Lead > Secondary Lead Smelter eTool

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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Lead > Secondary Lead Smelter eTool

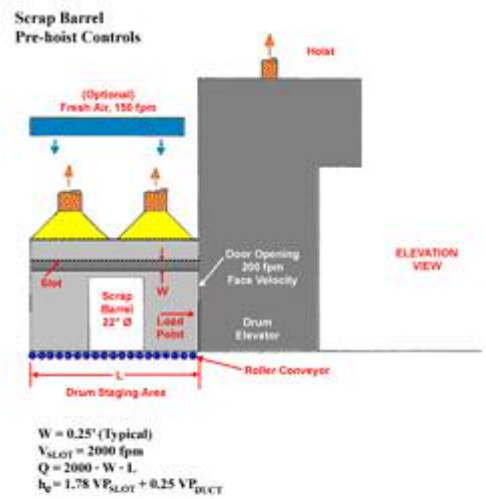
Raw Materials Processing > Raw Materials Receiving and Storage

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

eTool Home

Raw Materials Processing
Receiving and Storage
Battery Breaking/ Separating
Charge Preparation
Handling and Transport
Smelting
Refining and Casting
Environmental Controls
Maintenance
Engineering Controls
OSHA Lead Requirements ...

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

- 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

- 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.

- 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.

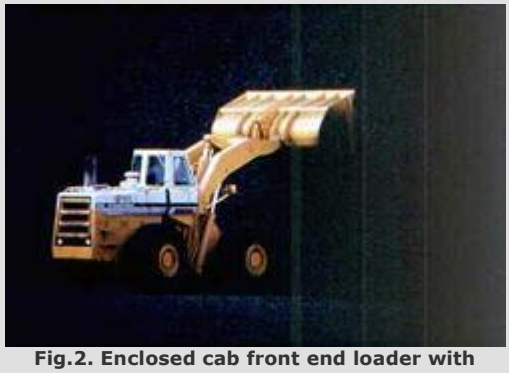


Fig.2. Enclosed cab front end loader with filtered air system

Fig. 3. Enclosed raw material storage

Fig. 4. Sweeper for paved roads

- 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.

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.

Fig. 5. Tetra ethyl lead (TEL) storage

eTool Home	Raw Materials Processing	Smelting	Refining and Casting
Environmental Controls	Maintenance	Engineering Controls	OSHA Lead Requirements
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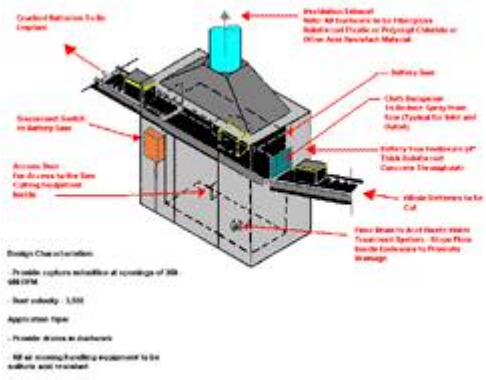
Lead > Secondary Lead Smelter eTool

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

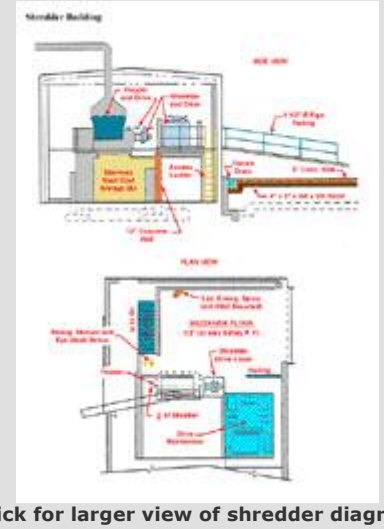
The use of saws and shears involves cutting the tops off of the batteries, then dumping the contents of the battery. The whole battery crushing process involves crushing the entire battery in a crusher, shredder or hammermill, and separating the components by gravity separation.

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.

- 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

- 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.

Fig.1. Enclosed and exhaust ventilated hammermill

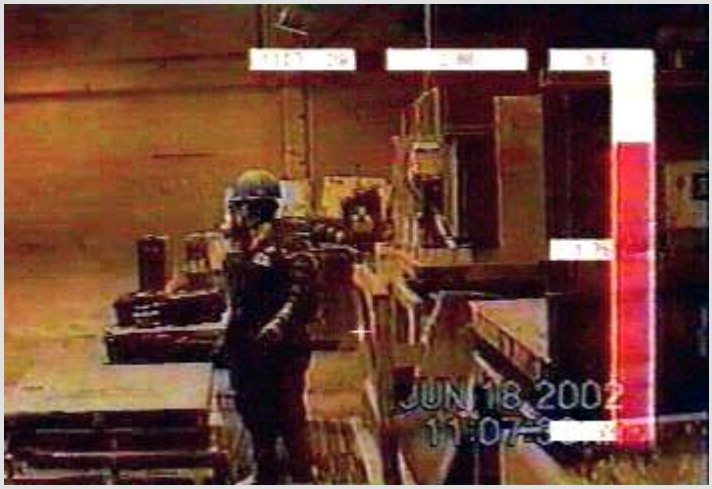
- Provide adequate make-up air.

- 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.

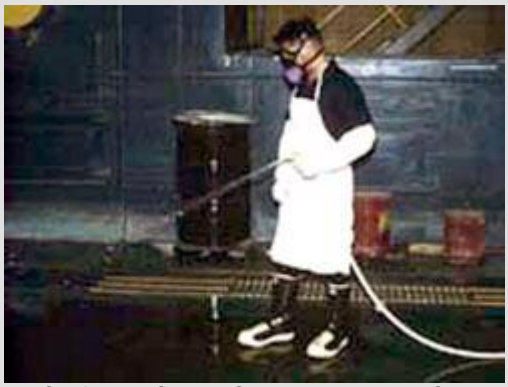

Fig. 2. Wetting surfaces to suppress dust generation

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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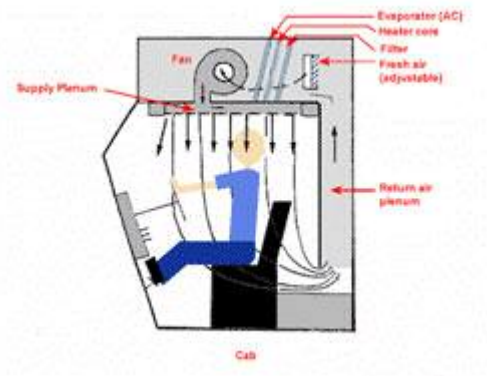
Lead > Secondary Lead Smelter eTool

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

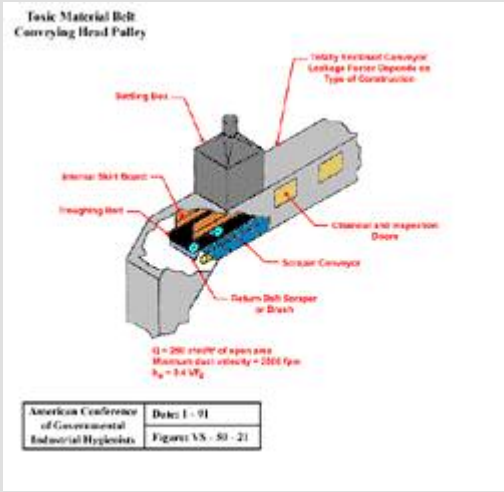
Belt conveying systems can be used to transport furnace feed material from storage to battery shredders and the furnace charging area.

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

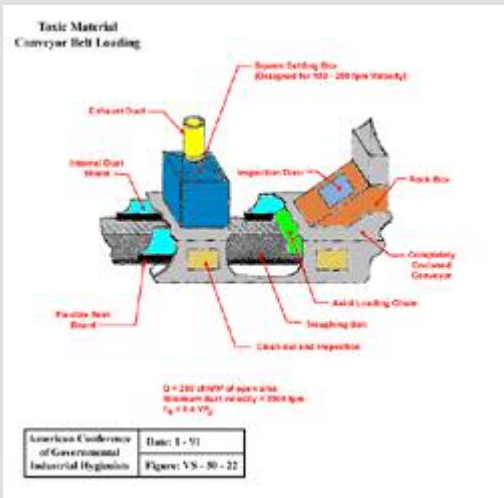
Possible Engineering and Work Practice Controls:

- 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
- 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.



Click for larger view of conveyor belt loading diagram

- 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

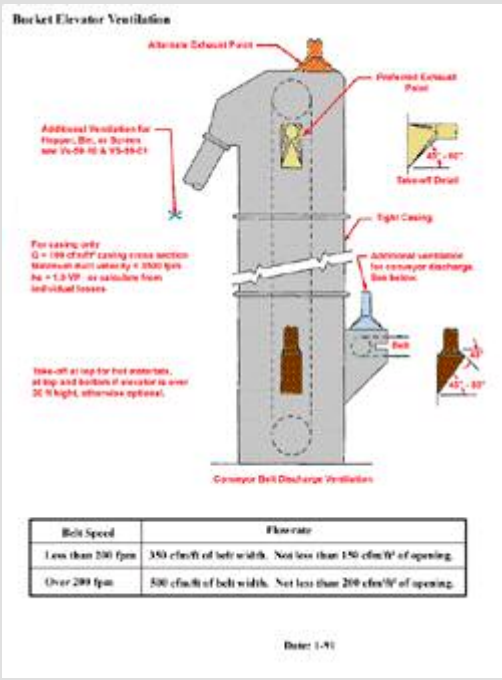
Commercially available bucket elevators and drag chains may be used in conjunction with some material handling operations.

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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