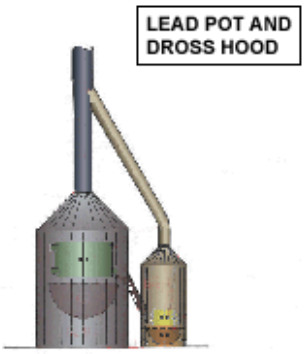
Lead Battery Manufacturing

Oxide and Grid Processing

Lead oxide is made from refined lead. The oxide is then made into a paste by mixing it with water, acid, and other chemicals. In a process parallel to the production of paste, grids are cast from lead alloy. The paste and grids are later combined in the pasting process. See Plate Processing for more information.

- Oxide Production
- Oxide Receiving
- Oxide Conveyance and Classification
- Paste Mixing
- Grid Production and Parts Casting



View larger diagram of lead pot and dross hood

Safety and Health Topics Page

Oxide and Grid Processing
- Oxide Production
- Oxide Receiving
- Oxide Conveyance and Classification
- Paste Mixing
- Grid Production and Parts Casting

Plate Processing

Battery Assembly

Battery Repair and Reclaim

Environmental Controls

Maintenance

Engineering Controls

OSHA Lead Requirements...

Source Identification Protocol

Lead Battery Manufacturing

Oxide and Grid Processing > Oxide Production

Lead oxide, which is used to create the paste used on the battery plates, is either produced by the Ball Mill Process or the Barton-Like Process. It may also be purchased from an oxide producer (see receiving). The major source of lead exposure in the oxide production process comes from leaking equipment and system upsets.

Furnace that melts lead for to the Barton Process

Oxide Production

Potential Sources of Exposure

- Lead dust can become airborne due to improper air flow or exhaust ventilation, which results in "puffing" of lead oxide at the mill inlet.
- Exposure may occur from handling lead pigs while loading the mill pots or the ball mill.
- Lead oxide dust may spill or leak from trunnion seals, bearing seals, conveying systems, and transfer points.
- Exposure to lead may occur when drossing the lead pots during the Barton process (Figure 1) and during maintenance operations that require entry into the pot for cleanout.
- Lead oxide may leak or spill during drive fitting and transfer operations.
- Lead exposure may occur while collecting and testing oxide samples.
- Operators may be exposed to lead oxide while cleaning the oxide production line.
- Exposure may be due to vehicular traffic in adjacent roadways stirring up oxide.

Figure 1
Drossing out the lead pot

Figure 2
Ensure that ventilation works

Safety and Health Topics Page

Oxide and Grid Processing
- Oxide Production
- Oxide Receiving
- Oxide Conveyance and Classification
- Paste Mixing
- Grid Production and Parts Casting

Plate Processing

Battery Assembly

Battery Repair and Reclaim

Environmental Controls

Maintenance

Engineering Controls

OSHA Lead Requirements...

Source Identification Protocol

Possible Engineering Controls

- Use local exhaust ventilation:
  - Install a hood enclosure for the lead melting pot.
    Gas fired lead pot, canopy hood
  - Install a hood enclosure on the dross pot or barrel.
  - Install tightly enclosed conveyer systems with ventilation at transfer stations (Figures 3 and 4).
  - Use exhaust ventilation at the sampling and process test stations (Figure 5).
  - Use exhaust ventilation around the agitator shaft or air intake of the Barton pot.
  - Place a hooded duct in close proximity to the air intake to contain the volume of a "puff" in order to prevent it from entering the workplace.
  - Place local exhaust ventilation around dust generation points.
  - Ensure that drum filling operations are ventilated and enclosed.
    Oxide drum filling, local exhaust ventilation
    Oxide barrel filling, local exhaust ventilation
    Gas fired lead pot, canopy hood
  - Add a pressure relief valve, vented through a filtering system, to the screw conveyer to vent dust generated during the transfer operation.
- Isolate the process:
  - Separate the operation from the rest of the plant and keep it under negative pressure.
  - Build a positive pressure control room for the operator.
- Use pneumatic conveyers for handling barrels rather than handling them manually.
- Use automatic sampling instead of manual sampling.
- Install a vertical classifier ahead of the

Figure 3
Enclosed screw conveyor

Figure 4
Inspect leaking equipment

Figure 5
Work station for analyzing oxide samples

Figure 6
Vacuum frequently

normal classifier and oxide collection equipment to reduce "puffing" of the Barton Process equipment.

- Protect or insulate storage tanks from the weather to prevent water condensation on the inside walls.
- Mechanize the system of feeding lead pots or mills.

Figure 7
Ball mill

Possible Work Practice Controls

- Notify supervisor of oxide leaks and perform temporary repairs immediately.
- Fill drums inside ventilated hoods or enclosures.
- Wipe down the exterior of drums before transferring them to storage or to other areas.

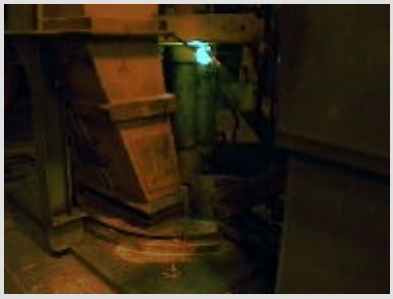


Figure 8
Barton pot

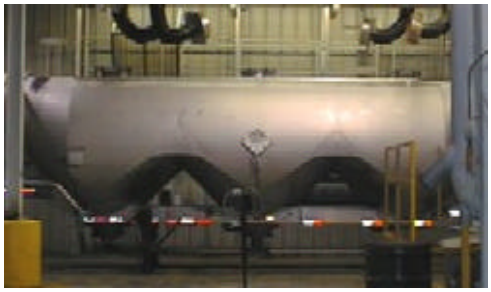
- Cap the drums before vacuuming.
- Prevent lead buildup on the inside perimeter of the pot because it can slough off and cause puffing.
- Provide adequate PPE, a change of clothes, and shower rooms (see OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities).
- Maintenance:
  - Ensure that ventilation is working properly (Figure 2).
  - Develop a written schedule of inspections for oxide mill operators.
    - The schedule should include weekly inspections of equipment such as overhead ducts and rotary valves.
- Housekeeping:
  - Vacuum all oxide spills immediately with a central vacuum system or a HEPA vacuum.
  - Vacuum equipment surfaces and floors whenever possible during each shift (Figure 6).
  - Use dust suppression compounds in place of water for dust suppression in the mill area to prevent the possibility of oxide fires and the mixing of water and molten lead.
  - Periodically shut down the plant to perform a thorough cleanup of settled dust.

back to top

Lead Battery Manufacturing

Oxide and Grid Processing > Oxide Receiving

Oxide is delivered to plants in "pod" cars, which loads the material into storage by pneumatic conveying (blowing) it into storage tanks. All lead oxide storage systems have the potential for leaking, particularly around seals and sampling points.



"Pod" car delivering oxide to a battery manufacturing plant

Oxide Receiving

Potential Sources of Exposure

- Leaking conveying equipment, particularly around flanges, seals, and transfer points.

Possible Engineering and Work Practice Controls

- Provide HEPA filtered bin vents correctly sized to handle conveying airflow or connect to central bag house.
- Develop a reliable preventative maintenance program to ensure the integrity of the system.

back to top

Safety and Health Topics Page

Oxide and Grid Processing
- Oxide Production
- Oxide Receiving
- Oxide Conveyance and Classification
- Paste Mixing
- Grid Production and Parts Casting

Plate Processing

Battery Assembly

Battery Repair and Reclaim

Environmental Controls

Maintenance

Engineering Controls

OSHA Lead Requirements...

Source Identification Protocol

Lead Battery Manufacturing

Oxide and Grid Processing > Oxide Conveyance and Classification

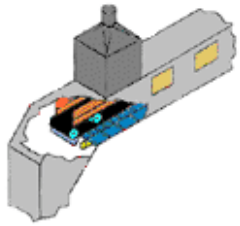
Certain material transporting operations call for mechanical conveyance. Common conveyance methods used in battery manufacturing facilities include:

- Pneumatic Conveyors
- Belt Conveyors
- Drag Link Conveyors
- Screw Conveyors

Classification separates the oxide particles by size, allowing only particles within the desired size range to the paste mixing operation.

- Classification

Toxic Material Belt Conveying Head Pulley



View larger image of belt conveying head pulley diagram

Pneumatic Conveyors

Pneumatic conveying systems use air to transfer lead oxide from one point to another via pipes.

Potential Sources of Exposure

- Leaking equipment.
- Damaged bags in bin vent or bag house.

Possible Engineering and Work Practice Controls

- Repair leaks and replace bags immediately.
- Use self-adhesive neoprene gaskets at all joints to provide a dust-tight seal.
  - Dust Control Handbook: Pneumatic Conveyors. OSHA and the Bureau of Mines, U.S. Department of the Interior (1987, February), 20 pages. This handbook consolidates information developed by industry and government laboratories on dust control engineering techniques for metal and nonmetal mineral processing.

back to top

Belt Conveyors

Belt conveying systems use belts to transport lead oxide material.

Potential Source of Exposure

- Lead dust may be emitted from open

Safety and Health Topics Page

Oxide and Grid Processing
- Oxide Production
- Oxide Receiving
- Oxide Conveyance and Classification
- Paste Mixing
- Grid Production and Parts Casting

Plate Processing

Battery Assembly

Battery Repair and Reclaim

Environmental Controls

Maintenance

Engineering Controls

OSHA Lead Requirements...

Source Identification Protocol

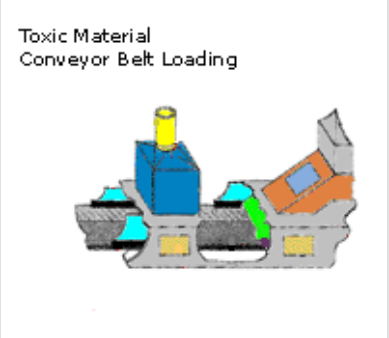
conveyor systems:

- At the receiving end.
- At the discharge end.
- At the underside of conveyor.
- From spillage along the conveyor belt.

View larger image of belt conveying head pulley diagram

Possible Engineering and Work Practice Controls

- Provide an enclosed conveying system, such as a screw or pneumatic conveyor, in place of an open conveyor belt where possible.
- Totally enclose and exhaust ventilate the conveyor from loading to transfer points.
  - Conveyor Belt Ventilation Diagram
  - 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



View larger image of conveyor belt loading diagram

- Provide a trough belt and conveyor skirting to minimize spillage.
  - Dust Control Handbook: Belt Conveyors. OSHA and the Bureau of Mines, U.S. Department of the Interior (1987, February), 20 pages. This handbook consolidates information developed by industry and government laboratories on dust control engineering techniques for metal and nonmetal mineral processing.
- 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.

back to top

Drag link Conveyor

Tubular drag link conveying systems consist of disc-shaped flights attached to a chain inside a tubular housing. The chain is driven by a motor connected to a drive sprocket. Hoppers located above holes in the housing, feed material into the

conveyor; holes cut in the bottom of the housing form the outlet.

Figure 1
Drag link conveyor

Potential Source of Exposure

- Lead dust may be emitted from open conveyor systems at:
  - The receiving end.
  - The discharge end.
  - Leaking flange connections.

Possible Engineering and Work Practice Controls

- Provide a preventive maintenance program to maintain system integrity.
  - Adjust the takeup (usually located near the drive sprocket) regularly to remove slack in the chain caused by stretching.
  - Inspect the chain and flights periodically for material buildup and wear.
  - Replace chain and flight components through the inspection opening to avoid dismantling the conveyor.
- Totally enclose and exhaust ventilate the conveyor from loading to transfer points.
  Drag link Conveyor Configuration Diagram #1
  Drag link Conveyor Configuration Diagram #2

Figure 2
Chain and flights (white discs) of a drag link conveyor

Figure 3
Clear tube showing how the drag link conveyor works

back to top

Screw Conveyors

Screw conveyors are sometimes used in the battery manufacturing industry to transport lead oxide to the paste mixing area (Figure 4).

Figure 4
Enclosed screw conveyor

Potential Sources of Exposure

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

Possible Engineering and Work Practice Controls

- Enclose screw conveyor systems that transport leaded materials.
  - Dust Control Handbook: Screw Conveyors. OSHA and the Bureau of Mines, U.S. Department of the Interior (1987, February), 20 pages. This handbook consolidates information developed by industry and government laboratories on dust control engineering techniques for

metal and nonmetal mineral processing.

- Enclose and exhaust ventilate screw conveyor transfer points.
  - Dust Control Handbook: Transfer Chutes. OSHA and the Bureau of Mines, U.S. Department of the Interior (1987, February), 20 pages. This handbook consolidates information developed by industry and government laboratories on dust control engineering techniques for metal and nonmetal mineral processing.
- Maintain cover gaskets and repair leaks immediately.
  Screw Conveyor Components
- Establish a preventive maintenance program for all lead handling processes and equipment.

back to top

Classification

Air classification equipment (cones or cyclones) operate by applying opposing air flows and centrifugal forces to the oxide material. By balancing the two forces, the heavier particles spiral out and down where they are collected, and finer particles flow up to the top, where they may be passed to another cyclone with finer classification capability. Through this process, the desired particle size distribution is obtained.

Figure 5
Cyclone classifiers

Potential Sources of Exposure

- Leaking equipment.

Possible Engineering and Work Practice Controls

- Provide a preventive maintenance program to maintain system integrity.

back to top

Lead Battery Manufacturing

Oxide and Grid Processing > Paste Mixing

During the paste mixing process, lead oxide, water, acid, and other chemicals are blended in a mixer to form a thick paste. The major source of lead exposure in this process is from lead oxide that escapes from the paste mixing machine, dries, and becomes airborne.

- Paste Mixing
- Video Exposure Monitoring: Paste Mixing

Paste mixer with supplied air island above testing station
View larger image of paste mixer

Paste Mixing

Potential Sources of Exposure

Figure 1
Ventilated paste mixer

- Major sources of exposure are leaking equipment such as:
  - oxide conveyance,
  - weigh hoppers,
  - or mixer door seals.
- Ventilation may be inadequate due to moist material plugging the system, which may allow lead dust to become airborne, or allow rising air currents to carry suspended lead to the employee's breathing zone.
- Sampling and testing oxide or paste may increase the employee's exposure to lead.
- Lead-containing expander may become airborne when added to the paste mixer.
- Manually scraping and cleaning the mixer during cleanup or while changing pastes may cause lead particles to become airborne.

View larger image of paste mixing, testing station diagram

- Lead exposure may increase when there is re-entrainment of dried and settled lead on buckets, the cone feeder, or other equipment.
- Lead dust can become airborne when workers fold lead-containing expander bags for disposal outside of a ventilated enclosure.
- Lead oxide can become airborne when dried oxide flakes off of gloves and hand tools.

Safety and Health Topics Page

Oxide and Grid Processing
- Oxide Production
- Oxide Receiving
- Oxide Conveyance and Classification
- Paste Mixing
- Grid Production and Parts Casting

Plate Processing

Battery Assembly

Battery Repair and Reclaim

Environmental Controls

Maintenance

Engineering Controls

OSHA Lead Requirements...

Source Identification Protocol

- When a cone feeder is empty, heat rising from the pasting machine causes a chimney affect. This may dry out the oxide and suspend it in the rising air currents.

- Lead dust and particles may become airborne due to drafts and air currents caused by moving equipment or motor drives.

Possible Engineering Controls

- Use local exhaust ventilation.
  - Perform testing and sampling at ventilated workstation.
    Paste mixing testing station

  - Provide exhaust ventilation at sampling port on mixer, and at expander handling areas.

  - Design clean-out hatches on exhaust system to facilitate cleaning.

  - Ensure ventilation is working properly and has adequate transport velocity. Recommended transport velocity for lead particulate is 4200 - 4500 fpm.
    Paste mixer, dual mixer emission controls, Part A
    Paste mixer, dual mixer emission controls, Part B
  - Keep weigh hopper, delivery system, and mixer continually under negative pressure (Figure 1).

  - Enclose the mixing platform tightly and keep under negative pressure.
- Maintain systems so they are leak-free.

- Install Laminar Flow (Supplied Air) Islands at operator work station.

- Eliminate manually handling paste by arranging mixer equipment so the cone discharge is directly over the paste machine feed hopper.

Possible Work Practice Controls

- Ensure that the exhaust vent damper control does not allow moist air from the acid addition cycle to go into the dry dust collector side of the system.

- Keep the cone feeder from becoming empty.

- Watch for oxide leaks and immediately report them to supervisors.

- Close all openings and doors to mixers.

- Empty lead-containing expander slowly into mixer while it is under negative pressure, then carefully discard the empty bags in a closed container.

- Do not shake or crush empty expander bags.

- Do not hammer the mixers, cone feeders, hoppers, ductwork or any other paste or oxide vessel with tools to loosen oxide or paste.

- Use plastic or some other material, which will not become heavily contaminated with oxide, to cover tubs of paste.

- Provide adequate PPE, a change of clothes, and shower rooms (see OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities).

- Maintenance:
  - Report to supervisors all mechanical problems such as defective seals at oxide transfer points, mixer doors, holes in the mixer or broken seals on the oxide screw conveyer.
  - Repair defective equipment promptly (see Preventive Maintenance Program).

- Housekeeping:
  - Wipe down exterior of mixer with a light coat of oil.
  - Use a central vacuum drop to remove any oxide spills or leaks at the oxide delivery area and at the mixing operator station.
  - Use high-pressure water spray instead of a putty knife during mixer cleanout.
  - Use a putty knife with a long handle if high-pressure water spray is not available.
  - Place tools such as putty knives or spatulas in a pail of water after use.
  - Keep tubs used for transporting paste clean.

back to top

Video Exposure Monitoring: Paste Mixing

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 left hand bar indicates changes in total dust concentrations over time.

As the employee loads material to the paste mixer, the red bar indicates increasing employee exposure occurs while dumping containers into the mixer.

Low Bandwidth Video
Dial up Modem, ISDN

High Bandwidth Video
LAN, DSL, T1, T3

Note: This example illustrates how VEM can be used for determining sources of employee exposure. Other sources can be determined by using VEM sampling for a full work shift.

back to top

Lead Battery Manufacturing

Oxide and Grid Processing > Grid Production (Book Casting and Continuous Casting), Strip Casting, and Parts Casting

In all of these processes, lead pigs are melted down and the molten lead is poured into molds or continuously cast into grids, strips, or parts. Expanded metal grid production involves mechanical operations on the cast strip and is not a source of airborne lead dust or oxide. The major source of lead exposure in this process is from lead fumes and lead oxide which can become easily airborne.

Grid production machine

Grid Production and Parts Casting

Potential Sources of Exposure

- Drossing the lead pot may increase lead exposure.
- High levels of lead fumes are generated when a flame is put in contact with lead, such as when cutting out frozen pots.
- Settled lead dust on surfaces and equipment may become airborne due to exhaust from fuel-powered fork-lifts or vehicular traffic.
- High exposure to lead fumes can occur when the pig is loaded into the lead pot.
- Airborne lead dust can migrate from other areas of the plant depending on the plant layout.
- Separator boards may become contaminated by using lead contaminated pallets that have not been cleaned after

Figure 1
Lead pot enclosure

Safety and Health Topics Page

Oxide and Grid Processing

Oxide Production

Oxide Receiving

Oxide Conveyance and Classification

Paste Mixing

Grid Production and Parts Casting

Plate Processing

Battery Assembly

Battery Repair and Reclaim

Environmental Controls

Maintenance

Engineering Controls

OSHA Lead Requirements...

Source Identification Protocol

being returned from the pasting line.

- Dust may become airborne as a result of using a rotary sander for cleaning molds.
- Oxide that has collected on the dross ladle may become airborne while cleaning or storing it in an area outside the hood.

Possible Engineering Controls

- Develop a system to minimize the formation of dross.
- Place a local exhaust ventilation on the lead melting pot and the dross pot (Figures 1, 2, and 3).
  - Lead pot and dross hood Part A
  - Lead pot and dross hood Part B
- Dross with a ladle with holes in it to allow lead to drain back into the pot.
- Install Laminar Flow (Supplied Air) Islands at the drossing station if exposures exceed the PEL.
- Provide local slot ventilation or a ventilated torch for cutting out frozen pots.
  - Ventilated torch
- Suspend plastic curtains to separate the casting areas from the traffic areas.
- Isolate the lead pots from casting operations.

Possible Work Practice Controls

- Handle dross carefully within a ventilated enclosure.
- Keep the doors closed on the dross cabinets when drossing into the containers.
- Keep the dross covered near an open door, window, or near areas of vehicular traffic; wind may cause powdery dross to become airborne.
- Cool waste drums under exhaust ventilation.
- Enclose cooled waste drums with a ply bag prior to storage (Figure 3).
- Do not add sawdust to the dross.
- Keep dross from calcium and antimonial alloys separate and dry since arsine and stibine gases could be emitted.

View larger image of lead pot and dross hood part B

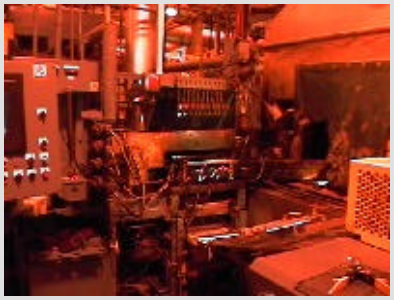
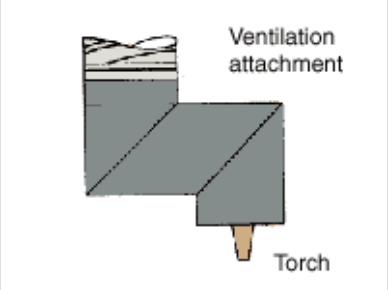


Figure 2
Continuous grid casting machine



View larger image of ventilated torch

Figure 3
Ventilated and automated lead pot

- Slide pigs into the casting pots.
- Use a long-handled push rod or mechanical system to feed the pigs into the pot.
- Use separate pallets for grid storage and pasted plate storage (Figure 4).
- Provide adequate PPE, change of clothes, and shower rooms (see OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities).
- Maintenance:
  - Ensure ventilation is working properly.
  - Use electric powered fork lifts.
  - Use an automatic conveyance system.
  - Avoid using a rotary sander to clean molds.
- Housekeeping:
  - Use dust suppression techniques, such as, using dust suppression compounds or vacuuming.
  - Keep the floor areas and work surfaces around the lead pots and lead storage areas free of oxide dust.
  - Scrape metal splashes with a shovel or long-handled scraper.

View larger image of supplied air island

Figure 4
Waste drum under exhaust ventilation

Figure 5
Lead-contaminated separator boards

back to top