Guidelines – Lead Works

Issued by: Inspection Department – Operations Section

1.0 Introduction

Lead is one of the oldest metals used by humanity and was known to the ancient Egyptians and Babylonians. It was one of the first metals mined in North America, where it was sought after especially for making shot. Although lead is seldom found uncombined in nature, its compounds are widely distributed throughout the world, principally in the ores galena, cerussite and anglesite.

Australia, United States, Canada and Russia are among the chief producers of lead. In the United States, lead sulfide ore is mines in Southern Missouri, with some ores coming from the western states. It comes from the mineral galena mined from man-made underground tunnels or mine shafts. After the mined galena undergone milling, it will be brought to a lead smelting plant. During smelting, sinter clumps are formed after lead roasting and it is mined with coke and blasted with hot air. After which, a chemical reaction takes place and lead bullion will be produced.

The single most important commercial use of lead is in the manufacture of lead-acid storage batteries. It is also used in alloys such as fusible metals, antifriction metals, solder and type metal. Shot lead is an alloy of lead, antimony and arsenic. Lead foil is made with lead alloys. Lead is used for covering cables and as a lining for laboratory sinks, tanks and the “chambers” in the lead-chamber process for the manufacture of sulfuric acid. It is used extensively in plumbing. Due to its excellent vibration-dampening characteristics, lead is often used to support heavy machinery and was used in the foundations of the Pan-Am Building built over Grand Central Station in New York. Lead is also employed as protective shielding against X-rays and radiation from nuclear reactors.

Although lead and most of its compounds are only slightly soluble in water, the use of lead pipe to carry drinking water is dangerous since lead is a cumulative poison that is not excreted from the body. The “lead” of lead pencils does not contain lead; it is a mixture of graphite and clay.

The Red Dog Mine in Alaska is the largest lead mine in the world and the largest lead producer in the United States. About four hundred fifty (450) million pounds of toxic releases in year 2000 alone and it has made Alaska to the list of top five (5) most polluted states.

These notes apply to:

a. Works in which compounds of lead are produced by the application of heat:

- Lead is extracted, recovered or recycled from any material containing lead or its compounds; or
- Lead is refined; or
- Lead is applied as a surface coating to other materials by spraying; or

b. Works in which compound of lead are manufactured, extracted, recovered, recycled or used in process which gives rise to dust or fume.

2.0 Sampling and Measurement of Emissions Monitoring

2.1 As a part of the supervision, the owner shall make inspections of the process and tests of the chimney emissions at least once per week for each exit. Where effective continuous monitors are fitted, less frequent manual test shall be carried out, with the agreement of the Authority, to check the performance of the monitors. The results of all the tests shall be recorded for examination by the Authority.

2.2 The fugitive emission shall be assessed by the company staff on a daily basis.

3.0 Emission Limits and Controls

3.1 The permitted limit for the mass rate of emission of lead is based on the aggregate volume of emission from all lead processes on the site, including emissions from secondary collection systems.

3.2 Each emission to air shall not exceed two (2) mg/m^3 of lead (0.00087 grains of lead per dry standard ft^3).

3.3 Where lead-containing fumes or dusts collected by secondary extraction, installed to prevent fumes entering the working atmosphere, they shall be passed through filters before discharging to air and the concentration of lead in each emission shall not exceed two (2) mg/m^3.

3.4 The concentration of total particulates in emissions to air shall not exceed 150 mg/m^3.

4.0 Materials Sourcing, Handling and Storage

4.1 Importation of lead-containing materials/wastes or other than lead-containing concentrates (ores) intended for recycling, recovery or processing (either by metallurgical or chemical methods) into refined lead, lead alloys or lead oxides is not allowed.

4.2 Storage of lead should be kept to a minimum. Only lead staged for immediate use is permitted in normally occupied areas.

4.3 Lead storage areas shall be properly identified.

4.4 Dusty materials shall be delivered to the works in a manner, which prevents their escaping into the external environment, e.g. wetted, in closed containers, or sheeted wagons. The same applies to the transport of dusty materials within the works.

4.5 a. Dusty materials shall be stored and handled under cover where practicable, preferably wetted. For outside storage of dusty materials, enclosed bays shall be provided with walls sufficiently high to prevent wind whipping and water sprays shall be installed where applicable.

b. Where materials contain compounds which could emit noxious or offensive substances (such as arsine or stibine) when in contact with water, they shall be stored under dry conditions in clearly marked bays or containers.

4.6 All lead in use or storage shall be covered with a protective covering such as lexan, metal or polyethylene sheet.

4.7 Outdoor storage of bulk materials containing more than 1% lead by weight of less than 200 mesh size particles is not allowed.

4.8 All materials containing more than 1% lead by weight of less than 200 mesh size particles shall be transported in closed containers or shall be transported by enclosed conveying systems that are vented to the atmosphere through particulate matter control equipment or shall be transported wet.

4.9 Control program shall be designed to minimize emissions of lead fro all non-process fugitive emission points. The program shall include good housekeeping practices for the cleanup of spills and for minimizing emissions from loading and unloading areas as applicable.

4.10 The handling and transfer of collected fine dusts from dry arrestment plant shall be carried out by methods which do not give rise to dust emission.

a. Preferred practices include

- Recycling within the process by means of a directly connected closed handling system.
- Conversion into a non-dusty form by feeding into a continuous fusion furnace.
- Discharging directly from the arrestment plant into bags or drums in an enclosed filling booth extracted to a filter.

- Direct filling into containers which can be charges unopened into furnaces.

b. Another option is the wet palletizing of dust, but this requires careful control to produce a stable pellet, which will not break down again.

4.11 At a minimum, safety shoes and safety glasses with side shield shall be worn when handling lead; handling of lead shall be done with Teflon-dotted cotton or leather work gloves; and if the possibility exists for clothing to become contaminated with lead, appropriate flame retardant clothing shall be worn.

4.12 Remember to do the following points:

a. No eating, drinking, smoking, gum chewing, etc. are allowed in lead storage area or handling areas;

b. Always wear gloves when handling more than few pieces of lead sheet or bricks;

c. Always wear non-porous gloves when handling when handling any lead shot; and

d. Always wash your hands after handling lead.

4.13 Transfer of duty materials to storage and the recovery of materials from storage shall be carried out by methods, which minimize dust emissions. Preferred practices for materials reclamation transport within the works include:

a. Transport of materials from stockpiles to process by fully enclosed mechanical conveying systems, with enclosed transfer points, and not by vehicles.

b. Chutes or conveyors discharging onto stockpiles shall be equipped with fixed water sprays.

c. Conveyor discharge points shall be arranged to minimize the height of fall into the stockpile or hopper.

d. For reclamation from stockpiles, an overhead grab crane of preferred to front end loaders.

e. All conveyors external to building shall be enclosed.

4.14 Storage silos for fine materials shall be enclosed and vented through air filters.

5.0 Operational Controls

All sources of lead and dust emissions from the process such as charging points, slag and metal pouring points, shall be closely hooded and adequately draughted to filters.

Preferred practices include:

a. The provision of lock chambers, where furnaces are top charged;

b. The use of covered launders and ladles for slag and metal tapping, together with close hooding of the tapping points;

c. The hooding facilities for removing hot drosses from reefing or metal furnaces, extended to include the dross receptacles; and

d. Effective local extraction, or almost complete enclosure, of rotary furnaces to contain combustion gases and fume escape from charging and tapping operations.

6.0 General Operations

6.1 The highest standards of housekeeping shall be achieved throughout the works;

6.2 Enclose/contain process vessels, feed and discharge points and conveyor systems;

6.3 Roadways and other areas where there is regular movement of vehicles shall be hard-surfaced and kept clean, preferably by a machine which combines sweeping, vacuum suction and wetting;

6.4 Lead work areas should be vacuumed with a HEA-filtered vacuum system at the end of each day, following the completion of lead handling operations or whenever lead dust or debris is visible in the workplace;

6.5 Measures shall be taken to control dust arising from works traffic, preferably as follows:

a. Preclude the access of private vehicles to the works area;

b. Restrict works operating vehicles to designated functions and do not allow such vehicles onto public roads;

c. Cover all transport vehicles;

d. Use one-way systems for delivery or collection vehicles entering or leaving works; and

e. A single exit route for vehicles to the site.

6.6 Adequate vehicle washing facilities shall be provided and used to prevent transport of dust outside the works. Particular attention shall be given to the cleaning of vehicle wheels. The area of the washing facility shall be equipped with a secured bunding and HDPE liner system.

7.0 Chimneys

7.1 The chimney heights shall be determined by the Authority after discussion with the works management. As a first assessment, the formula $He = 2 \times M^{½}$ shall be used, where He is the effective chimney height in meters and M is the total site lead emission in g/hour calculated at the emission limits specified in above paragraphs. The chimney heights so obtained may need to be adjusted to allow for thermal buoyancy and local circumstances such as topography, nearby buildings and other nearby emissions.

7.2 The minimum chimney height for lead works shall normally be thirty (30) meters, but in case of small scale processes, or works with dual arrestment systems the minimum chimney height shall be three (3) meters above the ridge of the attached or adjacent building.

7.3 In order to maintain maximum advantage from thermal buoyancy, it is recommended that hot emissions take place from the practicable minimum number of chimneys.

8.0 Cooling Water

Non-contact cooling water systems in the smelting and refining sector may be a direct once-through design or a recirculation route involving the use of evaporative cooling towers.

8.1 Water from a once-through system can be reused / discharged after appropriate consideration / reduction of temperature effects on the receiving water body.

8.2 Direct contact cooling water (e.g., for some casting operations) may contain elevated levels of metals and suspended solid, and should be routed through the facility wastewater treatment system.

9.0 Pollution Control

9.1 Dust removing equipment such as bag houses must be installed for the control of direct emissions.

9.2 In covering direct emission from the refining and alloying kettles, the refining and melting kettles must be provided with primary suction hoods and linked to fabric filters.

10.0 Bag Houses

The bag house used on a process or process fugitive source must be equipped with a bag leak detection system having an audible alarm that automatically sounds when an increase in particulate matter (PM) emissions above the standards is detected. The detection system must not sound more than 5% of the operating time.

Minimum requirements for the bag leak detection system required in the process and process fugitive standards:

a. Equipped with audible alarm that automatically sounds when an increase in particulate emissions above a predetermined level is detected.

b. The system shall be capable of detecting PM emissions at concentration 10 mg/actual m^3 (0.004 grains/ft^3) and provide an output of relative emissions.

c. Operators shall continuously record the bag leak detection system output.

d. Such a device shall serve as an indicator of the performance of the bag house and shall provide an indication of when maintenance of the bag house is needed.

e. An alarm itself would indicate noncompliance with the lead limit, but would indicate an increase in PM emission and trigger an inspection of the bag house to determine the cause of the alarm.

f. The operator would initiate corrective actions according to the procedures in their operation, maintenance and monitoring plan. The operator would be considered out of compliance upon failure to initiate within one hour the procedures to determine the cause of the alarm, as specified in the bag house operation and maintenance SOP manual.

11.0 Work Practice Standards

11.1 Charging, tapping and sinter handling sources must be equipped with a hood ventilated to an air pollution control device. The hood design and ventilation rate shall be consistent with the American Conference of Governmental Industrial Hygienists (ACGIH) recommended practices.

11.2 Sinter machines, crushing and sizing equipment shall be located in a building ventilated to a bag house or equivalent device at a rate that maintains in-draft through any doorway opening.

12.0 Disposal of Lead and Lead Compounds: Residues and Waste

Sources of hazardous and non-hazardous residues and waste in the smelting and refining sector include slag, drosses, mattes and skimming from pyrometallurgical processes, spent linings and refractories from furnaces; waste form abatement systems (e.g., flue gas dust, sludge and spent filter material); sludge from wastewater treatment (e.g., from wet scrubber systems and process water treatment, which may contain gypsum [$CaSO_4$] and metal hydroxides and sulfides); and sludge from leaching, purification and electrolysis activities.

12.1 Copies of the Materials Safety Data Sheet (MSDS) and any other information should be provided to the wastes disposal contractor on or before collection.

12.2 All wastes generated during lead handling operations, including waste pallets, paper, protective clothing and gloves shall be handled in accordance with laboratory hazard waste disposal requirements.

12.3 Recycling of the by-products and wastes (e.g., drosses, mattes, skimming, pot and furnace linings, clean outs) from the smelting and refining activities should be maximized.

12.4 Large quantities of slag produced at the smelting stage may be processed (e.g., fuming to recover residual metals) to produce an inert granular material that can be sold for industrial use, such as cement manufacturing and insulation products.

12.5 Waste from abatement systems and sludge from leaching and wastewater treatment may be recycled into pyro-processing stages depending on the level of process integration available at the facility.

13.0 Process and Process Fugitive Sources

A plant wide emission limit is being promulgated for lead compounds from process and process fugitive emission sources. The aggregated lead emissions from the following process and process fugitive sources are limited to five hundred (500) g/mg of lead produced (1.0 lb/ton of lead produced):

a. sinter machine
b. blast furnace
c. dross furnace
d. dross furnace charging location
e. blast and dross furnace tapping locations
f. Sinter machine charging location
g. sinter machine discharge end
h. sinter crushing and sizing equipment
i. sinter machine area

14.0 Environmental and Health Effects

Lead poses health and environmental hazard. Health effects from lead exposure are a concern both at the workplace and in the home. An adult's exposure to lead is usually from occupational sources. Children are exposed (primarily at home) from surface dust, floors and chewable surfaces contaminated with lead. Lead has no beneficial effect on humans. Between 5% and 10% of ingested lead passes from intestinal tract into the bloodstream, which distributes the lead to red blood cells, soft tissues and bone. Lead in the body is eliminated very slowly, mainly by the kidneys and digestive tract.

Exposure to lead compounds occurs through inhalation or ingestion but the effects are the same regardless of the route of exposure. Chronic exposure to lead compounds results in adverse effects on the blood, central nervous system, blood pressure, kidneys and vitamin D metabolism. Children are particularly sensitive and exposure can also results in reduced cognitive development and reduced growth. Adverse effects on human reproduction have also been reported. Lead compounds can be persistent in the environment and have the potential to accumulate in food chains.