Lead Battery Manufacturing

Plate Processing

Plate processing combines the oxide paste and the grids to prepare plates for assembly into batteries.

- Grid Pasting
- Hydrosetting
- Parting
- Enveloping and Wrapping

Plate processing

Lead Battery Manufacturing

Plate Processing > Pasting

During the pasting process, lead oxide paste is applied to the grid panels in a pasting machine to fill the spaces of the grid. The major source of lead exposure in the pasting process comes from lead oxide in the paste which can become easily airborne once it dries.

Workers may be exposed to lead dust during pasting and take-off operations. Contaminated gloves, clothing, tools, and equipment may also be a source of lead exposure.

Pasting machine

Pasting Operations

Potential Sources of Exposure

- Dried paste on equipment and other areas, such as the mixer, cone feeder, paste transfer equipment, paste return belt, pasting machine, floors, and adjacent areas, may become airborne due to equipment vibration or by being disturbed and as described below (Figure 1):
  - Scraping lead oxide off the hopper and exterior of the cone feeder during cleanup and upsets.
  - Inadequate exhaust ventilation on the drying oven.
  - Settled oxide on the housings of rotating drives and motor cooling fans (see Figure 2).
  - Improper handling and disposal of paste accumulated on the floor or other surfaces (see Figure 3).
  - Dried dust on equipment, controls, and gloves during operation of equipment located near the breathing zone.

Figure 1
Dried paste on work area

Figure 2
Oxide on motors

- Dried oxide on the floor or other surfaces being disturbed by employees, vehicle traffic, or wind.

Possible Engineering Controls

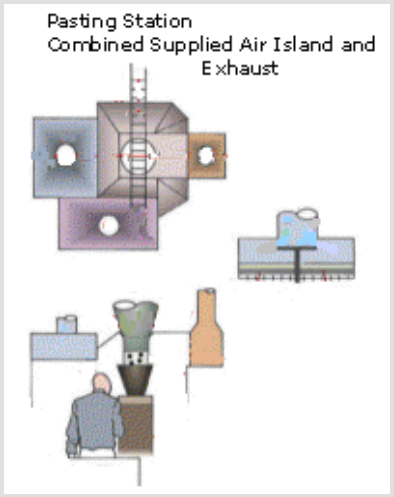
- Use a laminar flow (supplied-air) island providing 90-175 feet per minute at the face velocity of the plenum.
    - Use plastic skirting to increase hood efficiency (the skirt prevents induced air from entering the clean air stream).
- Install exhaust ventilation around paste machine feed hopper to prevent dust generation during scraping, cleanup, and operation (see Figure 4).
- Enclose oven all the way to the floor.
    - The oven or conveyor chain may stir up or re-suspend settled lead oxide dust that may escape through an open door.
- Maintain negative pressure in drying oven ventilation.
    - Ventilation efficiency decreases if oxide is allowed to build up in the bottom of the drying oven.
- Provide a fine water mist for paste return belts (see Figure 5).
- Use a totally encapsulated fan-cooled motors to reduce dust generation.

Possible Work Practice Controls

- Prohibit cooling fans or open doors and windows, which cause cross drafts or thermals and destroy effectiveness of local exhaust.
- Keep oven doors closed at all times.
- Keep breathing zone away from oxide or dry paste.
    - Place machine controls at machine level, not overhead near hopper.
- Provide adequate PPE, change of clothes, and shower rooms (see OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities).
- Housekeeping:
    - Clean up paste spills immediately.

Figure 3
Improper disposal of paste

Figure 4
Ventilate and partially enclose feed hopper



View larger image of pasting station, combined supplied air and exhaust diagram

Figure 5
Fine water mist on paste return belt

- If a paste spill was caused by mechanical problems, report it to a supervisor.

- Shovel paste and dispose of it in ventilated barrels in a manner to minimize airborne dispersion of lead.
  Scrap handling, barrel/drum exhaust hood

- Clean out oven regularly.
  - Buildup of oxide dust in the oven may cause an imbalance in the ventilation and raise airborne lead concentrates. Note: Water sprayed on a hot oven conveyor belt can be a high source of lead-in-air.

- Use dust suppression techniques such as keeping floors wet, using dust suppression compounds or vacuuming.
  - Using recycled water may increase lead-in-air levels if the water dries. Air bubbles in the water may pop and allow lead to escape into the air.

- Use long handle scrapers or putty knives.

- Wash-down equipment with water.

- Control pressure and direction of spray to prevent splash-back.

- Clean equipment at least once each shift.

- Coat equipment with a peanut oil and water emulsion to aid adhesion of dry oxide and to facilitate cleanup.

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Video Exposure Monitoring: Shoveling Paste

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 shovels lead paste into the pasting machine hopper, the red bar indicates increasing employee exposure to lead dust.

Low Bandwidth Video
Dial up Modem, ISDN

High Bandwidth Video
LAN, DSL, T1, T3

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

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Take-Off/Offbearer Operations

Potential Sources of Exposure

- Lead oxide dust may become airborne:
  - From handling dry plates or moving plates in and out of the workstation.
  - From the buildup of dust on equipment, racks, and floor.
  - When workers brush plate lugs during parting.
  - When workers improperly handle or dispose of scrap plates and oxide from catch tray.
  - From inadequate capture velocity for tamping plates.
  - From upset conditions or while clearing jam-ups in equipment.
  - From dried oxide on contaminated gloves, clothing, shoes, and tools.

Figure 5
Handling plates

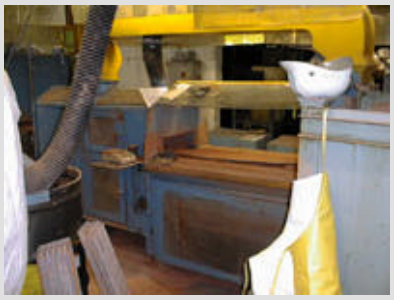

Figure 6
Pasting take-off

Possible Engineering Controls

- Place scrap plates into a ventilated barrel or box and dispose of them properly (see Figure 7). When designing and building local exhaust ventilation keep flexible tubing to a minimum.
  Scrap handling, barrel/drum exhaust hood
- Place a slot or down draft ventilation at take off station.
- Provide properly designed exhaust ventilation for the workstation.
  Integrated controls, plate take-off
- Provide exhaust between oven and take-off workstation to prevent dust contamination generated from existing plates and conveyor chains.
  Plate parting, transition hood between flash drier and take-off
- Provide ventilated lug brush.
- Use exhaust ventilated plate racks.
  Plate storage rack hood
- Break plates inside of hood or over ventilated tamping stand.

Figure 7
Ventilated scrap barrel

Figure 8
Suspended plastic curtains

Pasting take-off, work station hood

Figure 9
Pasting take-off and lug removal

- Evaluate the technical feasibility of robotics or automatic plate catching.
- Use dust suppression techniques such as using dust suppression compounds, or vacuuming, where practical.
- Provide a clear plastic plate between the operators breathing zone, and the conveyor and tamping stand.
- Install a piece of Plexiglas across the front of the hood to increase hood efficiency and prevent possible contaminated air from being induced into the operator's breathing zone while allowing the operator to see clearly.
- Use a laminar flow (supplied-air) island at workstation.
- Ventilate the testing station.
  Test station ventilation
- Note: Industrial batteries may require ventilation that is not always necessary for SLI batteries. This includes rack ventilation, a ventilated lug breaking station and a directed air system through the operator's breathing zone.

Possible Work Practice Controls

- Leave work shoes or shoe coverings in the pasting department to avoid transport of lead throughout the plant.
- Vacuum table, equipment, and racks to prevent accumulations of oxide.
- Use dust suppression techniques such as keeping floors wet, using dust suppression compounds or vacuuming.
  - Using recycled water may increase lead-in-air levels if the water dries. Air bubbles in the water may pop and allow lead to escape into the air.
- Provide adequate PPE, a change of clothes, and shower rooms (see OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities).
- Brush toward the hood ventilation when brushing lugs, the edge of the panels, or the plates to remove adhering oxide.
- Cover ventilated barrels or boxes with a plastic bag before moving it, or if a wax-coated cardboard box is used, close, and remove to storage.
- Do not store plates on ventilated tamping stands.
- Do not break plates on a metal plate or solid board.
- Prohibit cooling fans or open doors and windows that cause cross drafts or thermals and destroy the effectiveness of local exhaust.

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Video Exposure Monitoring: Pasting Take-Off

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 removes plates from the pasting machine and brushes the edges of the plates, the red bar indicates increasing employee exposure to lead dust.

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 of employee lead exposure can be determined by using VEM sampling for a full work shift.

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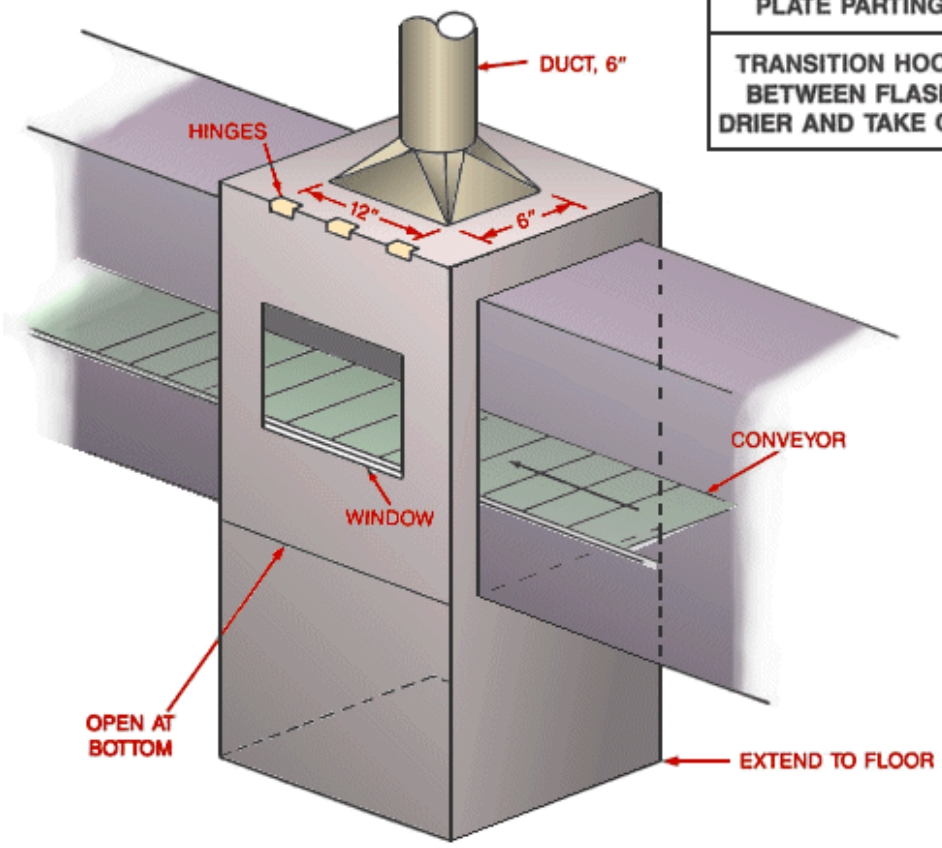
PLATE PARTING

TRANSITION HOOD BETWEEN FLASH DRIER AND TAKE OFF



DESIGN CRITERIA

$Q \cong 1200$ ctm
$V_{DUCT} \cong 6{,}000$ fpm
$SP_h = 3.4$" W-6
$he = 0.44\ VP_{DUCT}$

or

SIZE FOR Q=400 fpm AT OPENINGS TO ROOM (BOTTOM OF HOOD)

Lead Battery Manufacturing

Plate Processing > Hydrosetting

Hydrosetting methods vary between battery plants, ranging from placing the pasted plate racks in the workroom to placing the racks within a temperature- and humidity-controlled room or chamber. The major source of lead exposure in the hydrosetting process comes from lead oxide when the grids are handled incorrectly.

Hydrosetting oven

Hydrosetting

Potential Sources of Exposure

- Lead may become airborne from handling or moving dry plates.
- Lead particulate may become airborne from positioning pallets of pasted plates near drafts or thermals.
- Handling burlap that has been contaminated with lead oxide improperly.

Possible Work Practice Controls

- Do not cover with burlap; instead use plastic or some other material that will not become heavily contaminated.
- Position pallets away from cross drafts or thermals.
- Vacuum pallets, racks, and edges of plates and panels to prevent dried lead-bearing dust from being re-entrained.
- Provide adequate PPE, a change of clothes, and shower rooms (see OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities).

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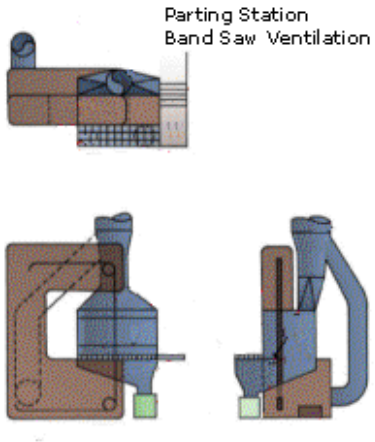
Lead Battery Manufacturing

Plate Processing > Parting

Grids are commonly produced and pasted as pairs called pasted plates or panels. They must be separated before the battery can be built. The major source of lead exposure in the parting process comes as a result of the grids being handled incorrectly, which causes particles to become airborne when plates are cut or broken.

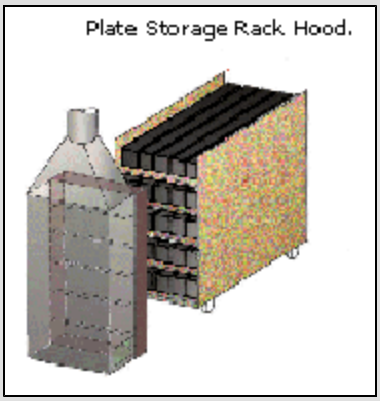


View larger image of parting station, band saw ventilation

Parting

Potential Sources of Exposure

- Lead dust may become airborne when workers handle dry plates and move plates in and out of the workstation.
- Lead oxide may become airborne when there is dried oxide on equipment, racks, and floors. This is especially critical for dry-charge batteries since formation and curing in the oven has already occurred and the plates are dry.
- Increased exposure to lead may occur when workers use buffing wheels or parting saws that throw particulate faster than the local exhaust ventilation can handle.
- Lead oxide particles may become dislodged and airborne during clearing of machine jam-ups.
- Lead dust may become airborne due to improper disposal of defective plates.
- Lead dust may become airborne due to emptying the clean-out tray improperly.
- Leaking tamping boxes contribute to settled dust on the floor.



View larger image of plate storage rack hood

Figure 1
Ventilated scrap barrel

Possible Engineering Controls

- Ventilate work station, using a down draft or a slot hood with a grating or perforated plate tamping stand.
- Provide an opening in the tamping stand or raised positions so lugs will not be impacted.
- Use ventilated scrap barrel (Figure 1).
  Scrap handling, barrel/drum exhaust hood
- Provide a vacuum drop at the workstation (Figure 2).
- Retrofit buffing wheels on parting machines with stationary brushes.
- Enclose ends of machine to prevent particles from being thrown out.
- Use a radial saw with local exhaust ventilation instead of a band saw.
  Parting Station, Band Saw Ventilation
- Clamp plates to a tilt plate when using a band saw, fit it with a long handle so the operator can stand beside the hood opening while cutting plates.
- Use a laminar flow (supplied-air) island.
- Use a guide bar (belly bar) to prevent the operator from leaning against equipment.

Figure 2
Vacuuming grid plates

Figure 3
Contaminated clothing

Figure 4
Water wash-down

- Install see-through glass or a plastic plate at the tamping stand and breaking station.
- Exhaust ventilate rack.
- Provide a rotating base for pallet of plates.
- Locate racks close to workstation, in ventilated areas.

Possible Work Practice Controls

- Do not bang plates excessively during manual plate breaking.
- Do not break plates on metal plate or a solid board.
- Handle plates only with hands.
- Do not lean plates against the stomach.
- Wear an apron (Figure 3).
- Place, do not throw, defective plates into scrap barrel.
- Cover drums with a plastic bag before removing from area.
- Keep access doors closed.

- Provide adequate PPE, a change of clothes, and shower rooms (see OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities).
- Maintenance:
  - Ensure ventilation is working properly.
  - Prevent cross drafts.
  - Enclose hood opening.
- Housekeeping:
  - Vacuum clean-out trays, do not dump into barrels.
  - Use dust suppression techniques including keeping floors wet (where it does not create a hazard), using dust suppression compounds or vacuuming (Figure 4).
  - Vacuum the tops of trays, workstations, and adjacent areas.

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Lead Battery Manufacturing

Plate Processing > Enveloping and Wrapping

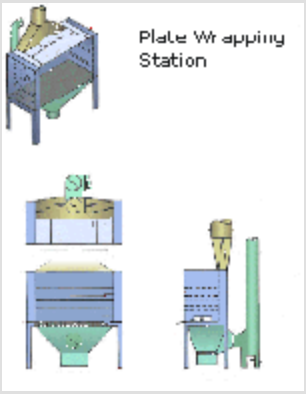
Enveloping involves placing a plate (usually positive), either automatically or manually, within porous membranes. The major sources of exposure in this process result from lead oxide being released when the plates are handled incorrectly.

Enveloping Machine

Enveloping and Wrapping

Potential Sources of Exposure

- Lead oxide may become airborne due to workers improperly handling plates at the feed and discharge ends of enveloping machines as well as from the bellows effect when handling unsealed envelopes.
- Exposure to lead may occur when the lead oxide that has accumulated on equipment, racks, and floors becomes airborne.
- Lead dust may become airborne when workers improperly handle scrap plates.
- Lead may contaminate clothing when a worker leans against contaminated equipment.
- Increased exposure to lead oxide may occur when tamping plates in unventilated areas, such as the rack, creates puffs of lead dust.



View Larger image of plate wrapping station diagram

Possible Engineering Controls

- Use local exhaust ventilation, such as a grating or a perforated plate tamping stand that is equipped with downdraft and side-draft ventilation (Figure 4).
- Enclose and ventilate equipment.
- Use a ventilated scrap barrel.
  Scrap handling, barrel/drum exhaust hood
- Provide a vacuum drop at the workstation.

Figure 1
Oxide build up on machines

Figure 2
Wear an apron

- Use a rotating base for placing pallets of plates so employees do not have to reach across.
- Use a laminar flow (supplied-air) island over operators workstation.

Possible Work Practice Controls

- Tamp plates carefully over ventilated work station.
  - Do not bang plates excessively while tamping.
- Keep open ends of envelopes away from the face.
- Handle groups of plates with hands only rather than leaning them against the stomach.
- Wear an apron (Figure 2).
- Place, do not throw, defective plates into a scrap barrel.

Figure 3
Enveloping machine

Figure 4
Tamping stand that is equipped with down-draft and side-draft ventilation

- Cover drums with a plastic bag before removing them from the area.
- Seal all doors, windows, and other openings on the enveloping machine.
- Perform plate parting at the local exhaust ventilation (downdraft or side-draft), and not while the plates are moved from the pallets to the enveloping equipment.
- Do not store plates on ventilated tamping stands.
- Provide adequate PPE, a change of clothes, and shower rooms (see OSHA Lead Requirements for PPE, Housekeeping, and Hygiene Facilities).
- Maintenance:
  - Ensure ventilation is working properly.
  - Prevent cross drafts.
  - Catch material that is too heavy to be conveyed by the ventilation system in a plastic bag (not catch drawers).
- Housekeeping:
  - Vacuum the separator boards, workstation, and adjacent areas.
  - Use dust suppression techniques, such as keeping the floor wet, using dust suppression compounds, or vacuuming.
  - Ensure plate trays are vacuumed clean.

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Lead Battery Manufacturing

Plate Processing > Handling and Transport

Handling and transporting of materials is an essential part of the battery manufacturing process. Materials are primarily transported through the use of mobile equipment (forklifts). 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.

Mobile Equipment

Potential Sources of Exposure

- Lead dust from feed materials can become airborne during handling and transport (Figure 1).
- Lead dust that has settled on surfaces and equipment may become airborne due to vehicle traffic and wind.

Figure 1
Forklift transporting materials

Possible Engineering and Work Practice Controls

- Reduce vehicle speeds to minimize stirring up settled dust.
- Clean the inside and outside of mobile equipment frequently.
- Periodically clean floor surfaces to reduce accumulation of lead dust.
- Pave all roadways to facilitate housekeeping.

Figure 2
Hand truck

- If it is determined that lead dust is coming from mobile equipment or is from adjacent areas, evaluate material handling patterns and practices and area isolation.
- Provide dedicated fork lifts for clean and dirty areas to avoid cross contamination.
- Raise and lower loads gently to prevent jarring.
- Vacuum any skid, pallet, tub, or other conveyance that holds or has held plates before moving.

Other Hazards

- Vehicle accidents may occur during the material transport, which may release contaminated material throughout the plant.

Possible Solutions

- Ensure that each vehicle is equipped with hazard lights and audible horns.
- Ensure that loading and receiving docks are clearly marked and lighted.
- Write schedules for all drivers and operators, to minimize "surprises."

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