# Lead

## A Good Practice Guide

**Lead (Pb) is a dense, bluish grey, heavy metal and is one of the most commonly used and important metals after iron (Fe) in industrialised economies.**

**Due to its abundance, low cost and physical properties (low melting point, high corrosion resistance, waterproof nature and malleability), lead and lead alloys have been utilised in a variety of products. Water pipes, glazes on prehistoric ceramics, and cosmetics (cosmetic kohl) are all ancient uses of lead. Nowadays, lead is still one of the most important metals used in industry.**

# Uses of Lead

Lead is used in several processes and in various industries such as:

- Mining, smelting, refining, alloying, casting;
- Lead-acid battery manufacture;
- Jewellery manufacture;
- Manufacture of pigments and colours;
- Glazes and transfers in the pottery industry;
- Plumbing;
- Manufacture of inorganic and organic lead compounds;
- Electronics industry;
- Antique restoration (stripped pine);
- Shipbuilding, repairing and breaking;
- Protective shielding against X-rays and radiation from nuclear reactors;
- Demolition industry; painting of buildings;
- Spray painting of vehicles;
- Scrap industry;
- Vehicle radiator repair;
- Stabilising some plastics in the manufacture of pipes;
- Use of lead alloys, eg manufacture of solder; and on firing ranges;
- Pharmaceutical industry – laboratory analysis.
- Shots and bullets.

# Routes of Entry

Lead can enter the body through:

**Inhalation** such as breathing lead dust, fume or vapour. Processes such as cutting, grinding and burning, can lead to the production of dust or fumes, which is generated at temperatures higher than 500$^{o}$C.

**Ingestion**, for example handling lead powder, dust, paint or paste and then eating, drinking, smoking or biting nails.

**Absorption** through the skin such as exposure to lead alkyl (which is an additive to petrol) or lead napthenate.

Lead alkyls can also be absorbed through the skin, respiratory and gastrointestinal tracts, where they are transported in the blood and are distributed throughout the body. The highest concentrations are found in the liver, followed by the kidney, brain and muscle.

Lead can also pass from a pregnant worker to the unborn baby through placental transfer.

# Harmful Effects Due to Lead Exposure

Lead is a cumulative and persistent toxic substance.

Lead compounds are classified as either harmful (Xn) or Toxic (T), in EU countries. When lead enters the body, it causes several harmful effects; binding of lead with red blood cells induces anaemia. Furthermore, lead can also end up in bones taking the place of calcium and can be found in the liver and the kidneys. The nervous system is the main target for several metals, lead can cause irreversible damage to this system. Symptoms include shaky hands, muscular weakness and paralysis, which begins in muscles of forearms and hands.

***"If lead exposure is not controlled, the symptoms can become more serious and lead to kidney damage, nerve and brain damage and infertility."***

Lead-related health effects may result from low levels of exposure over prolonged periods of time. Lead can accumulate in almost all the body tissues but effects or symptoms are only observed when the level of lead that has entered the body is very high and thus, this will eventually cause lead poisoning. Symptoms of lead poisoning include stomach ache, loss of appetite, fatigue and sleeplessness. If lead exposure is not controlled, the symptoms can become more serious and lead to kidney damage, nerve and brain damage and infertility.

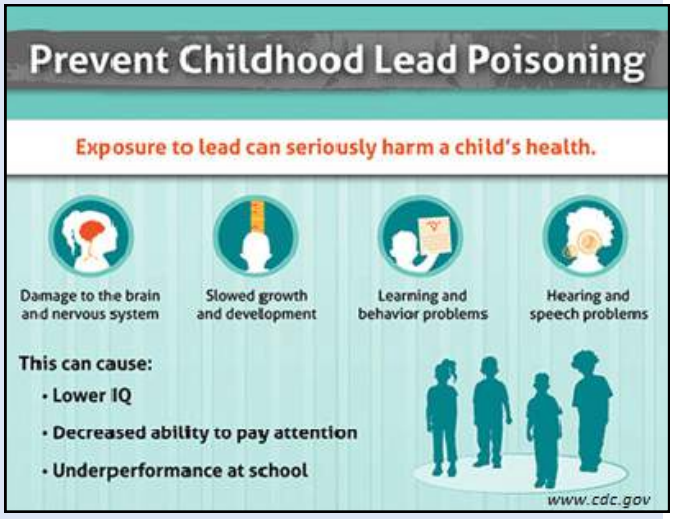
A blood lead test can determine if a worker has lead poisoning. However, a blood lead level test only measures the most recent exposures to lead and not the long-term exposures. An indication of chronic lead poisoning is the formation of a blue-purplish line along the gum.

Medical treatment which can aid the body to get rid of lead includes chelation. The amount of lead in the blood does not necessarily indicate the total amount of lead in the body. Lead travels from the lungs and intestinal tract to the organs and is stored in bones and teeth.

Lead also combines with the alkyl radical to form lead alkyl compounds. Two lead organic compounds of industrial significance are tetraethyl lead and tetramethyl lead. These compounds together with the halogenated hydrocarbon components of lead anti-knock compounds, all have toxic properties. Tetraethyl lead decomposes slowly in air and rapidly in the presence of sunlight to yield needle-like crystals of ethyl lead compounds. The inhalation of these compounds induces irritation of the upper respiratory tract as well as paroxysmal sneezing and when exposed to sufficient amounts, mild to severe systemic responses can be induced. In contact with the skin, itching, burning and temporary redness are induced.

Absorption of a sufficient quantity of tetraethyl lead results in tetraethyl lead intoxication which is mainly an acute intoxication of the central nervous system. Symptoms include insomnia, lassitude, and nervous excitation. More severe symptoms include episodes of disorientation with hallucinations, facial contortions and intense general somatic muscular activity with resistance to physical restraint. Such episodes can be converted into seizures which may ultimately result in coma and death.

Analysis of the urine and blood determines whether one has been intoxicated with lead. This is shown in a striking elevation of the rate of excretion of lead in the urine or a slight elevation of the concentration of lead in the blood.



# Health and Safety Measures

As stated in **Legal Notice 36 of 2003**, it is the duty of the employer or self-employed person to ensure that a risk assessment is carried out by a competent person. The risk assessment must be a suitable, sufficient and systematic assessment and include all the occupational health and safety hazards which may be present at the place of work and the resultant risks involved concerning all aspects of the work activity.

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When chemical agents such as lead are present at the workplace, the employer shall assess any health and safety risk that the workers may be exposed to arising from the use of chemical agents as stated in **Legal Notice 227 of 2003**. The following points need to be taken into consideration:

- The hazardous properties of lead;
- Information on health and safety provided by the supplier which must include the relevant Material Safety Data Sheet;
- The level, type, duration and frequency of exposure;
- The circumstances of the work which includes the amount of lead involved;
- Occupational exposure limit values or biological limit values;
- The effect of preventive and control measures which have been or will be taken;
- If available, conclusions to be drawn from any health surveillance already undertaken.

# Hierarchy of Prevention

## Elimination and Substitution

The most practical way by which lead can be eliminated is by replacing lead-containing material with a less hazardous material such as:

- Applying a non-leaded paint rather than one which contains lead. Care must be taken whenever substituting with a less hazardous material, to ensure that it does not contain equally or more toxic compounds, such as cadmium or chromium. The material safety data sheet (MSDS) can be checked to help identify potentially hazardous components.
- Process equipment can be changed, such as using less dusty methods for example vacuum blast cleaning, wet abrasive blast cleaning, shrouded power and chemical stripping in order to substitute for open abrasive blast cleaning thus reducing exposure to respirable airborne particulates, which contains lead.
- Demolition work can be performed using hydraulic shears instead of a cutting torch in order to reduce exposure to lead fumes generated by heating lead compounds.

## Engineering Controls

As lead generates airborne hazards, engineering measures may include local and general exhaust ventilation, process and equipment modification, material substitution, component replacement, isolation or automation.

Some engineering controls which can be used, to reduce worker exposure to lead include:

- Ventilation; local or dilution. Local exhaust ventilation includes portable ventilation system and shrouded tools, which are supplied with ventilation. Options were lead being released is localised includes welding, brazing and casting operations.
- Exhaust Ventilation Power Tools – which can be used for the removal of lead-based paint and which is equipped with dust collection shroud exhausted through high efficiency particulate air (HEPA) vacuum system.
- Enclosure/encapsulation – lead-based paint can be made inaccessible by encapsulating with material bound to surface such as acrylic or epoxy coating or through flexible wall coverings or by enclosing it in gypsum wallboard, plywood panelling and aluminium, vinyl or wood exterior siding.
- Process modification – wet working methods can minimise amount of lead dust which is produced. Lead or lead-containing materials are cut by hand sawing or mechanical shearing rather than using oxy-fuel torches or arc-air gouging.

## Administrative Controls

Administrative controls include:

- Worker education and training. Workers require training and instruction on hazards of lead, correct operation and use of engineering controls, eg. Local exhaust ventilation systems, proper use of personal protective equipment.
- Good housekeeping. Workers must maintain work areas and surfaces clean. Surfaces cannot be wiped or swept as this will raise lead dust in the air.
- Proper use of washing facilities and clean eating and drink areas. Adequate washing, showering and change facilities have to be provided. A separate room isolated from work area must be provided for storing food, drinking and eating food.
- Safe work procedures. Employers must ensure safe work procedures where workers are exposed to lead.

- Maintenance of equipment. Employers must ensure that equipment is working properly especially engineering controls such as local exhaust ventilation which remove lead fume and dust. Workers must cooperate with their employer and report equipment problems and failures.
- Scheduling of the work or the worker. The amount of time a worker is exposed to lead should be minimised through job rotation and different work assignments.

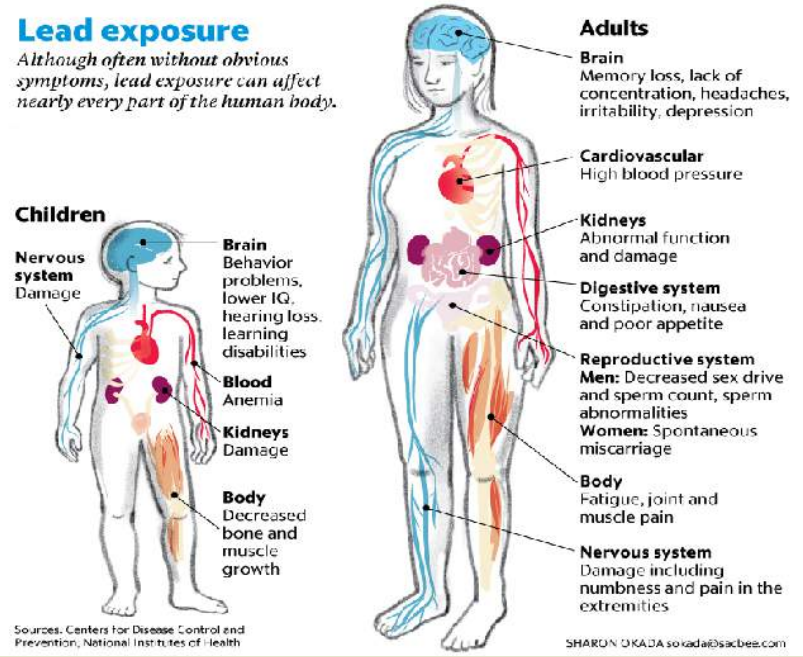
Implementation of a health protection program. If the workers are being exposed to high levels of lead, a health protection program has to be in place whereby employers will undergo the regular monitoring of blood lead levels of workers.

However if feasible engineering controls and work practice controls do not minimise worker exposure to lead, personal protective equipment must be used to complement the engineering and work practice controls.

## Personal Protective Equipment

In case of residual exposure, where the workers are still exposed to a particular chemical after all possible measures were taken, the use of personal protective equipment (PPE), must be enforced. This is always the last resort. In any processes which generate airborne lead levels, employers must ensure that employees are given the appropriate personal protective equipment which includes coveralls, shoe covers, head covers, gloves and respirators.

Leather gloves or the equivalent must be used when unencapsulated lead bricks are used. Gloves and protective clothing are more appropriate when solvents and caustics are used. Contaminated clothing and equipment must not reach worker's home or vehicle.



## Limit Values and Health Surveillance

Employees whose exposure to lead is significant must be placed under medical surveillance. In fact, Legal Notice 36/03 states that "a worker is entitled to undergo health surveillance at regular intervals, and for this purpose an employer shall ensure that workers are provided with health surveillance appropriate to the health and safety risks at work, and shall make all arrangements as are required".

Health surveillance programmes for workers exposed to lead can be divided into two distinct parts: biological monitoring and medical examination.

Schedule I of Subsidiary Legislation 424.24, L.N 227 of 2003 lays down a binding occupational exposure limit value of inorganic lead (and its compounds) of 0.15 mg $m^{-3}$ (8 hours time limit value). Meanwhile Schedule II states that the binding biological limit value of blood-lead level (PbS) using absorption spectroscopy is 70µg Pb/100ml blood. Medical surveillance has to be carried out if the exposure to a concentration of lead in air is greater than 0.075 mg/$m^3$, which is calculated as a time-weighted average over 40 hours per week, or if the blood-lead level greater than 40 µg Pb/100 ml blood is measured in individual workers.

Health surveillance must be designed to detect workers who are particularly sensitive to lead and its ionic compounds, whether permanently or temporarily, for example: workers of childbearing age, workers with changes in target organs, etc. Their detection will allow, as far as possible, the worker's job to be adapted to their condition by establishing special prevention measures required to preserve their health.

The medical examination should include the following:

- A full work history
- A clinical history exploring previous history and current effects on target organs. It is also important to collect information on smoking, alcohol intake, medication and exposure to lead outside work.
- Physical examination focusing particularly on digestive and cardiovascular systems (including taking blood pressure) and also on the nervous system.

Persons responsible for health surveillance should also be responsible for developing and applying the biological monitoring programme, regardless of the use made of this within the undertaking.

Biological monitoring should include the determination of lead in blood (PbB). This serves two main purposes: on the one hand, as a supplement to the environmental moni-

toring (assessment of exposure) and, on the other hand, as a tool of occupational medicine integrated in the health surveillance of exposed workers. Other tests which may be included on a non-routine basis and always on medical advice are:

- Haemoglobin concentration and haematocrit value.
- Zinc protoporphyrin levels (PPZ). PPZ levels are indicators of long-term effects. These could be useful when there are discrepancies between environmental and biological values.
- Other indicators such as lead in urine, erythrocyte ALAD activity, delta-aminolevulinic acid, levels of coproporphyrin in urine and even the concentration of lead in the hair. The usefulness of such tests will always be complementary and they must never be established as the alternative to lead in blood but as a complement to it.

Exceeding the biological limit value of 70µg Pb/100ml blood stated in Schedule II of Subsidiary Legislation 424.24 will entail the compulsory removal of the worker from his/her job and the performance of bimonthly checks until the value is, on two consecutive occasions, below the binding biological limit value.

The non-existence of 'safe' values to avoid repercussions on the foetus or breastfed child, which exposure to lead and its ionic compounds may have, makes it advisable to avoid exposure on the part of a pregnant or breastfeeding worker to levels of lead in blood which are greater than those of the general reference population. For this reason, care is to be taken to see that this level is not exceeded and that the job is immediately changed if it is.

In workers under 18, the cut-off level will be 50µg/dl, using the same reinstatement procedure as for adult workers.

The prevention of changes affecting reproduction in the exposed population (among both men and women) makes it advisable to reduce the exposure of workers of childbearing age to lead as far as possible. In the case of men, the critical period will be 90 days prior to conception. In women, keeping lead levels in blood below 25-30µg/dl would be advisable, given that lead is also a toxin which accumulates in the body and can be released during pregnancy or breastfeeding.

## Vulnerable Groups

Lead is toxic to children including the unborn child. As a result, its exposure to all workers under 18 years of age and to pregnant workers is prohibited by local legislations (Subsidiary Legislation 424.10, and Subsidiary Legislation 424.11).

# References

Burton's line in lead poisoning. https://www.karger.com/Article/Fulltext/98100 (accessed March 1, 2016).

ILO Encyclopedia http://www.ilo.org/legacy/english/protection/safework/cis/products/safetytm/metals.htm (accessed March 1, 2016).

Lead and the workplace. http://www.cwa-union.org/pages/lead_the_workplace (accessed March 1, 2016).

Lead and you. http://www.hse.gov.uk/pubns/indg305.pdf (accessed March 1, 2016).

Lead Fact Sheet. https://www.des.umd.edu/os/rest/lead.html (accessed March 1, 2016).

Lead Preventing Exposure at Work. http://www.worksafebc.com/publications/health_and_safety/by_topic/assets/pdf/lead.pdf (accessed March 1, 2016).

Occupational Safety & Health Administration. https://www.osha.gov/dts/osta/otm/otm_v/otm_v_3.html (accessed March 1, 2016).

Parmeggiani, L. Encyclopaedia of occupational health and safety, 3rd (revised) ed.; International Labour Office: Geneva, Vol. 2; 1197:1199.

Practical guidelines of a non-binding nature on the protection of the health and safety of workers from the risks related to chemicals agents at work. http://ec.europa.eu/transparency/regdoc/rep/2/2004/EN/2-2004-1594-EN-1-0.Pdf (accessed March 1, 2016)

Public Health Statement for Lead. http://www.atsdr.cdc.gov/phs/phs.asp?id=92&tid=22 (accessed March 1, 2016).

**Legal Notices**

General Provisions for health and safety at work places regulations, Subsidiary Legislation 424.18.

Protection of the health and safety of workers from the risks related to chemical agents at work regulations, Subsidiary Legislation 424.24.

Protection of young workers at work places regulations, Subsidiary Legislation 424.10.

Protection of maternity at work places regulations, Subsidiary Legislation 424.11.

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