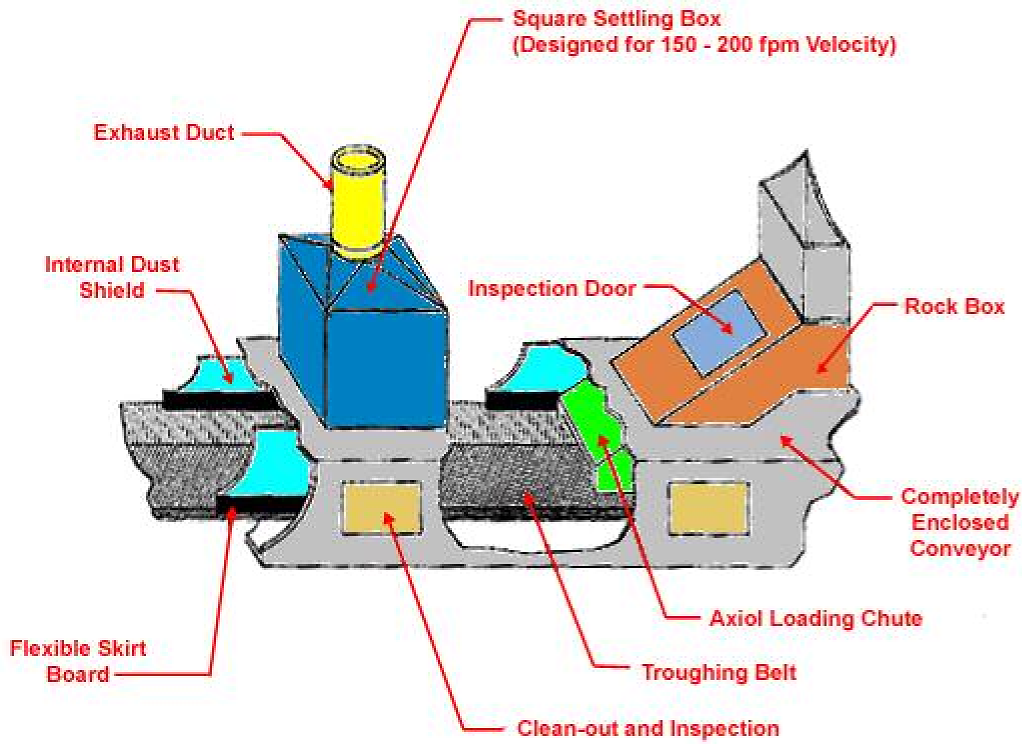
Section Through Conveyor Showing a 20° and 45° Troughing Idler, Chute, and Sealing Skirt with Idler Guard



Eclosure of Belt Conveyor



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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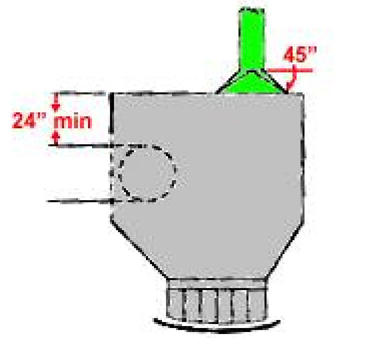
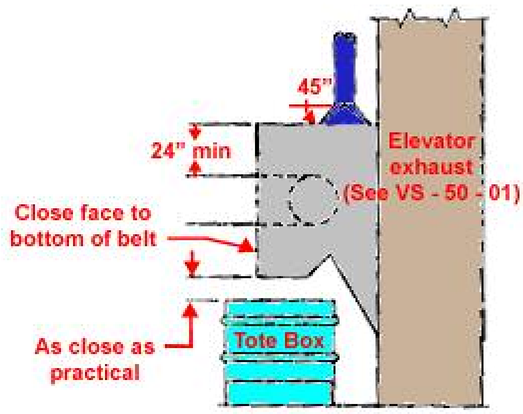
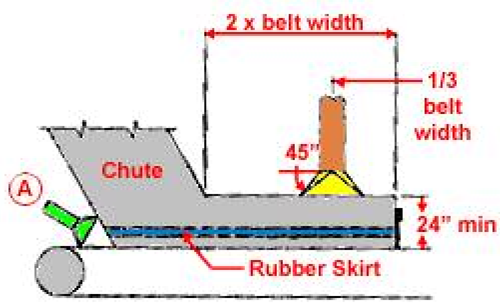
Conveyor Belt Ventilation



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.
$h_e = 0.25\ VP_d$



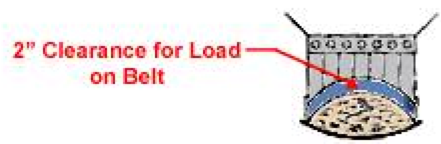
3. Chute to belt transfer and conveyor transfer, greater than 3' fall. Use additional exhaust at (A) for dusty material as follows:
Belt width 12"–36", Q=700 cfm
Belt width above 36", Q=1000 cfm
$h_e = 0.25\ VP_d$

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.

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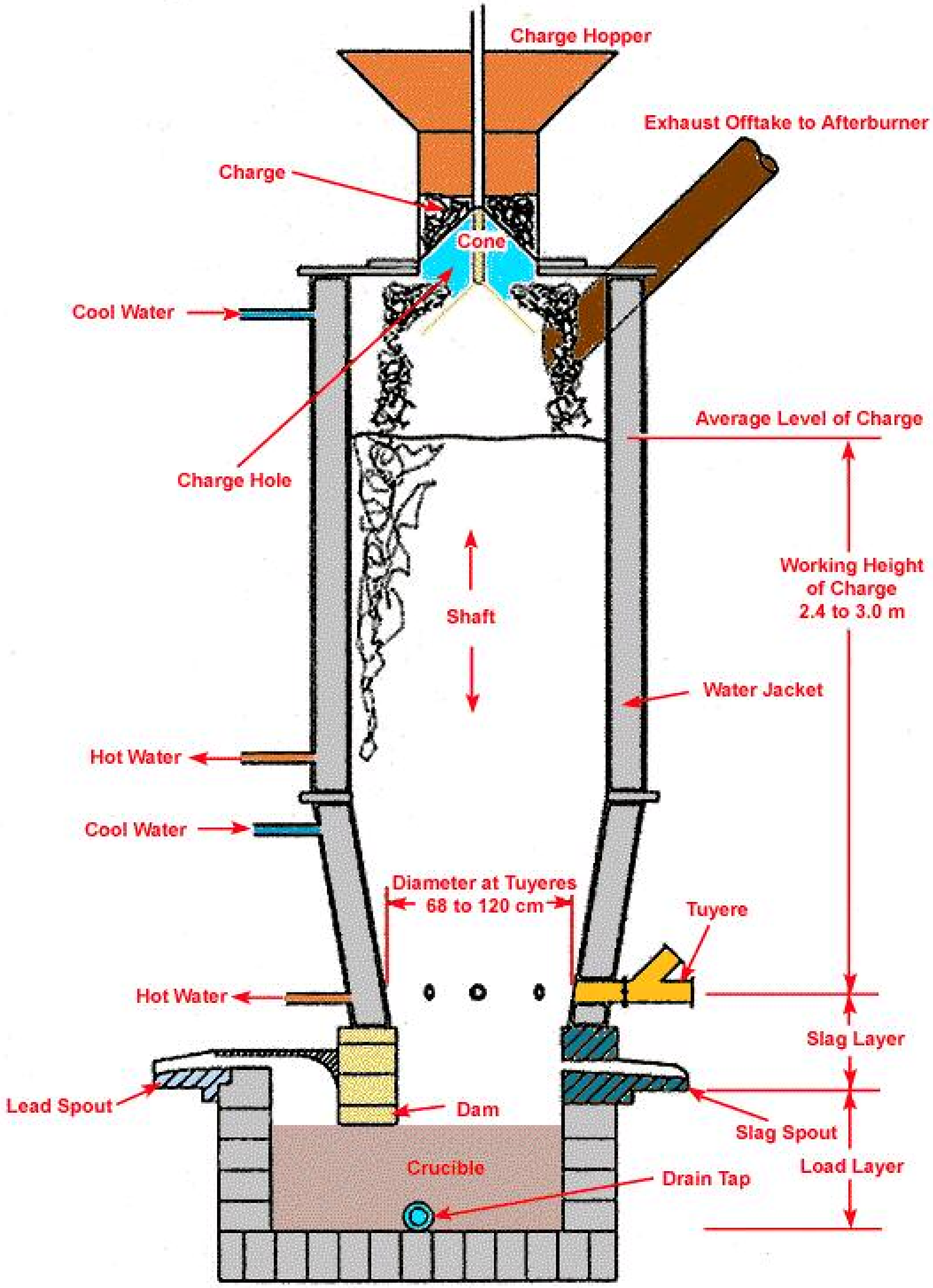
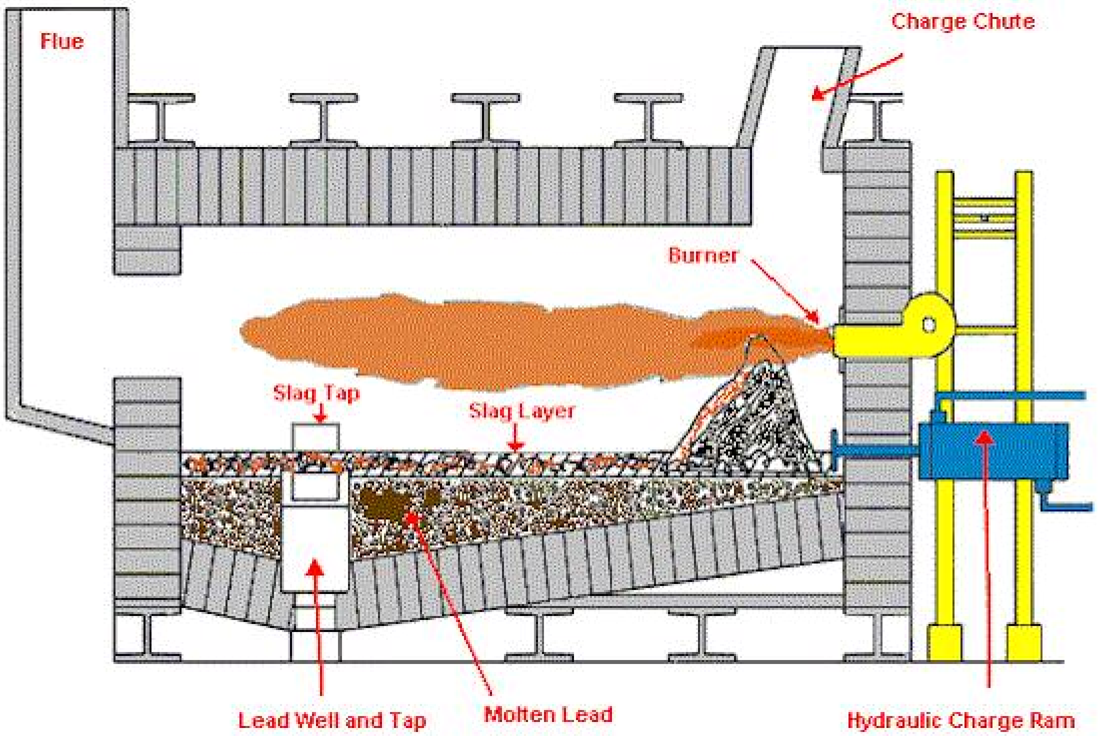
	Figure: VS - 50 - 20

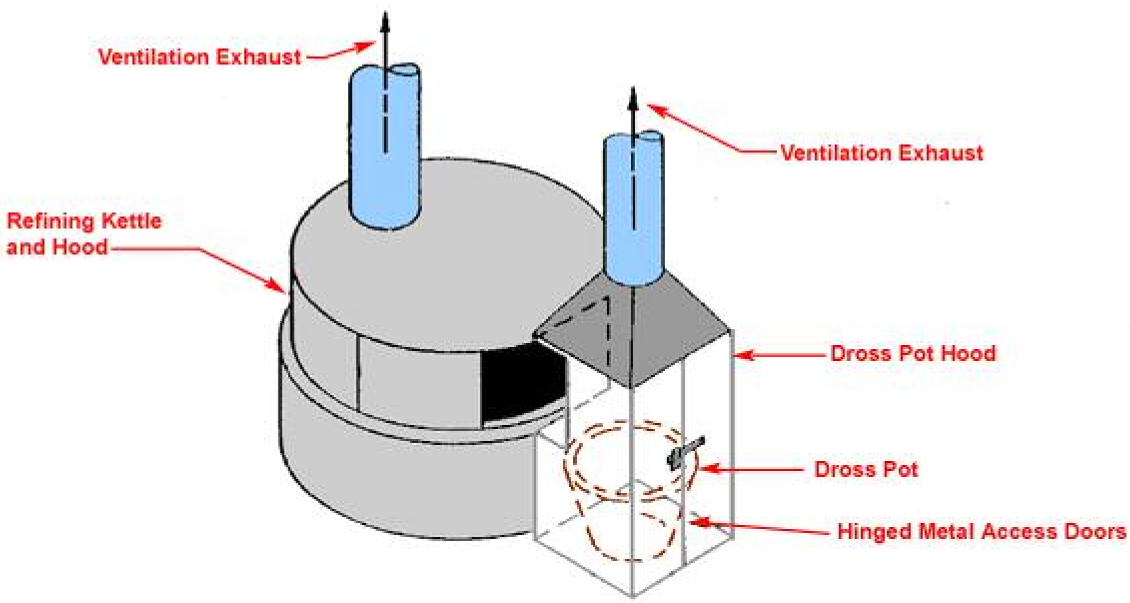
Cross Section of a Typical Furnace



Reverberatory Furnace



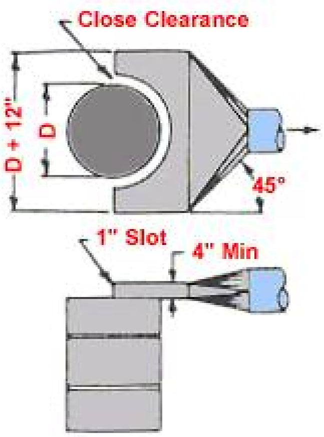
Dross Pot Hood

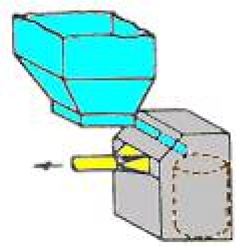


Design Characteristics

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

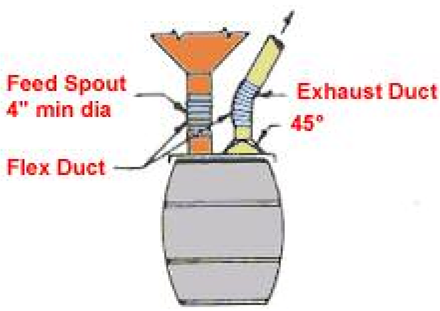
Dross and Skimmings Storage Ventilation

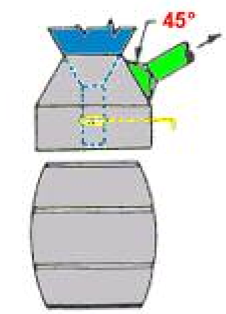




· Q = 100 cfm/sq ft barrel top min
· Duct velocity = 3500 minimum
· Entry loss = 0.25 vp + 1.78 slot vp
· Manual loading

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

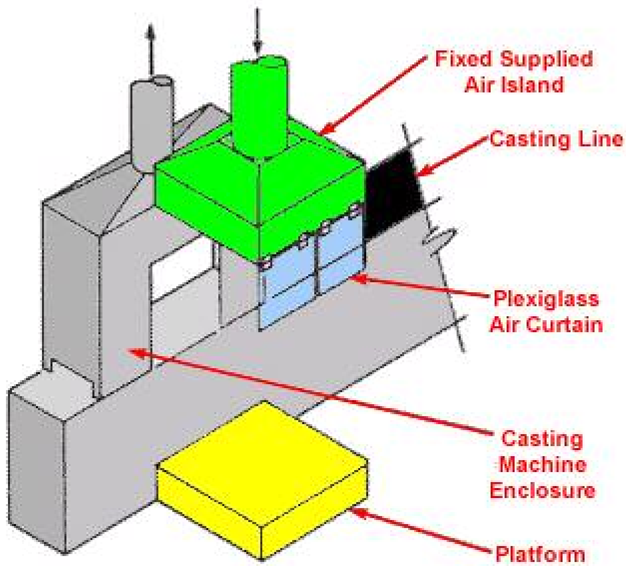




· Q = 50 cfm x drum dia (ft) for weighted lid
150 cfm x drum dia (ft) for loose lid
· Duct velocity = 3500 fpm minimum
· Entry loss = 0.25 vp

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

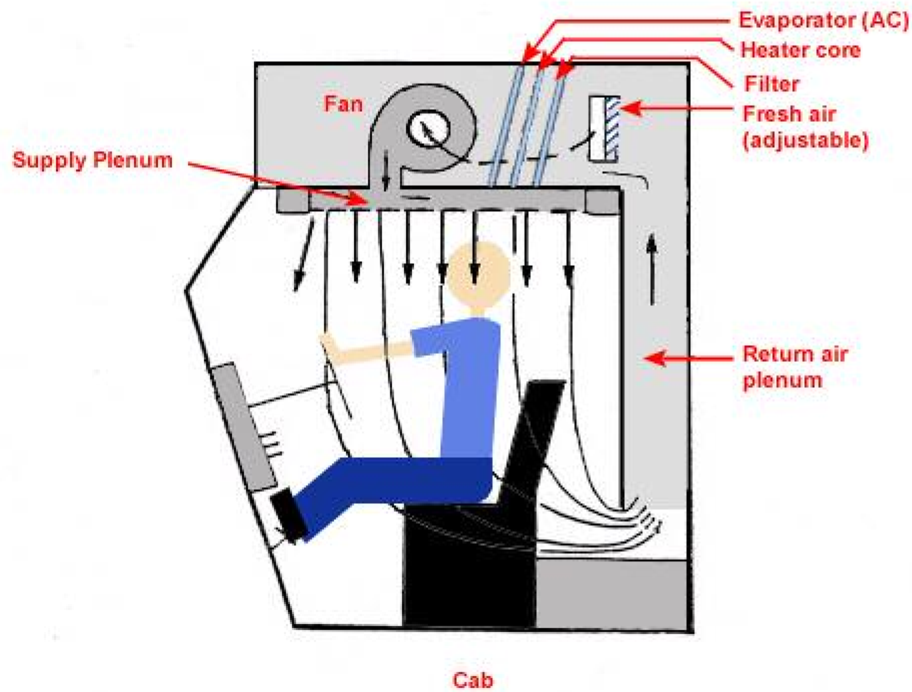
Fixed Supplied Air Island



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.

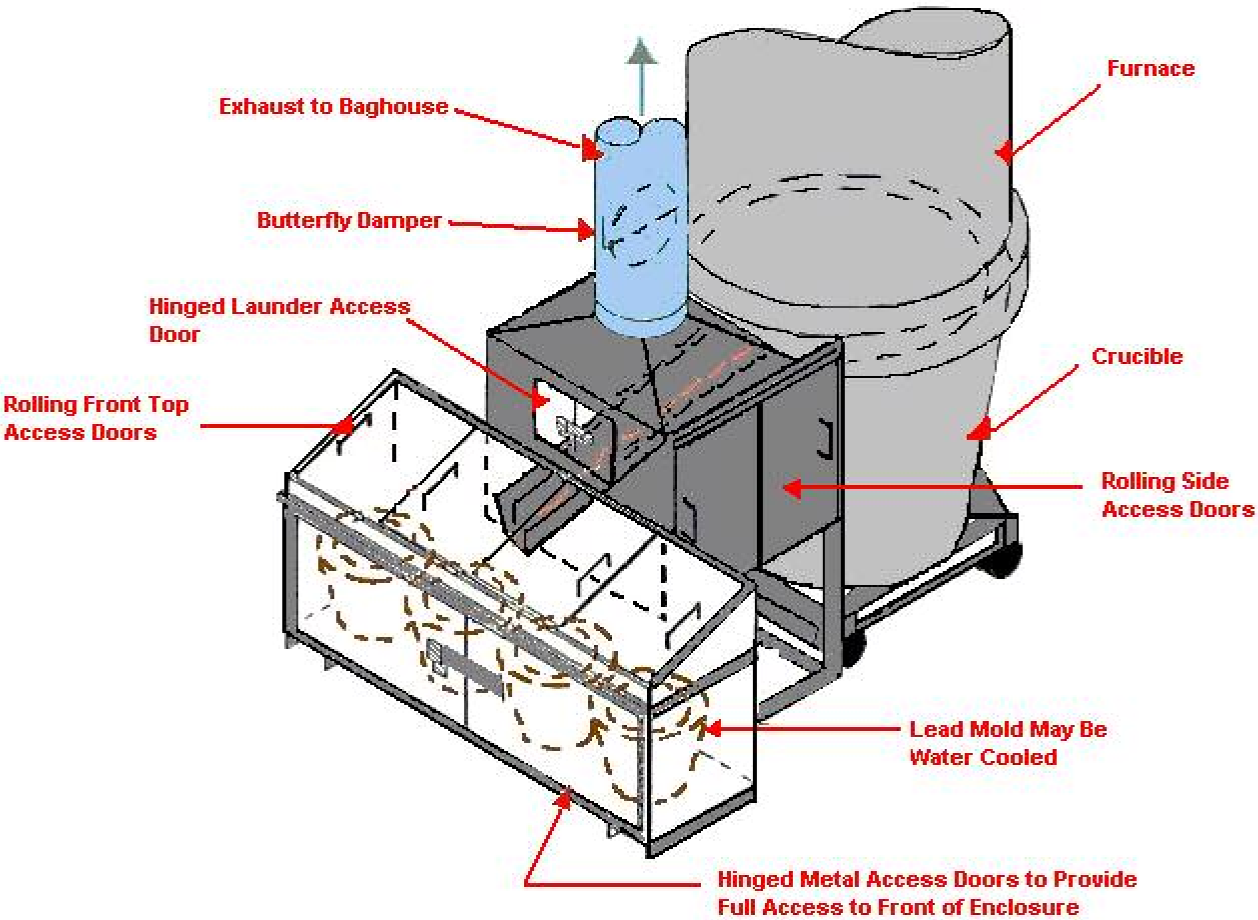
Provide temperature controls at operators station.

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



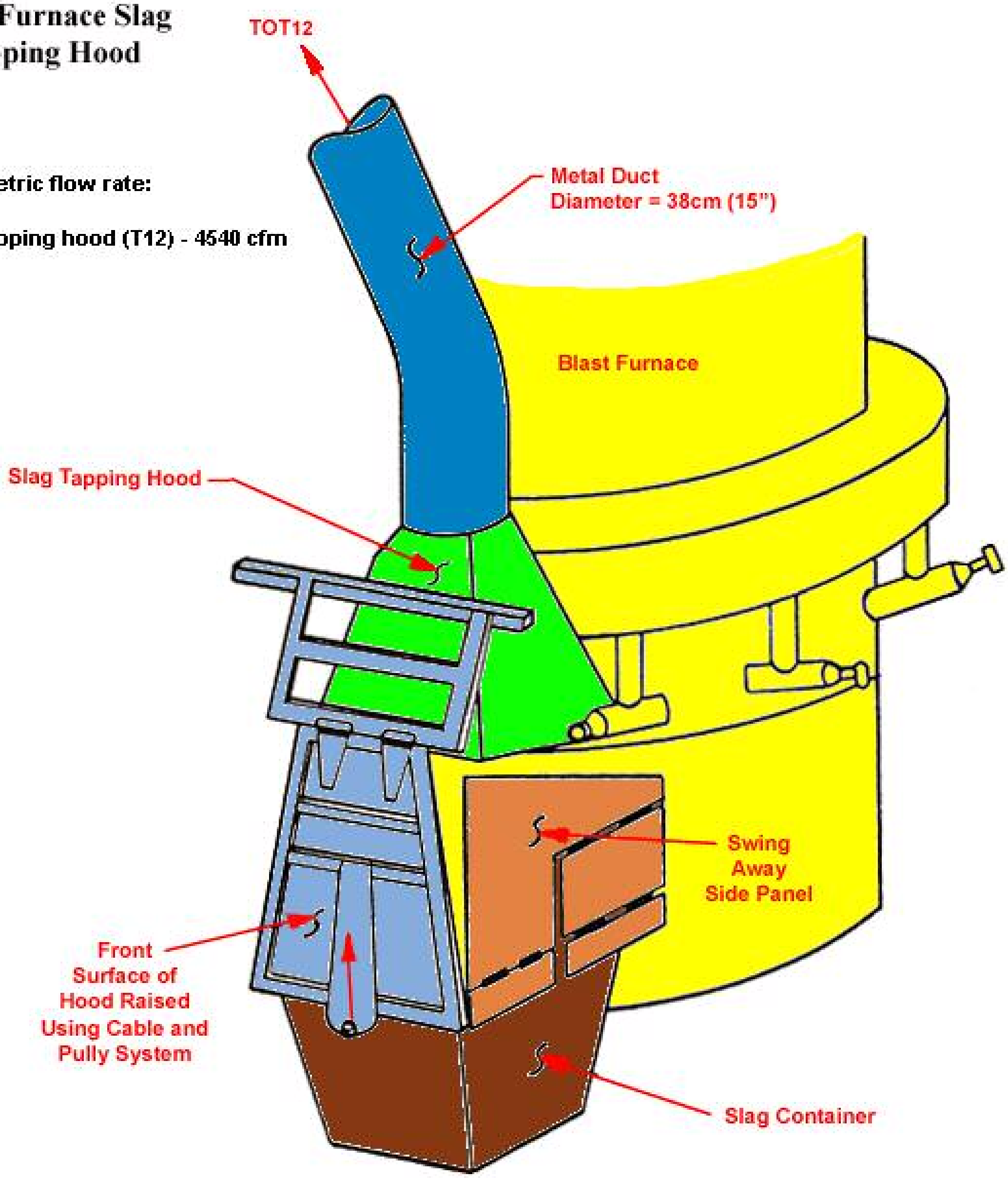
Design Characteristics

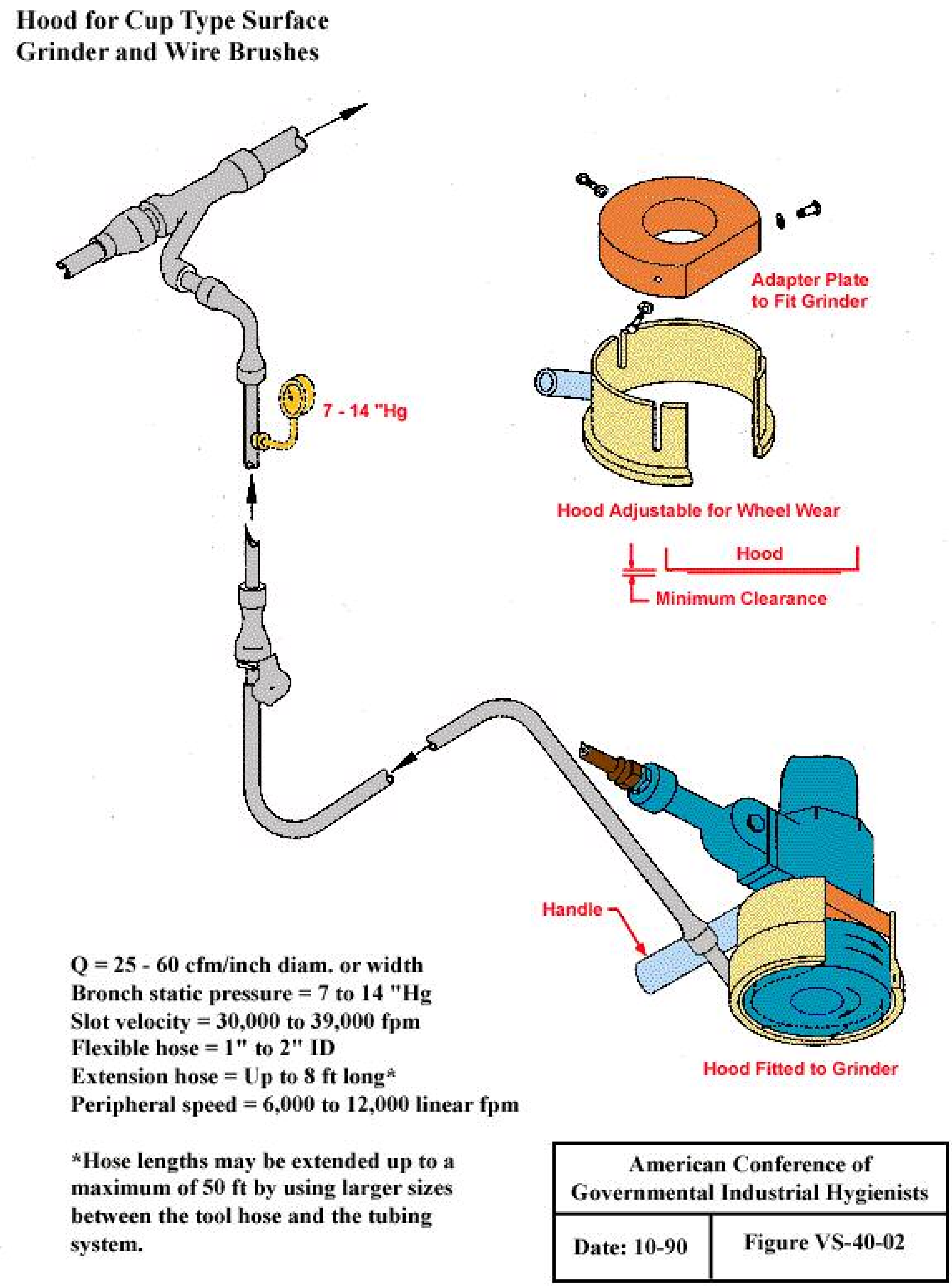
- Enclosure to provide capture velocities at opening of 350-500 FPM
- Transport velocity in ducts greater than or equal to 4000 FPM

Blast Furnace Slag Tapping Hood

Volumetric flow rate:

Slag tapping hood (T12) - 4540 cfm





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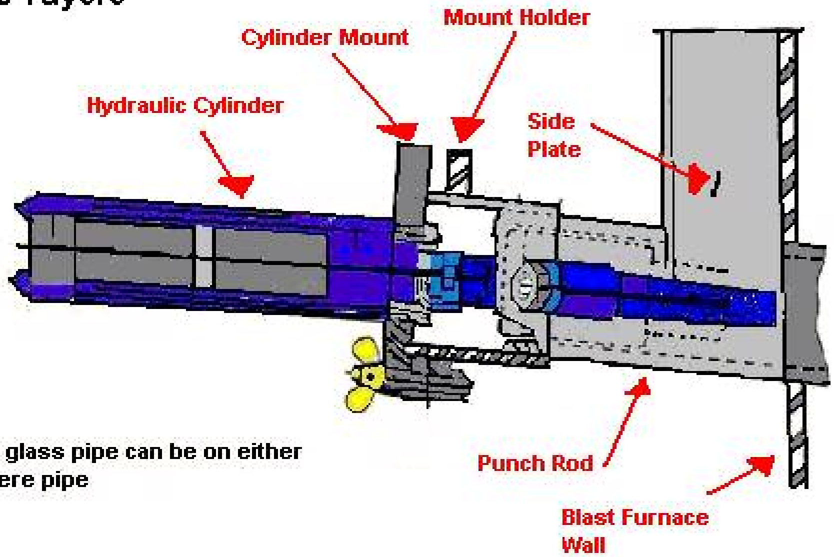
Hydraulic Tuyere Puncher



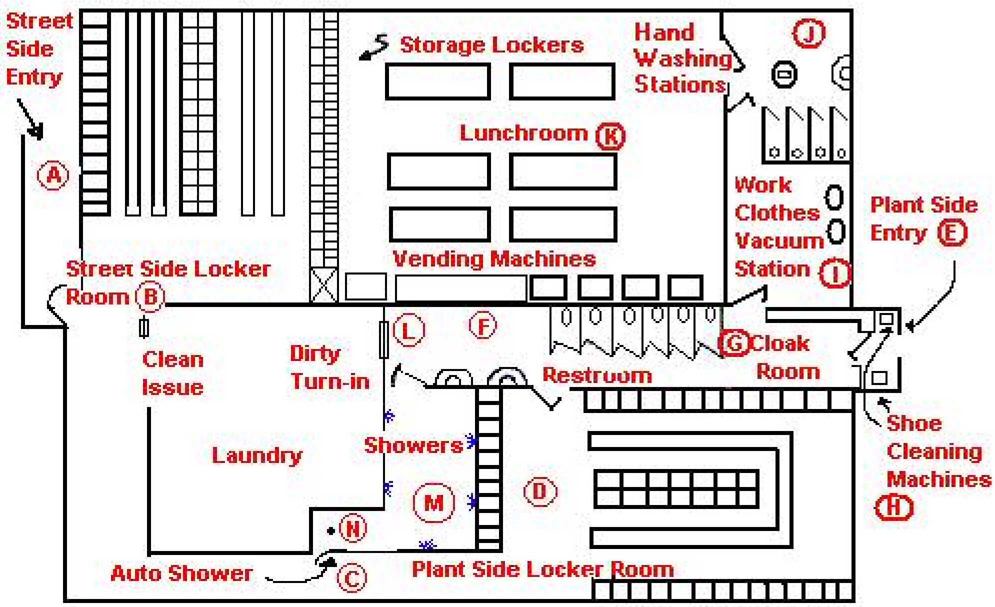
Note: Sight glass pipe can be on either side of tuyere pipe

Application Tips:

- **Limited to compatible metallurgical conditions**

- **Moderate maintenance required**

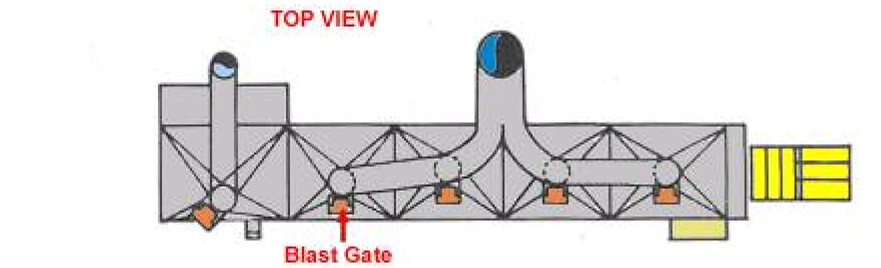
Two-Stage Hygiene Facility

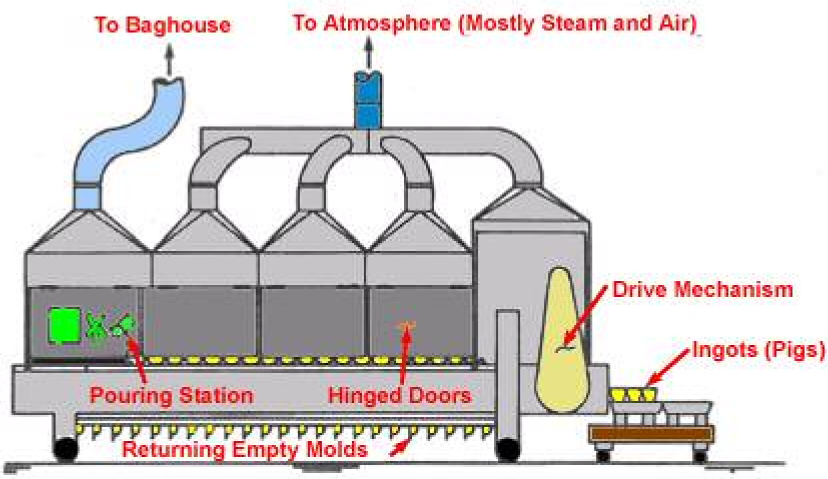


Facility Function/Description

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

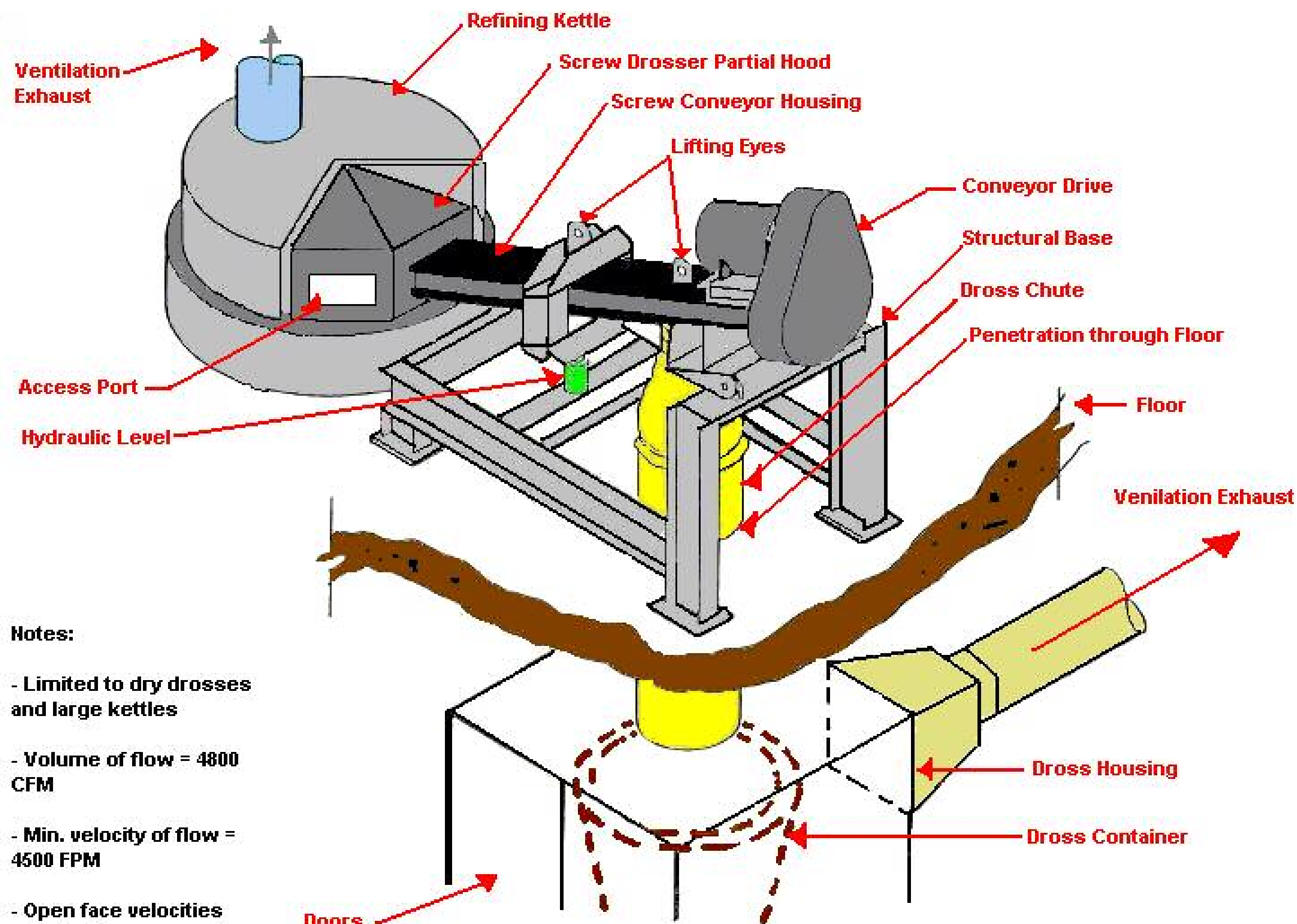
Cooling Hood:

$Q = 100$ 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



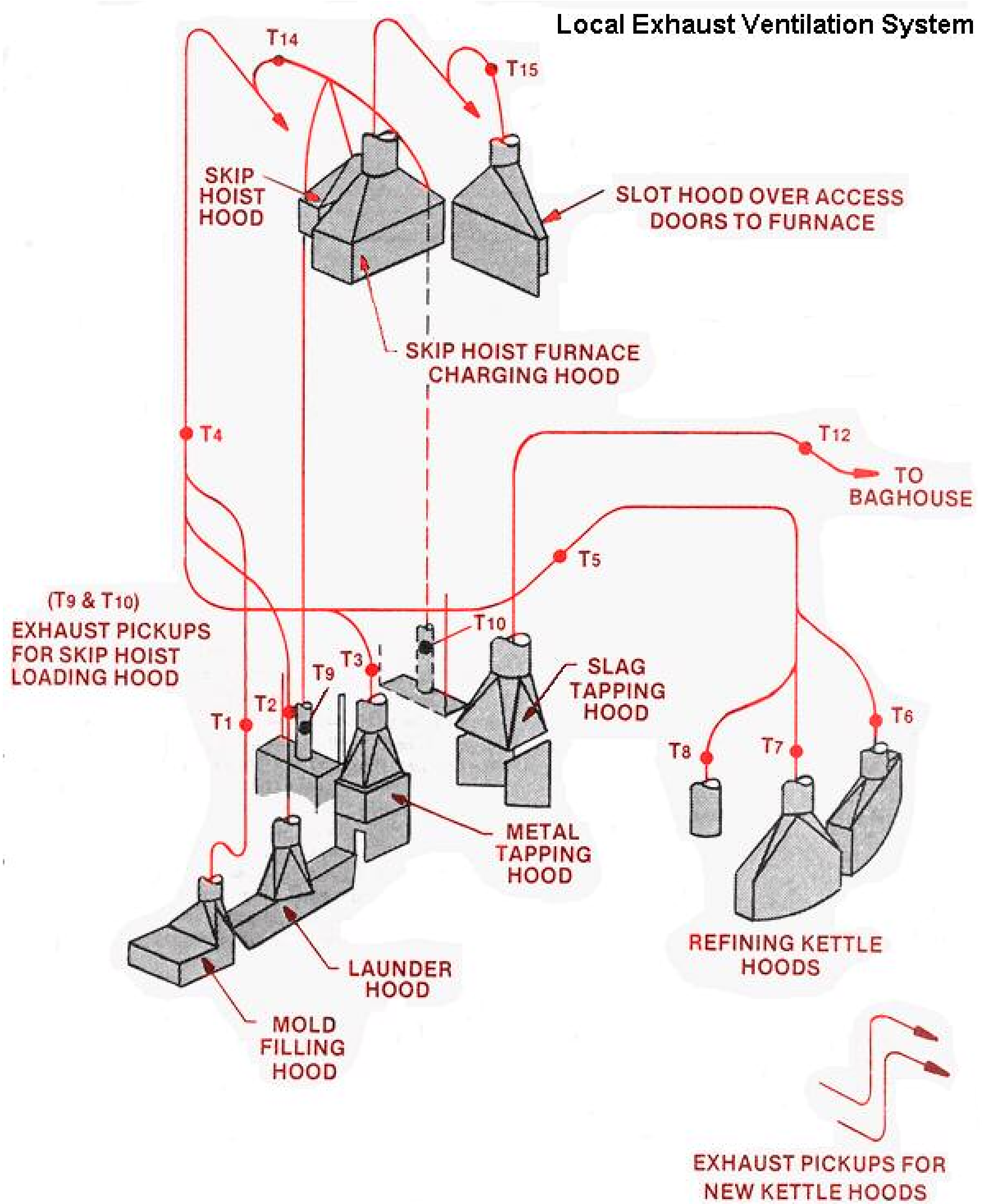
Notes:

- 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

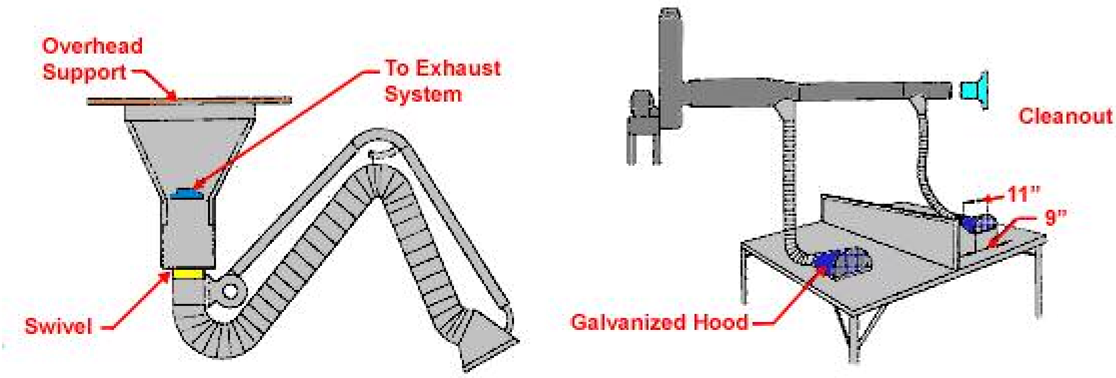
Exhaust pickups for new kettle hoods - 2940 cfm

Discharge from slag tapping baghouse - 5000 cfm

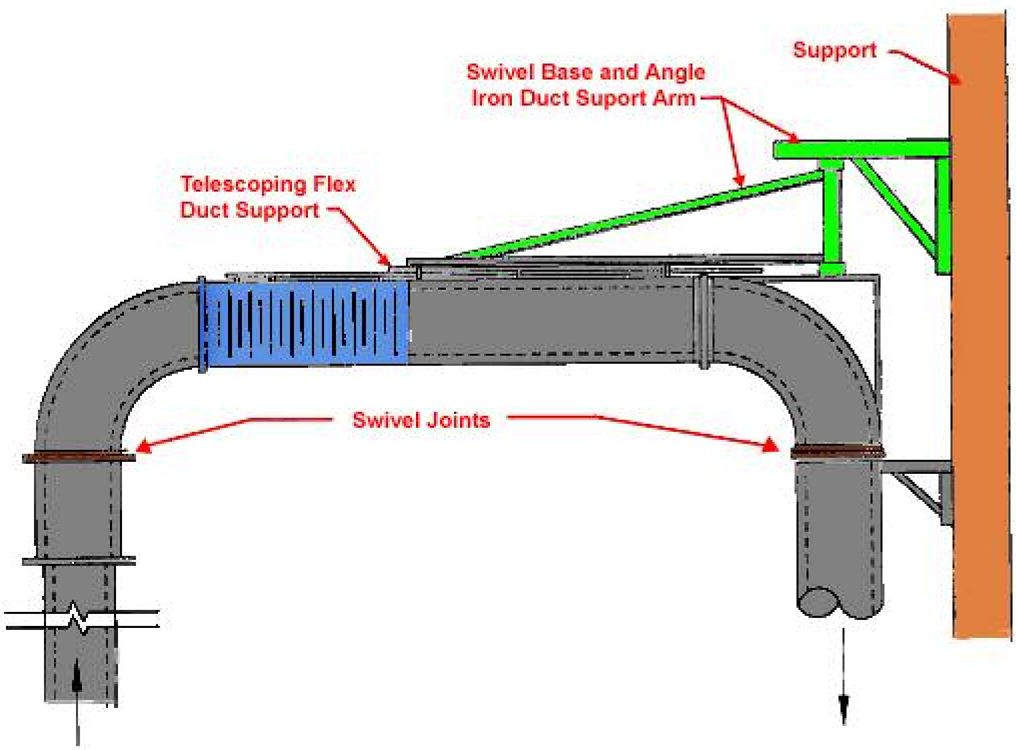
Inlet to main exhaust fan for smelter exhaust ventilation system - 41700 cfm

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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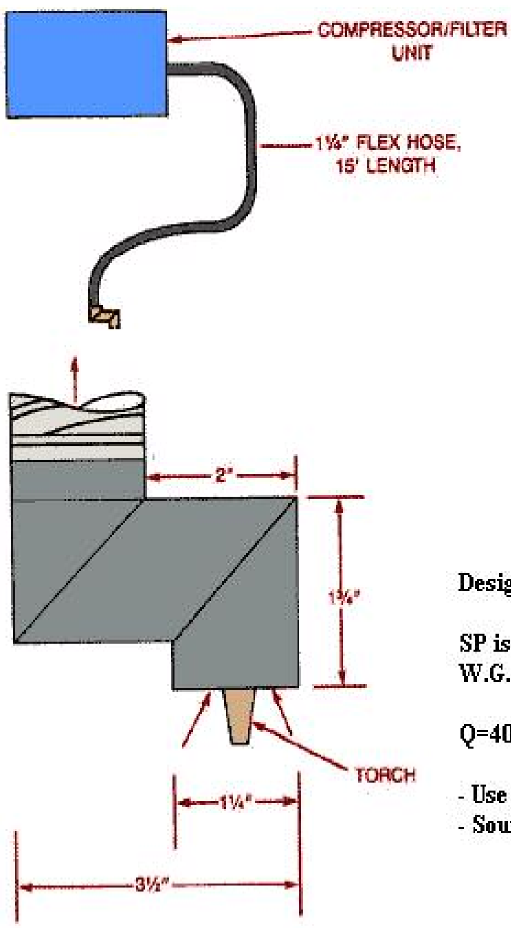
Portable Tool Exhaust
(High Velocity/Low Volume)



Design Criteria:

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

Q=40 cfm

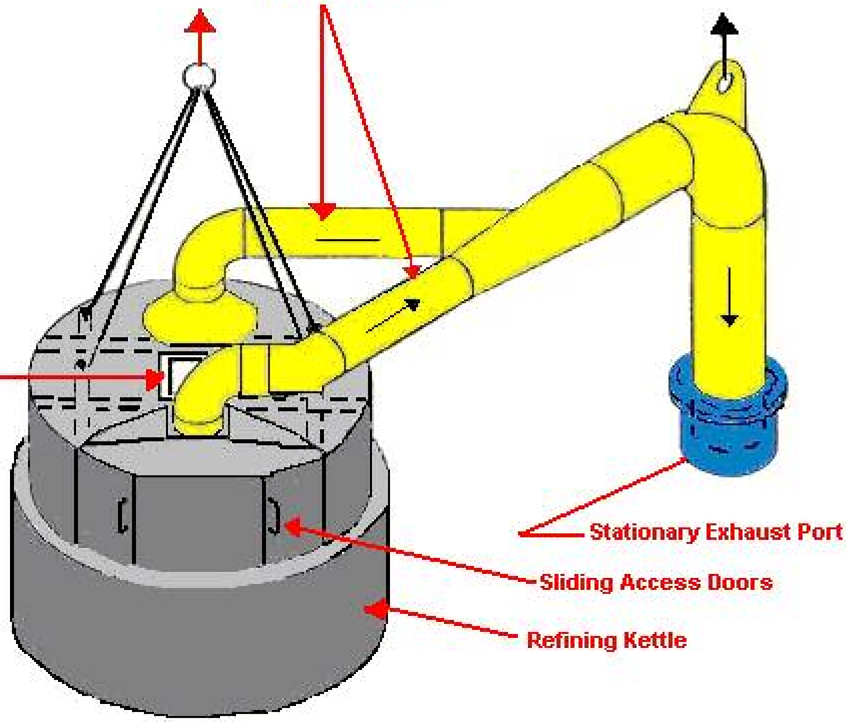
- Use steel mold
- Source must be within 1" of hood

Enclosure Hooding - Refining Kettle Emissions Control

Design Characteristics

- Volume flow rate of kettle surface area

- Dust Velocity greater than or equal to 4000FPM

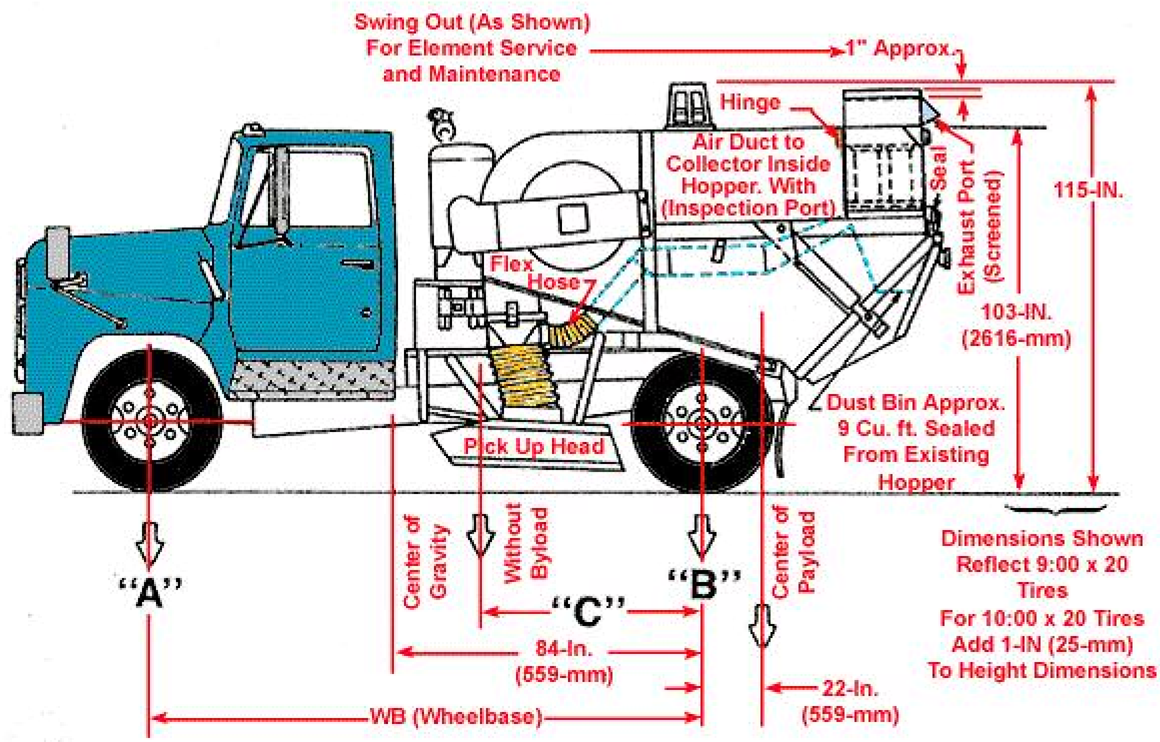


Construction Notes

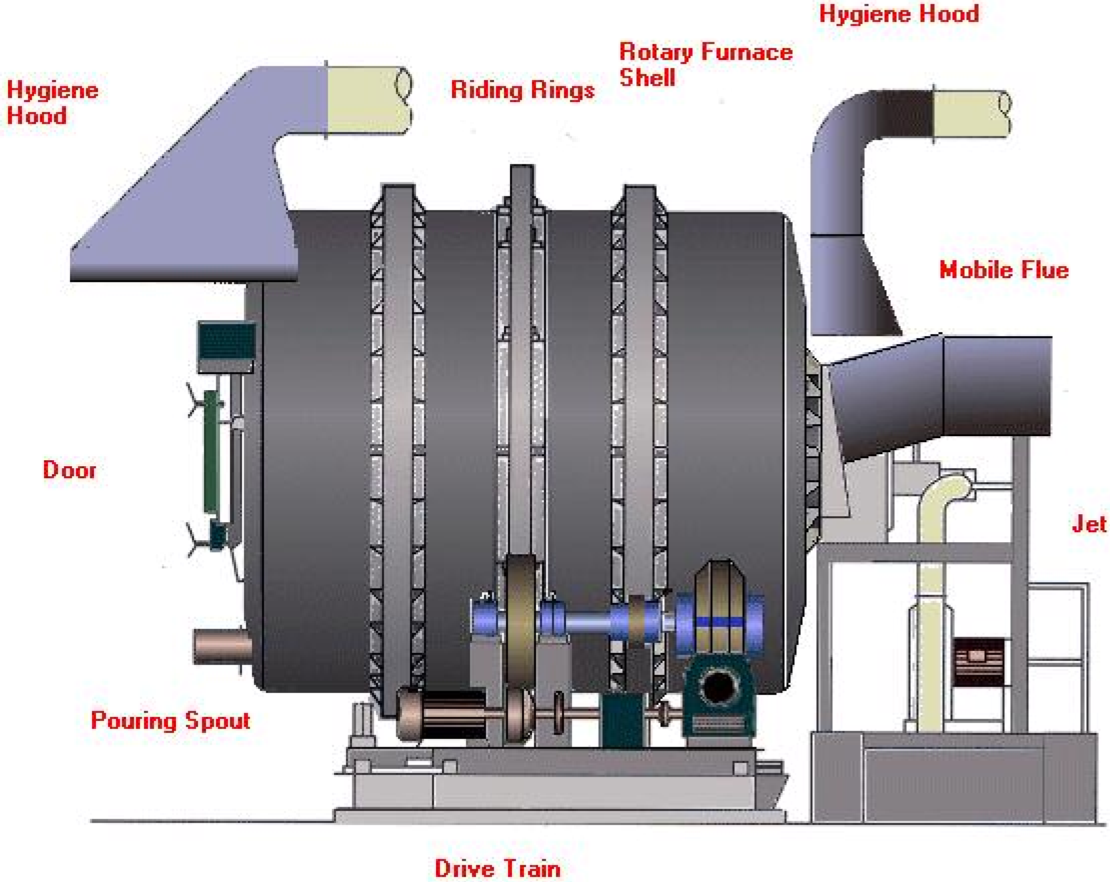
- Enclose to provide at least 250 FPH face velocity at all openings

- Provide adequate lifting points for hood assembly associated ductwork

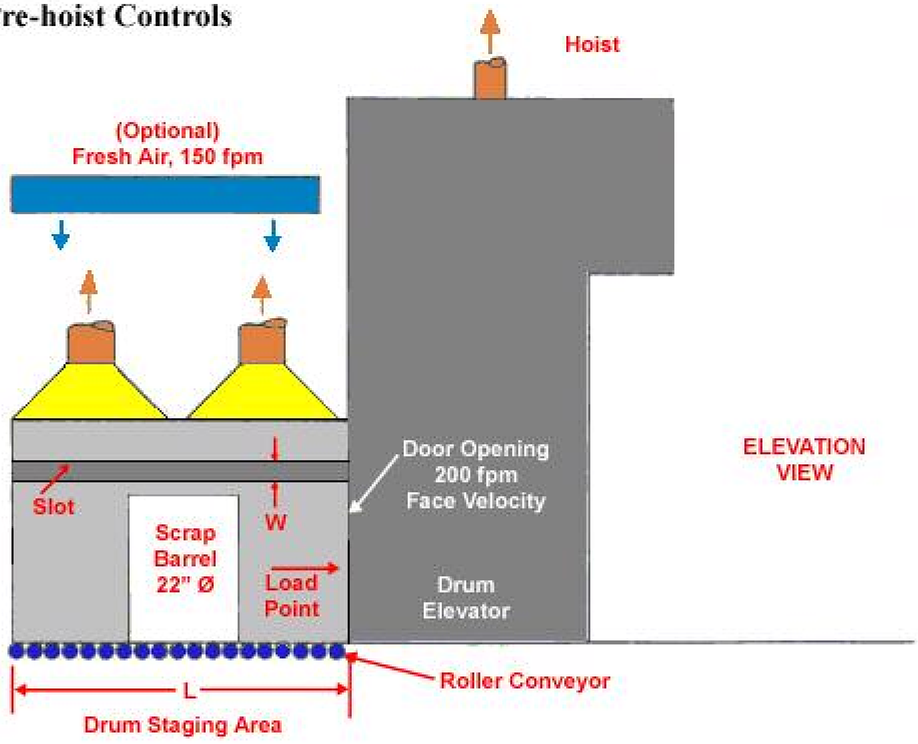
Regenerative Sweeper



Reverberatory Furnace



Scrap Barrel
Pre-hoist Controls



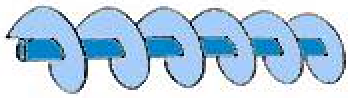
W = 0.25' (Typical)

$V_{SLOT} = 2000$ fpm

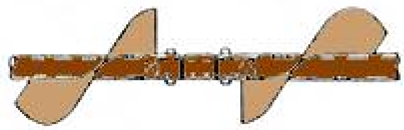
$Q = 2000 \cdot W \cdot L$

$h_e = 1.78\ VP_{SLOT} + 0.25\ VP_{DUCT}$

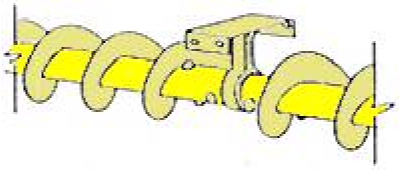
Conveyors -
Screw Conveyor Components



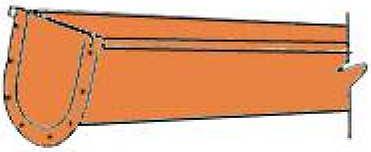
THE CONVEYOR SCREW imparts a smooth positive motion to the material as it rotates within the trough.



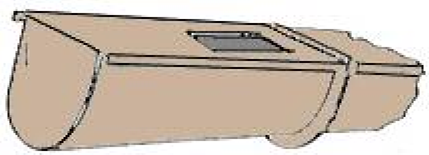
COUPLINGS AND SHAFT connect and transmit motion to subsequent screw conveyors. Held in place by self-locking Tem-U-Lac bolts.



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

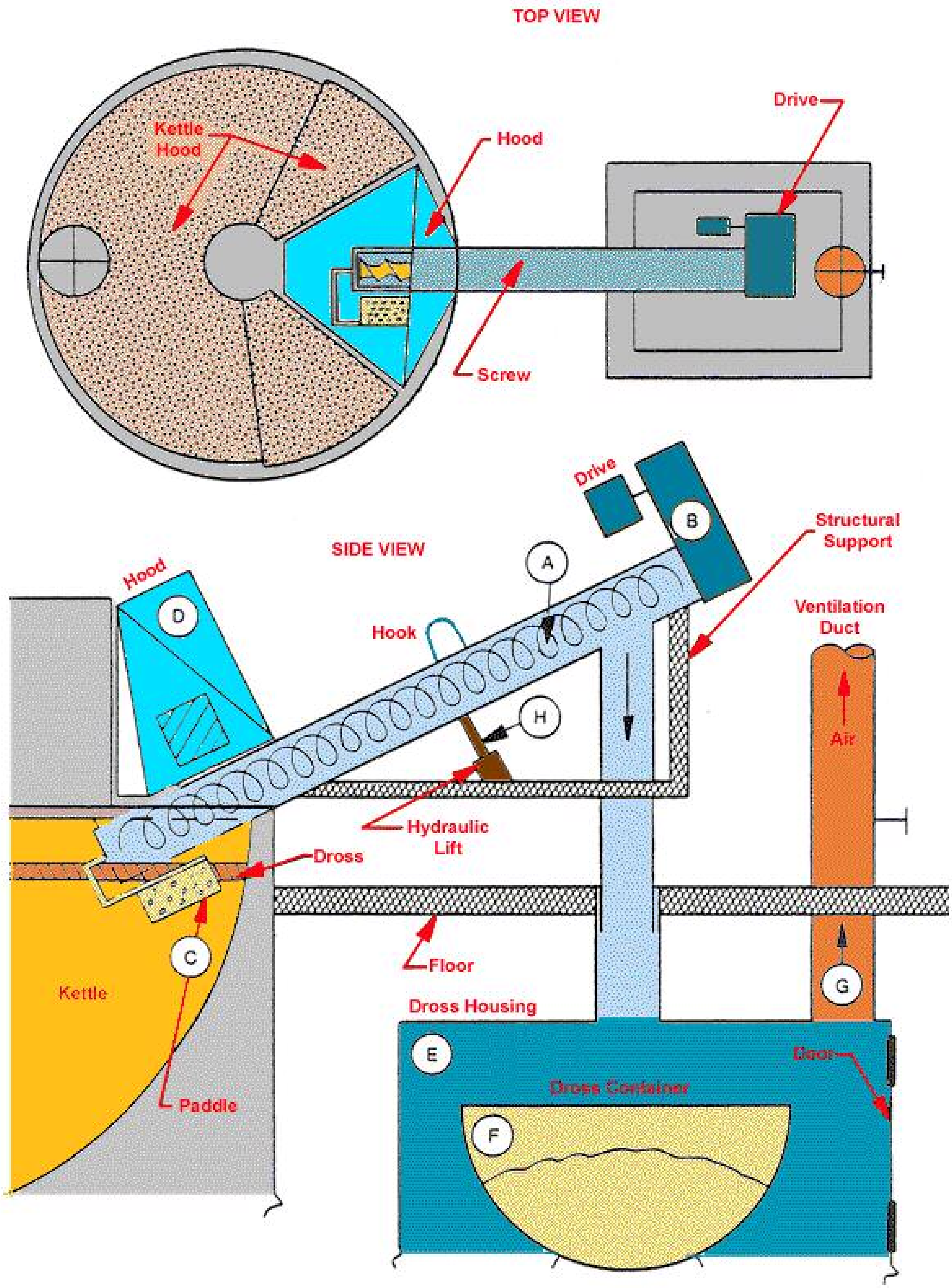


TROUGHS AND CONVEYORS completely enclose the material being conveyed and the rotating parts. Covers are availavle in various types and are secured to the trough by Spring, Screw, Tite-Seal or quick-acting Barron Clamps depending on the trough being used.

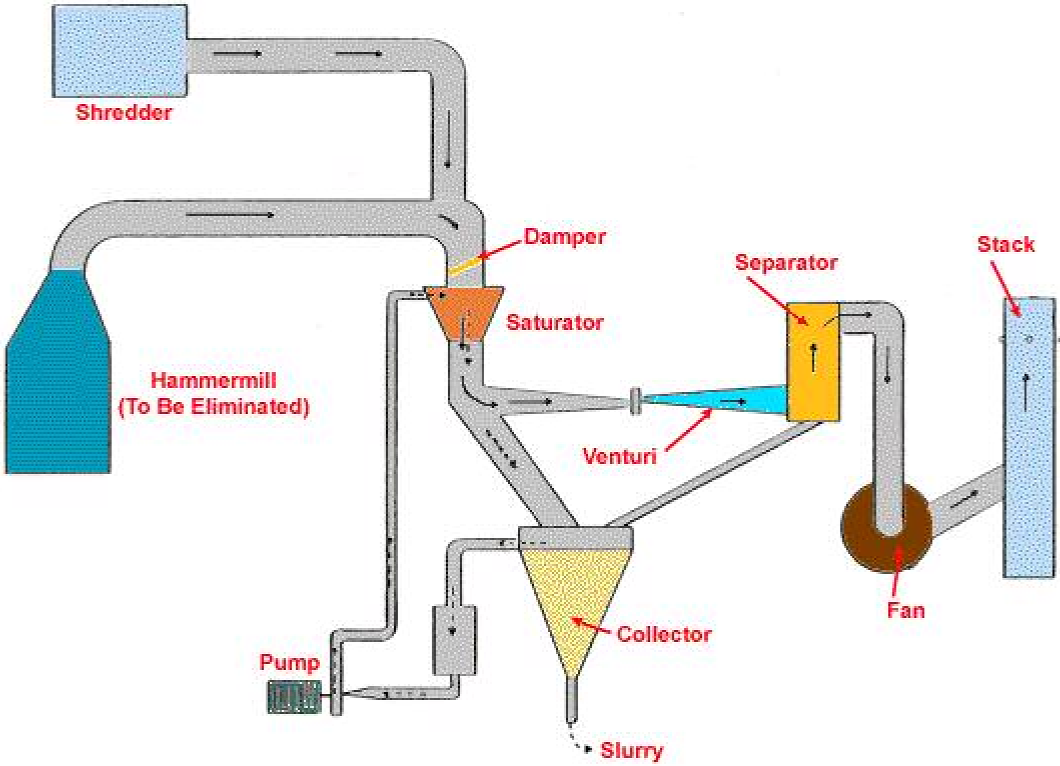


INLET AND DISCHARGE OPENINGS may be located wherever needed, discharge spouts may be without slides or fitted with either flat or curved slides. These slides may be operated by hand, rack and pinion gears, or by power.

Screw Drossing

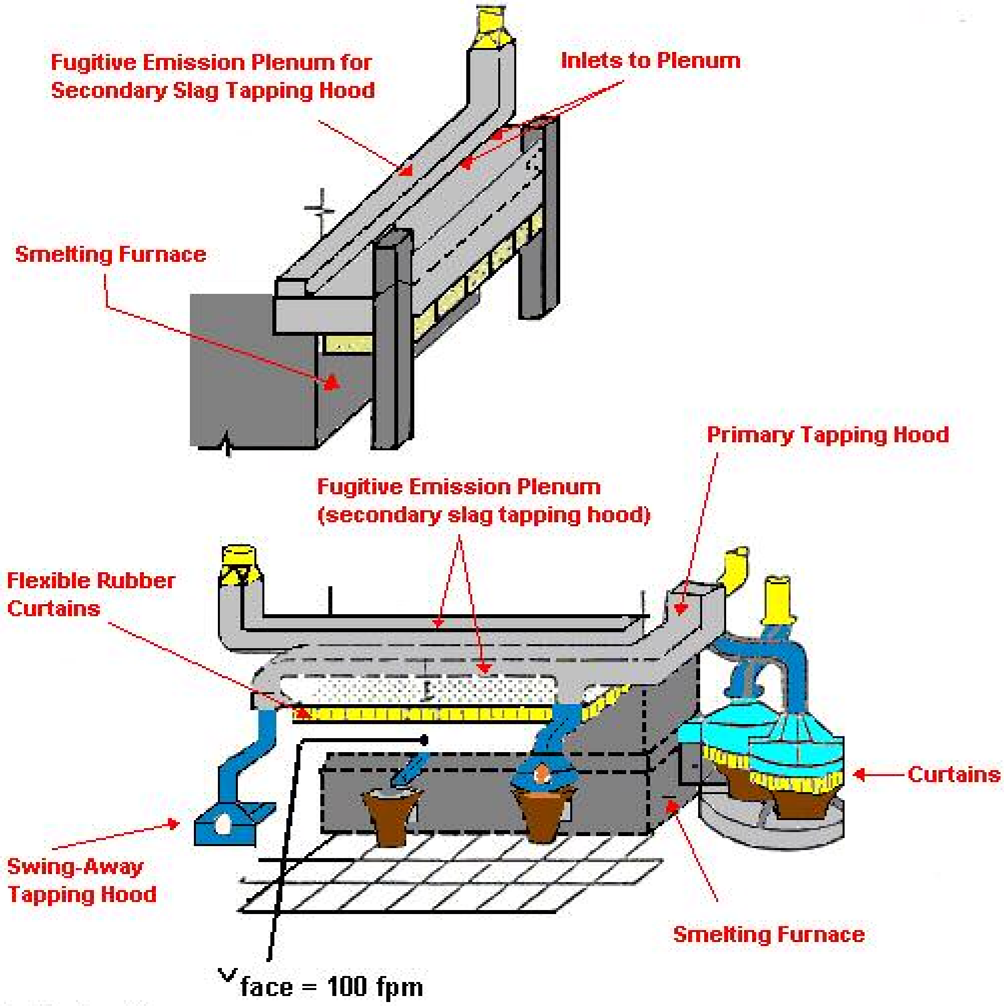


Scrubber



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

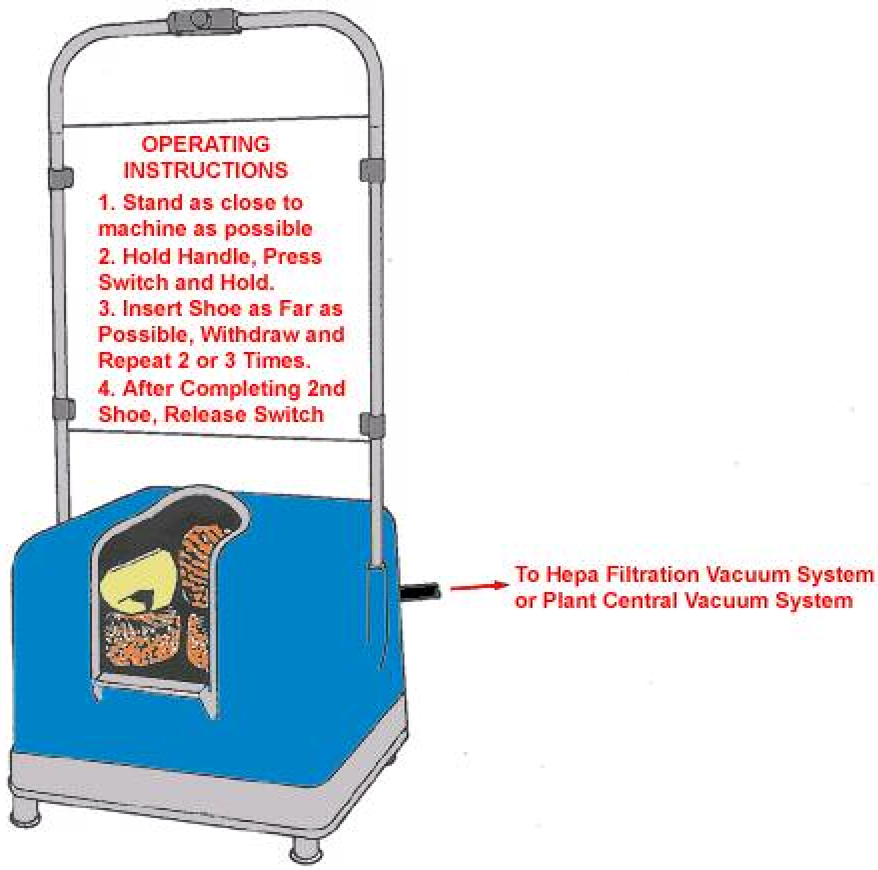
Design Characteristics:

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)

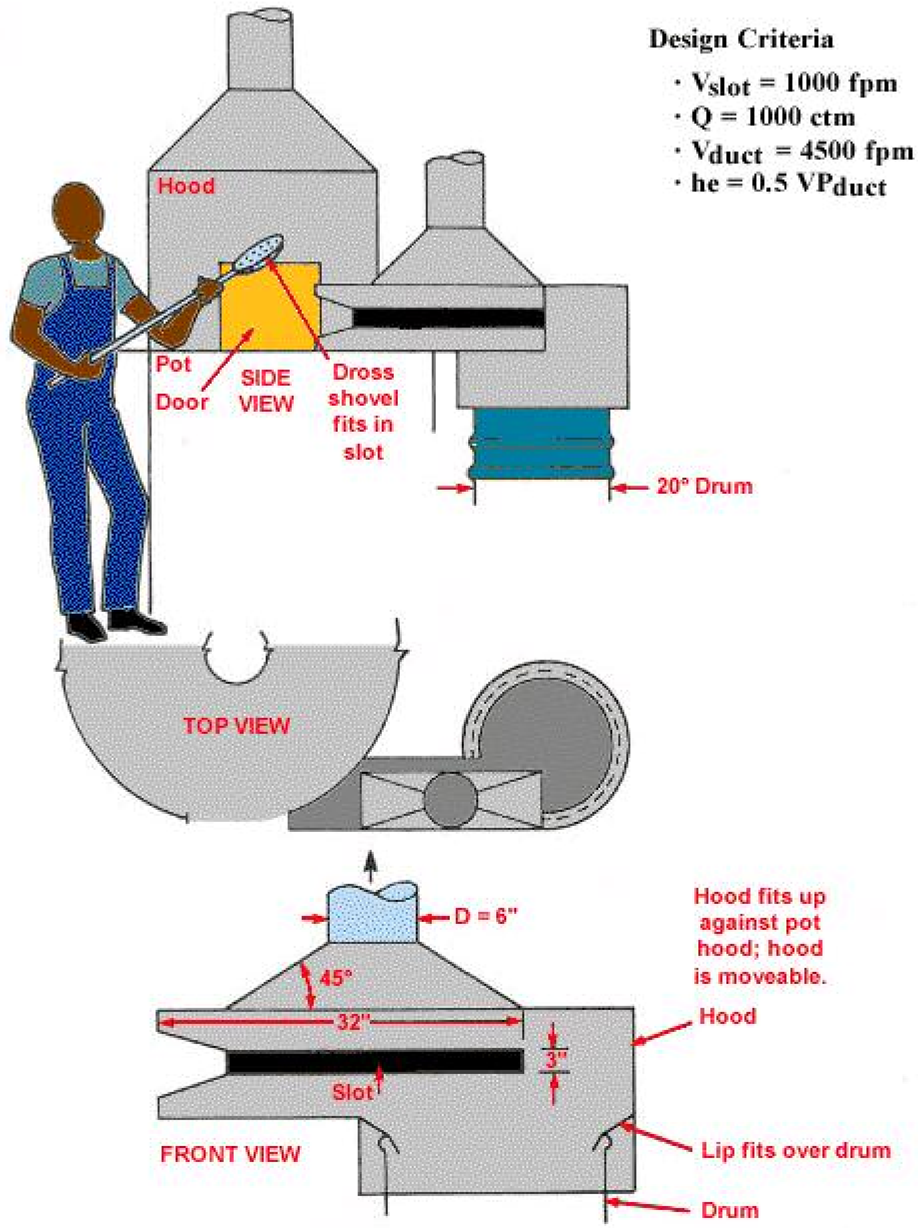
he = 2.2VP

Shoe Cleaning Machine



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

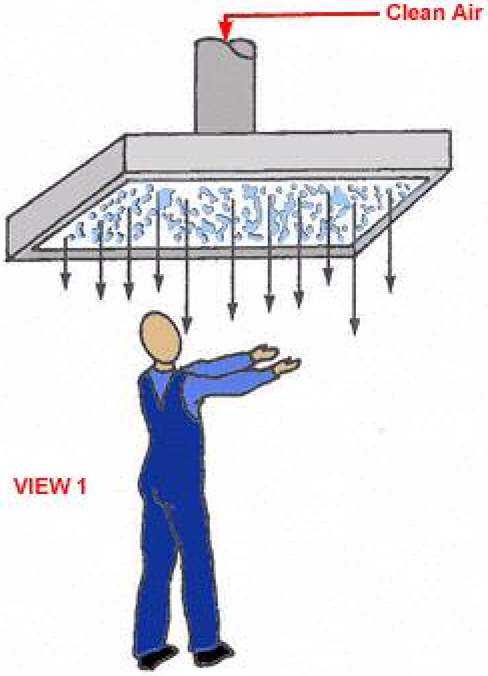
Scrap Handling Remelt Pot and Slag/Dross/Skim Hood



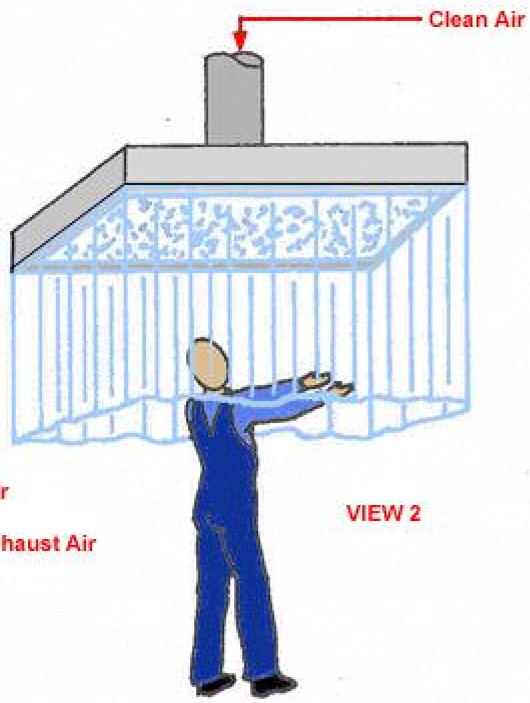
Design Criteria

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

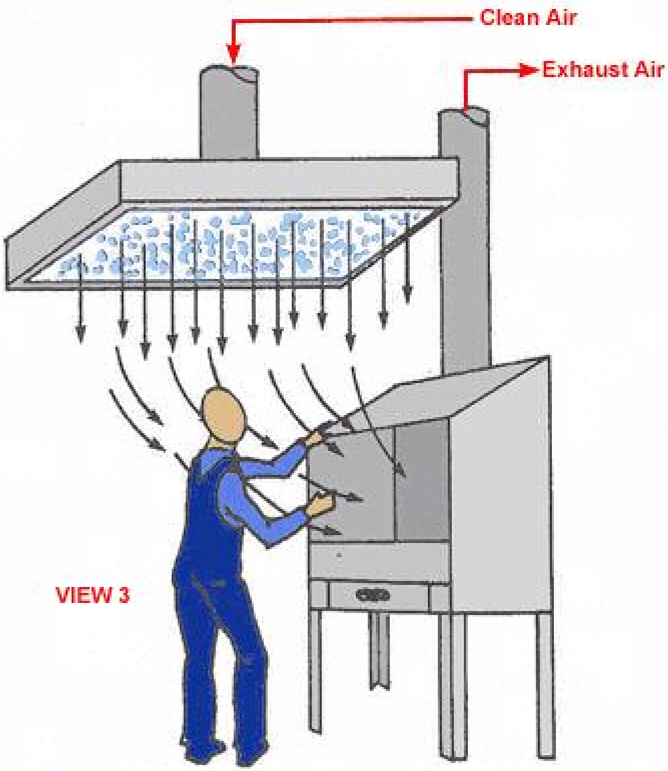
Supplied Air Island



VIEW 1

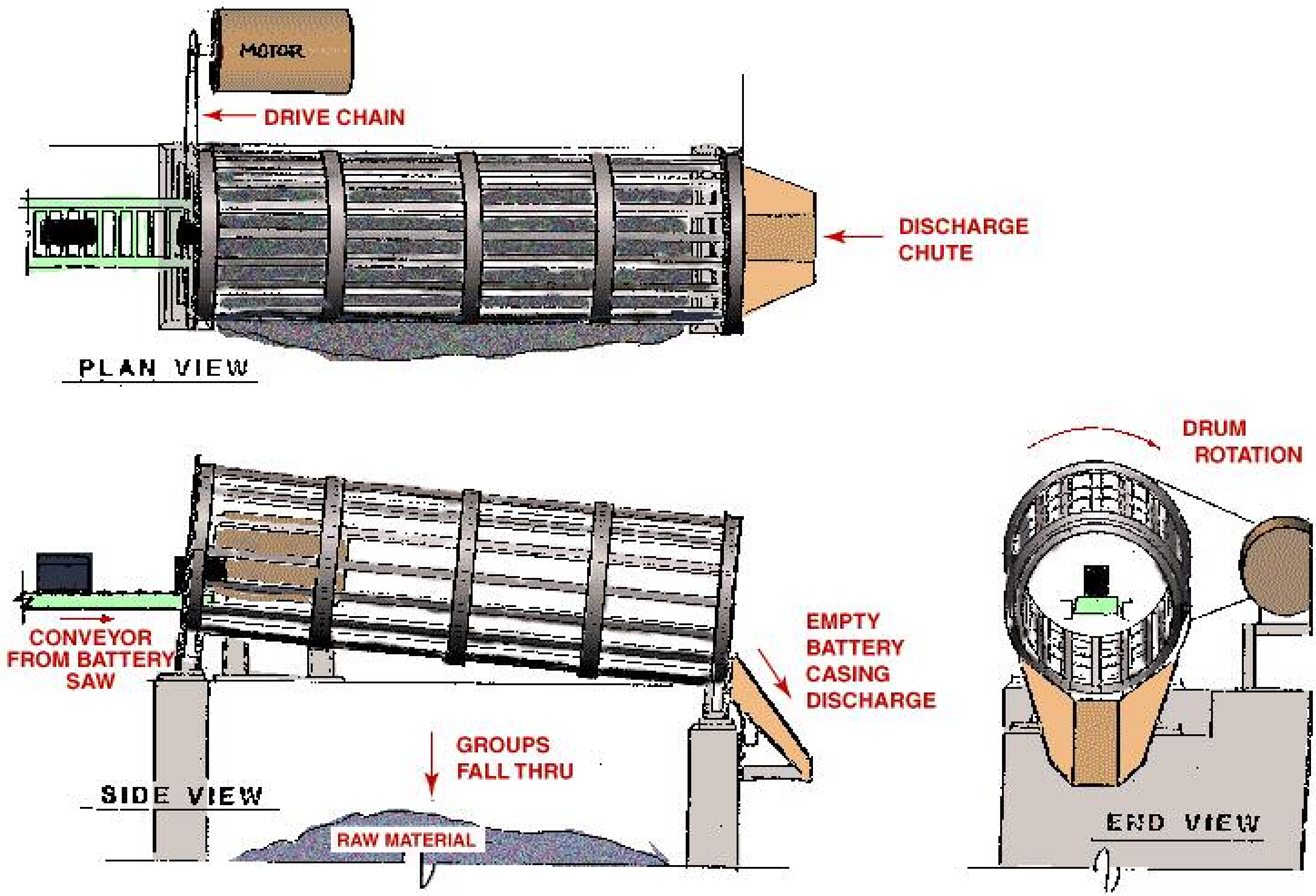


VIEW 2

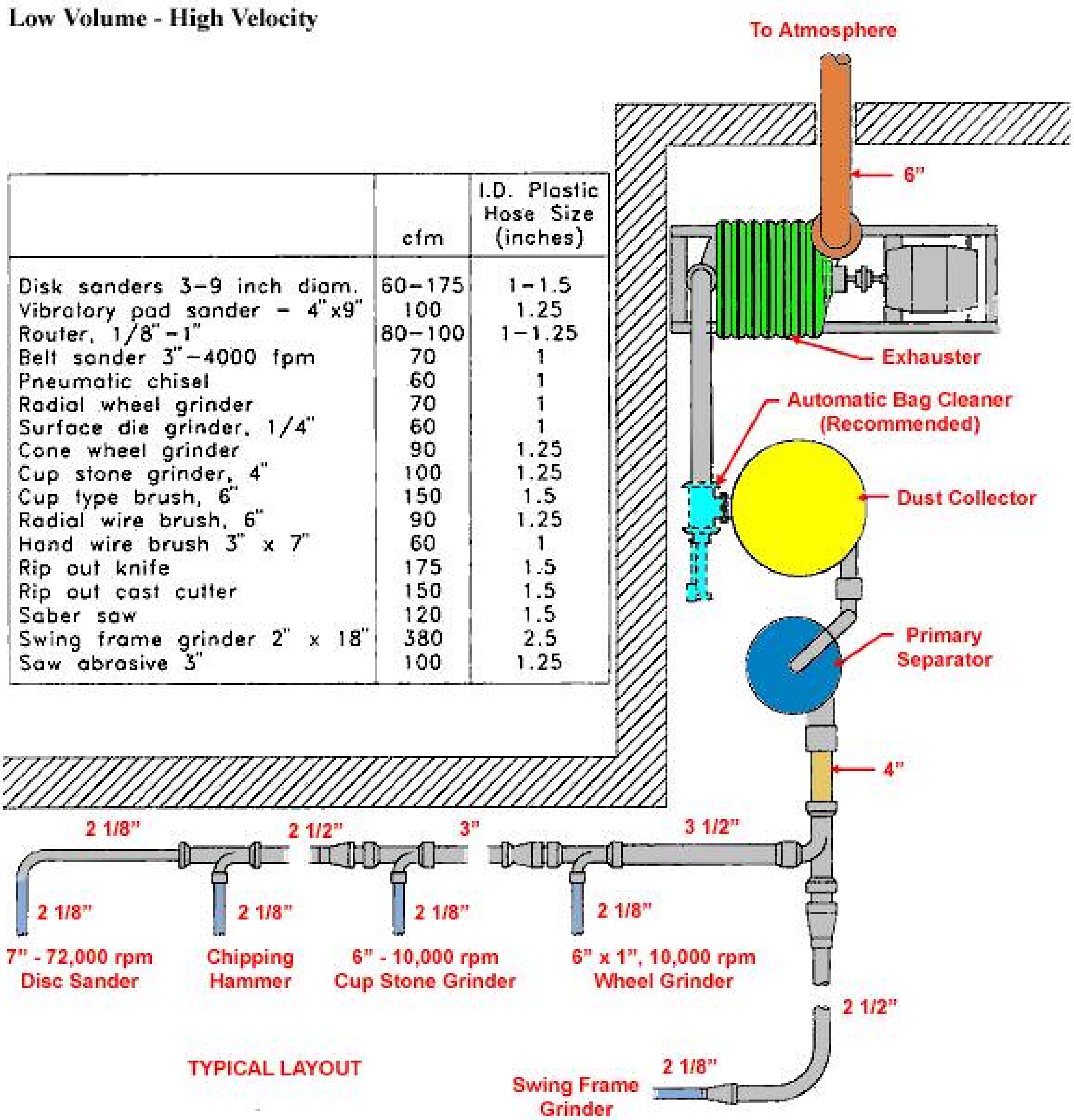


VIEW 3

Tumbler


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

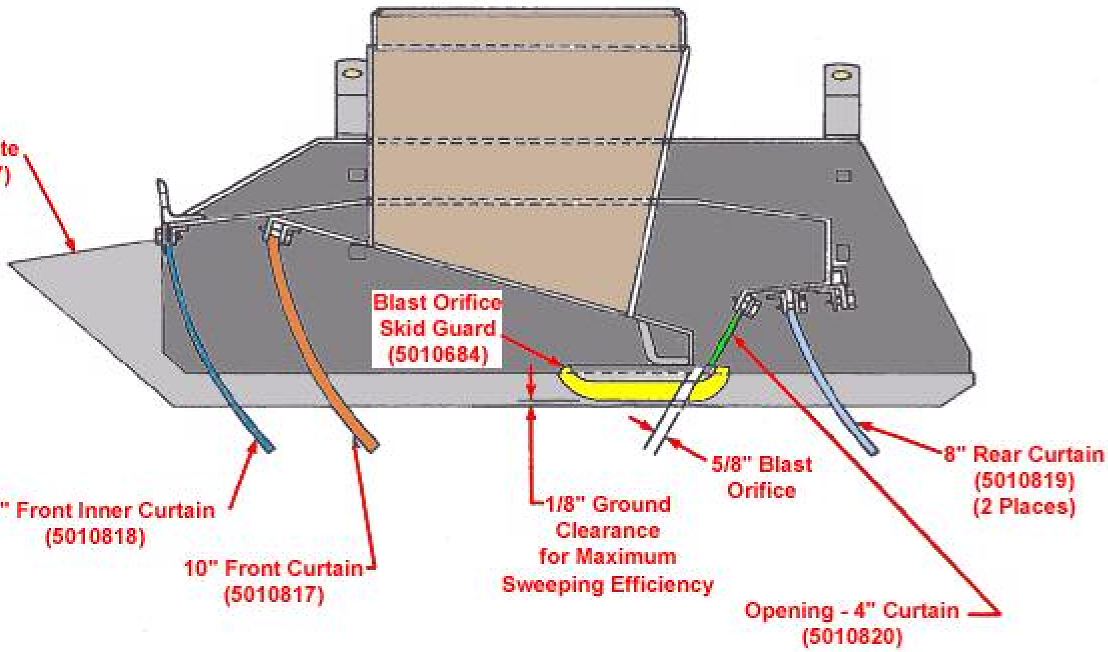
American Conference of Governmental Industrial Hygienists	Date: 10 - 90
	Figure: VS - 40 - 20

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 Nol40 pipe and cast iron drainage fittings, or heavier, should be used in place of tubing.

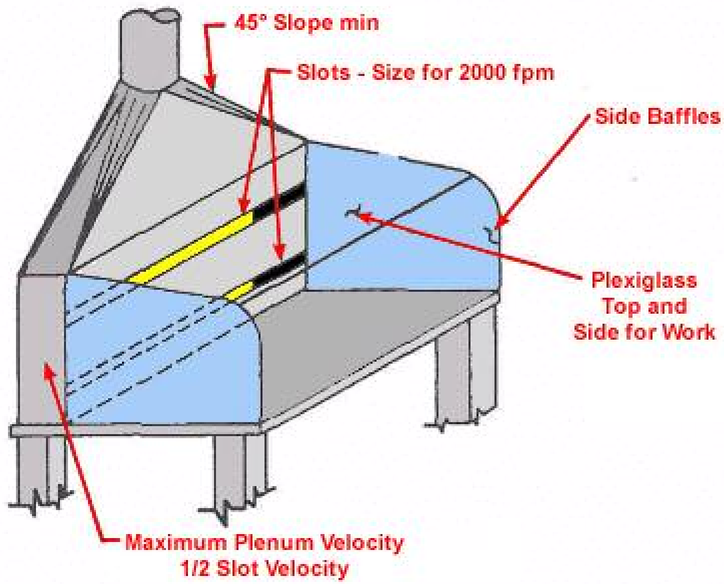
Vacuum Truck
Mobile Vacuum



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

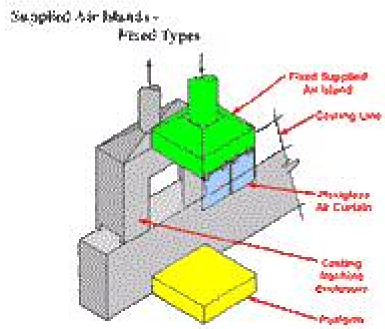
Engineering Controls > Supplied Air Island and Clean Air Rooms

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

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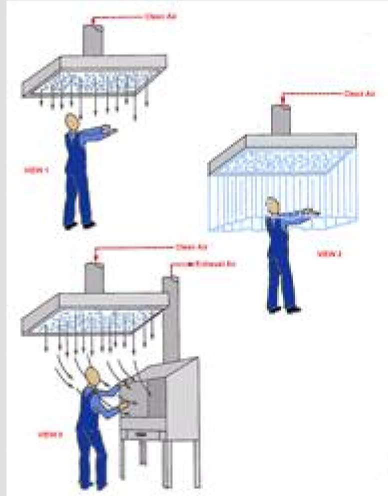
designed so that the velocity measured at the employee's breathing zone is 100-150 feet per minute. Higher velocity may stir up lead dust. SAIs can be used in conjunction with exhaust- ventilated work benches. In this case, the air should be balanced so that make-up air is provided equal to the amount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

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Process Controls

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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.

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OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities

The OSHA Lead Standard addresses specific requirements for the following:

- Protective Clothing and Equipment
- Housekeeping
- Hygiene Facilities

Locker Room

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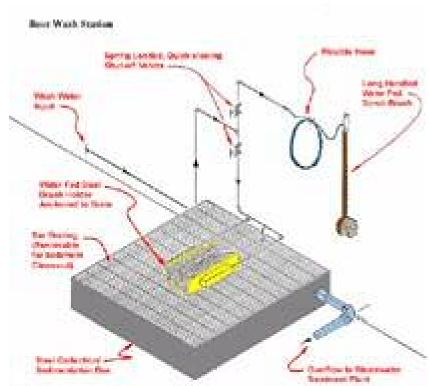
Lead > Secondary Lead Smelter eTool

OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities > Protective Work Clothing and Equipment

Appropriate personal protective equipment and clothing limits lead exposure. OSHA requires the following for:

- Clothing and Equipment



Click for larger view of boot wash station diagram

Clothing and Equipment

- The following protective clothing and equipment must always be used when lead levels are above the PEL: **(Fig. 1)** [1910.1025(g)(1)]
  - Coveralls or similar full-body work clothing; [1910.1025(g)(1)(i)]
  - Gloves, hats, and shoes or disposable shoe coverlets; and [1910.1025(g)(1)(ii)]
  - Face shields, vented goggles, and other appropriate protective equipment. [1910.1025(g)(1)(iii)]

Fig. 1. Appropriate PPE

- Clean and dry protective work clothing must be provided daily or weekly depending on exposure levels. [1910.1025(g)(2)(i)]
  - Cleaning, laundering, or disposal of protective clothing and equipment must be provided. [1910.1025(g)(2)(ii)]
  - Protective clothing and

equipment must be repaired or replaced as needed to maintain its safety and effectiveness. [1910.1025(g)(2)(iii)]

Fig. 2. Vacuum to remove lead from protective clothing

- All protective clothing must be removed at the end of a work shift in change rooms provided for that purpose. [1910.1025(g)(2)(iv)]
- Contaminated protective clothing, which is to be cleaned, laundered, or disposed of, must be placed in a closed, labeled container in the changing area. [1910.1025(g)(2)(v)]

Boot Wash Station Diagram

Shoe Cleaning Machine

Clothes Cleaning Air Shower Diagram

- Persons who clean or launder protective clothing or equipment must be informed in writing of the potentially harmful effects of exposure to lead. [1910.1025(g)(2)(vi)]

- Containers of contaminated protective clothing and equipment must be appropriately labeled. [1910.1025(g)(2)(vii)]
- Removal of lead from protective clothing or equipment by blowing, shaking, or any other means which disperses lead into the air is prohibited. [1910.1025(g)(2)(viii)] **(Fig. 2)**.

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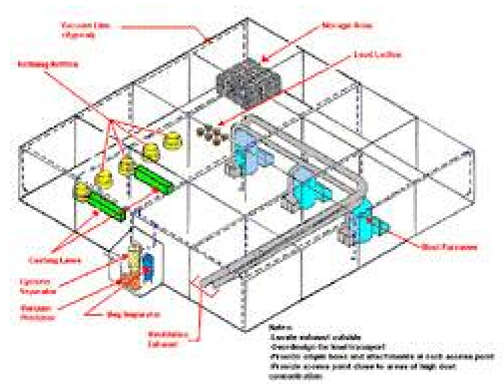
Lead > Secondary Lead Smelter eTool

OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities > Housekeeping

A rigorous housekeeping program is necessary to keep airborne lead levels as low as feasibly possible. OSHA requires the following regarding general housekeeping:

- OSHA Housekeeping Requirements
- Video Exposure Monitoring: Glove Removal
- Video Exposure Monitoring: Shoveling



Click for larger view of central vacuum system diagram

OSHA Housekeeping Requirements

- All surfaces must be maintained as free as practicable of accumulations of lead. [1910.1025(h)(1)]
- Floors and other surfaces where lead accumulates may not be cleaned by the use of compressed air. [1910.1025(h)(2)(i)]
- Shoveling, dry or wet sweeping and brushing may be used only where vacuuming or other equally effective methods have been tried and found not to be effective **(Fig. 1)**. [1910.1025(h)(2)(ii)]
- Where vacuuming methods are selected, the vacuums shall be used and emptied in a manner which minimizes the reentry of lead into the workplace. [1910.1025(h)(3)]

Fig. 1. Vacuum instead of sweep

▶ Central Vacuum Diagram

▶ Regenerative Sweeper Diagram

▶ Vacuum Truck Diagram

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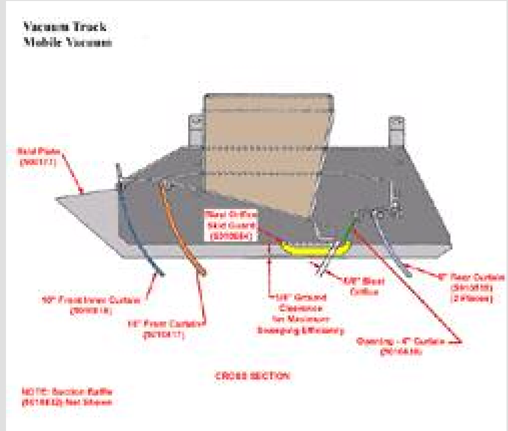

Click for larger view of vacuum truck diagram

Video Exposure Monitoring: Glove Removal

With video exposure monitoring (VEM), worker exposures to lead are monitored and recorded with a direct reading instrument. At the same time, work place activities are recorded on a video tape. The right hand bar indicates changes in total dust concentrations over time.

As the employee removes the protective gloves, the increasing red bar indicates that the employee is exposed to lead due to dispersion of lead from the surface of the improperly cleaned or stored gloves.

Low Bandwidth Video

Dial up Modem, ISDN

High Bandwidth Video

LAN, DSL, T1, T3

Note: This example illustrates the level and duration of exposure to total dust and is used to show how VEM can be used for determining sources of employee exposure. Other sources of employee lead exposure can be determined by using VEM sampling for a full work shift.

Video Exposure Monitoring: Shoveling

With video exposure monitoring (VEM), worker exposures to lead are monitored and recorded with a direct reading instrument. At the same time, work place activities are recorded on a video tape. The right hand bar indicates changes in total dust concentrations over time.

As the employee shovels the slag during cleanup and places it into the slag pot for disposal, the increasing red bar indicates that the employee is exposed because lead dust is inadequately captured when the slag is shoveled and dumped into the pot.

Note: This example illustrates the level and duration of exposure to total dust and is used to show how VEM can be used for determining sources of employee exposure. Other sources of employee lead exposure can be determined by using VEM sampling for a full work shift.

Low Bandwidth Video
Dial up Modem, ISDN

High Bandwidth Video
LAN, DSL, T1, T3

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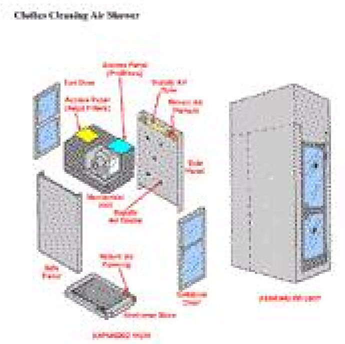
OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities > Hygiene Facilities

Lunch rooms, break rooms, and control rooms in secondary smelting plants should exhibit low ambient lead levels. The following are OSHA requirements that have been established for the provision and maintenance of:

- Hygiene Facilities

Hygiene facility diagram



Click for larger view of clothes cleaning air shower

Hygiene Facilities

- Food, beverage, and tobacco products must not be present or consumed, and cosmetics must not be applied, except in change rooms, lunchrooms, and showers. [1910.1025(i)(1)]
- Clean change rooms must be provided **(Fig. 1)**. [1910.1025(i)(2)(i)]
  - Change rooms must be equipped with separate storage facilities for protective work clothing and equipment and for street clothes. [1910.1025(i)(2)(ii)]
- Employees exposed to lead above the PEL must shower at the end of the work shift. [1910.1025(i)(3)(i)]
  - Shower facilities must be provided. [1910.1025(i)(3)(ii)]
  - Employees must not leave the workplace wearing any clothing or equipment worn during the work shift. [1910.1025(i)(3)(iii)]
- Lunchroom facilities must be

Fig. 1. Change room

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provided for employees **(Fig. 2)**. [1910.1025(i)(4)(i)]

  - Lunchroom facilities must have a temperature-controlled, positive- pressure, filtered air supply. [1910.1025(i)(4)(ii)]

  - Employees must wash their hands and face before eating, drinking, smoking or applying cosmetics **(Fig. 3)**. [1910.1025 (i)(4)(iii)]

Fig. 2. Lunchroom

- Employees must not enter lunchroom facilities with protective work clothing or equipment unless surface lead dust has been removed by vacuuming, down draft booth, or other cleaning method. [1910.1025 (i)(4)(iv)]
  Clothes Cleaning Air Shower Diagram

Fig. 3. Hand wash station

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Lead > Secondary Lead Smelter eTool

Scope

This eTool is designed to assist the secondary lead smelting industry in identifying potential engineering and work practice controls to reduce employee lead exposure. It is the employer's responsibility to evaluate the sources of exposure and the controls necessary for their particular operation in order to reduce employee lead exposure to the lowest feasible level [1910.1025(e)(1)]. The sources of exposure can be identified through task analysis sampling or through video exposure monitoring.

The engineering and work practice controls listed in this eTool are intended as guides for design purposes and apply to typical operations in secondary lead smelters. Many of the controls have been shown to reduce employee lead exposure and are provided to assist employers and employees in complying with the OSHA Lead Standard. Not every control presented will be applicable to all lead smelters without modifications because of special conditions such as work place constraints, cross-drafts, motion, differences in temperature, or use of other means of contaminant suppression. Additionally, other controls not presented in this eTool may exist, which may be applicable to a particular smelter.

It is the employer's responsibility to acquire industrial hygiene and ventilation expertise to evaluate sources of employee exposure, and to design, install, operate and maintain exhaust ventilation systems according to recognized industrial hygiene practices. These practices can be found in publications such as the American Industrial Hygiene Association and the American Conference of Governmental Industrial Hygienists.

Respiratory protection and medical surveillance are not addressed in this eTool, but are required for the following; compliance with the Lead Standard, controlling lead exposure levels, and preventing lead-related disease. Please refer to the following for more information:

- 29 CFR 1910.1025 - Lead. OSHA Standard
    - 29 CFR 1910.1025(f) for respiratory regulations
    - 1910.1025(j) for medical surveillance
- Respiratory Protection Safety and Health Topic
- Respiratory Protection eTool
- Medical Surveillance Safety and Health Topic

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Disclaimer

eTools are "stand-alone", illustrated, Web-based training tools on occupational safety and health topics. As indicated in the disclaimer, eTools do not create new OSHA requirements.

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Scope: Source Identification Protocol

Source Identification Protocol

Each smelter has literally hundreds of sources of emission, any of which might contribute to an employee's overall daily exposure. Because of limited technical and financial resources, it is often necessary to prioritize control needs and implement controls on a step-wise fashion. This requires planning so that controls can be applied on a true "worst-case first" basis.

Therefore, a systematic evaluation of emissions, exposures, contributors to exposure, optional controls, and costs of controls should be made prior to any attempt to install engineering controls. This will save time, money, and provide the most cost-effective application of controls and give the optimum control for the money spent.

The following is an inexpensive assessment procedure:

1. Employee exposures are measured using 8-hour time-weighted average, breathing zone sampling techniques (8-hour, TWA-BZ). Standard methods for sampling and analysis are available from OSHA's Salt Lake Technical Center at:

   www.osha.gov/dts/sltc/methods/index.html

2. An emission inventory is conducted to identify all potential emissions to the work environment. This inventory qualitatively identifies emission sources which potentially contribute to employee exposure. The second plan view on the figure "Source Characterization" (Figure 1) demonstrates the approach.

3. Employee work practices, work locations, and air movements are studied to determine potential contact with emissions. See, for example, the third and fourth plan view on Figure 1.

4. Based on the available information, the industrial hygiene engineer ranks emission sources in order of contribution to exposure. If enough information is available, percentage contribution of emissions may also be estimated. Spot examples (short term) may be taken to confirm the estimate.

Major data inputs to these methods are:

- Employee exposure levels
- Area monitoring results
- Local emission source characterization
- Work practices and geographical location of employee throughout shift
- Employee interviews concerning emissions, work practices, and upset conditions
- Air flow patterns in the work area
- Plant engineering appraisals of the relative importance of emissions sources. (See Example Appraisal Form)

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Sample Calculation:

If a yardman works 7 hours in the yard (average lead value from area samples: 60 $\mu g/m^3$) and one hour in the bedding area (average lead value: 500 $\mu g/m^3$), is the bedding operation the major contributor to exposure? To "quantify" the contribution, it is possible to calculate the expected exposure level and the

$$\mathbf{TWA} = \frac{(7)(60) + (1)(500)}{(8)} = 115\ \mu g/m^3$$

relative contribution of each major source (420 hr × $\mu g/m^3$ vs. 500 hr. × $\mu g/m^3$, or 45% from the yard and 55% from the bedding operation). Now, to verify this estimate, we can imagine the monitoring records for the yardman. If the average TWA exposure level is near 115 $\mu g/m^3$, then we have some evidence to support our calculations. If the actual exposure level is higher, or lower, we should go back to the beginning and evaluate the initial assumptions (thereby possibly identifying other sources contributing to the worker's exposure, or making an adjustment in the initial exposure assumptions).

Having identified the major contributor, we can now make a judgment for control (i.e., should yard emissions be controlled? How much control of each emission source can be achieved? What control will give the greatest reduction of lead levels versus the number of employees exposed?).

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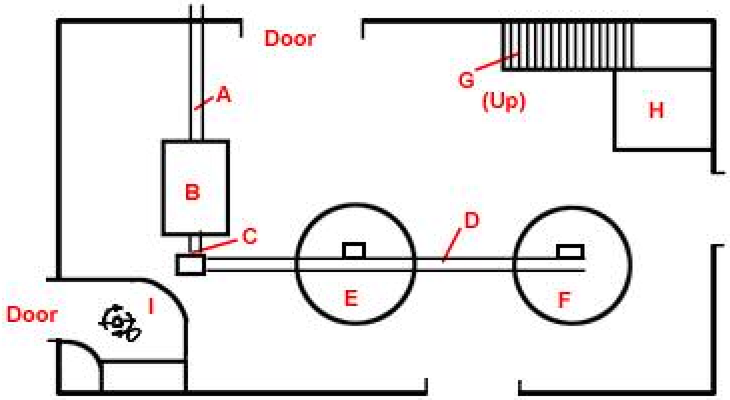
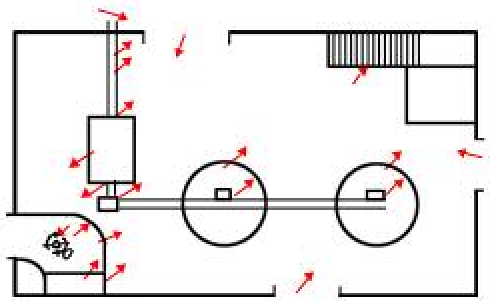
Figure 1: Source Characterization

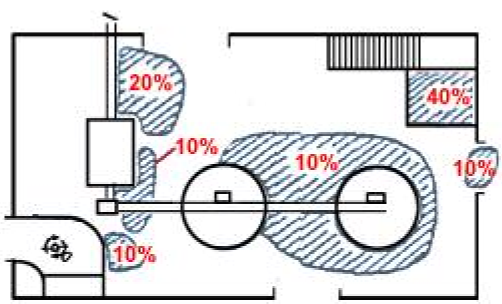


A. Conveyor belt
B. Dryer
C. Launder, conveyor
D. Screw conveyor
E. Hopper
F. Hopper
G. Stairway
H. Control room
I. Front-end loader



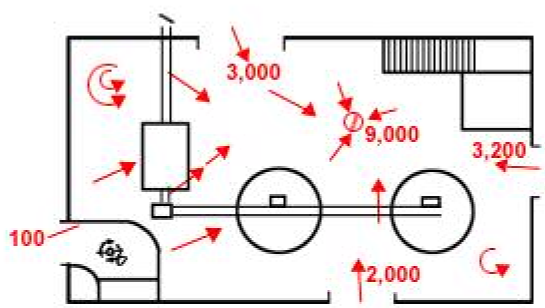
Emission Sources

(Includes re-entrainment and background)



Employee Work Areas

Figures are % of time in area



Air Flow Patterns

Figures are air volumes in cfm

Example Appraisal Form

Name:

Job:

Location:

Emission Source	Rank in Order of "Largest Source" of Lead to Atmosphere	Approx.% Contribution of Lead to Atmosphere	Rank in Order of Greatest Contributor to Exposure	Approx. % Contribution of Lead to Employee Exposure

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Definitions

ACGIH - American Conference of Governmental Industrial Hygienists

Agglomerating furnace - A furnace used to melt into a solid mass flue dust that is collected from a baghouse

ANSI - American National Standards Institute

ASME - American Society of Mechanical Engineers

Action level - Exposure to a level of airborne contamination that requires an employer to implement some, but not all, of the surveillance and control activities of an OSHA standard. The action level is usually equal to one-half of the permissible exposure level. An exception is the action level for lead, which is 30 micrograms per cubic meter of air as compared to the permissible exposure limit of 50 micrograms per cubic meter of air.

Battery breaking area - The plant location at which lead-acid batteries are broken, crushed, or disassembled and separated into components.

Baghouse - The structure housing the bags of tubular or envelope shaped fabric filter, used for the high-efficiency collection of solid particulate (i.e., dust and fumes) from a contaminated air stream/gas stream.

Blast furnace - Blast furnaces are reduction furnaces that produce hard or antimonial lead containing about 10% antimony. Pretreated scrap metal, rerun slag, scrap iron coke, recycled dross, flue dust, and limestone are used as charge materials to the blast furnace. The process heat needed to melt the lead is produced by the reaction of the charged coke with blast air that is blown into the furnace near the bottom through tuyeres. Some of the coke combusts to melt the charge, while the remainder reduces lead oxides to elemental lead.

Charging location - The physical opening through which raw materials are introduced into a sinter machine or furnace.

Charge - Material introduced into a furnace to be smelted or refined.

Converter - Steel shells lined with magnesite brick. Converters are used to purify the matte after smelting.

Cupola furnace - A refractory-lined, vertical, cylindrical shaft furnace equipped with air ports (known as tuyeres) at the bottom. Air is supplied from a forced- draft blower. Melting is accomplished in the cupola by heat released from the combination of coke (the reaction between oxygen in the air and carbon in the fuel) that is in direct contact with the metallic portion of the charge and the fluxes. The molten metal is drawn off through a taphole.

Dross - A scum formed on the surface of molten metal. Dross refers to the lead oxides, copper, antimony, and other elements that float to the top of the molten lead.

Dryer - A chamber that is heated and that is used to remove moisture from lead-bearing materials before they are charged to a smelting furnace.

Enclosure hood - A hood that covers a process fugitive emission source on the top and on all sides, with openings only for access to introduce or remove materials to or from the source and through which an induced flow of air is ventilated.

Flux - Any of a variety of materials used to purify metals or prevent undue oxidation of molten metal surfaces. It is a substance used to aid in the extraction of a furnace charge because of its ability to fuse with undesired matter (impurities/contaminants) in forming a more liquid slag.

Fugitive dust source - A stationary source of hazardous air pollutant emissions at a secondary lead smelter resulting from the handling, storage, transfer, or other management of lead-bearing materials where the source is not associated with a specific process or process fugitive vent or stack. Fugitive dust sources include, but are not limited to, roadways, storage piles, and materials handling transfer points, materials transport areas.

Hammermill - A machine designed for the crushing of complete full lead acid storage batteries and for the classification of their components. It produces plastic, paste, grid metal. and waste organic fractions and avoids the hazardous, time consuming procedure of sawing and dumping prior to classification.

Ladle - A large vessel for receiving and handling molten metal and slag.

Matte - A valuable metal concentrate. It is an impure metallic sulfide mixture produced by smelting the sulfide ores of such metals as copper, lead, or nickel.

Pigging machine - A metal casting machine which pours molten metal into molds to form ingots.

Primary smelting - Pyrometallurgical processes that utilize high temperatures and are accompanied by chemical changes. Primary smelters process sulfide concentrates, sulfates, oxides, and metallic scrap.

Refining kettles - Top-access pots sunk into the refinery floor. Refining kettles can purify the metal taken from the smelting furnace, or scrap lead supplied in clean metallic form (e.g., sheet or pipe) to remelt and refine without having to undergo smelting.

Refractory - A term used to describe materials with a high melting point that will retain its shape and chemical identity when subjected to high temperatures, and is used in applications that require extreme resistance to heat, such as furnace linings. Brick and ceramic are examples of refractory materials.

Reverberatory furnace - A furnace, with a shallow hearth, operating by radiating heat from its burner flame, a roof, and walls onto the surface of the charge (material being heated). This type of furnace may be gas fired or oil fired, or a combination of both. Combustion of fuel occurs directly above the molten bath. The reverberatory furnace is used to separate lead from scrap metal as well as to reclaim lead from oxides and drosses.

Secondary lead smelting - Secondary smelting produces lead and lead alloys from lead-bearing scrap metal. Raw materials used in secondary lead smelting include scrap automobile batteries, wheel balance weights, pipe, solder, drosses, and lead sheathing.

Slag - A product resulting from the interaction of flux and impurities in the refining and smelting of metals. The fluxing agent aids in separating the molten lead from the impurities, and forms a slag which floats on top of the molten metal.

TWA - Time-weighted average.

Tapping - The process of opening the pouring of a melting furnace to remove molten metal and slag. The molten metal is poured into molds or ladles.

Tuyere - An opening in the shell and refractory lining of a furnace through which air is forced.

Tuyere Punching - The process of cleaning the tuyere. Tuyere punching is achieved by an operator or "puncher" driving and withdrawing a punch-bar through the tuyere with sufficient force to penetrate and dislodge the adhering frozen solids. Manual tuyere punching has generally been replaced by an automated punching machine which mimics and enhances the human action of tuyere punching.

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