CLEARING THE AIR: A CASE STUDY ON MANAGING THE RISK OF LEAD DUST

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INTRODUCTION

A property owner had been managing the risk of exposure to lead through a workplace protocol known as a lead dust management plan (LDMP). The contaminated dust was in ceiling cavities and there was potential for various contractors to encounter the dust during general maintenance activities. The owner was concerned about the effectiveness of this LDMP and faced the prospect of a costly and disruptive remediation project.

QED Environmental Services (QED) was commissioned to conduct a desktop risk assessment involving the review of previous sampling reports. As you will read, QED determined that adopting a site specific approach to the issue resulted in an in-depth understanding of the relative risk of exposure to lead and was able to suggest critical controls. This also fruited secondary benefits of significant cost savings for the client, by adopting a staged risk assessment regime and resisting a large disruptive, and ultimately inconclusive, remediation project.

HIERARCHY OF CONTROL

In assessing this project, QED considered the *Hierarchy of Controls.*

The Hierarchy of Controls is a framework used in occupational health and safety to manage and minimise workplace hazards and risks. It is a systematic approach that helps organisations prioritise and implement control measures to protect workers and create a safer work environment.

The hierarchy of control is typically applied in the following order (order of effectiveness), with the first four elements being referred to as 'above the line' controls, and the last two elements being 'below the line' controls.

Elimination: The most effective and preferred control measure is the complete elimination of the hazard. This means finding ways to remove the hazard entirely from the workplace. While this is not always feasible, it should be the first consideration.

Substitution: If elimination is not possible, the next best option is to substitute the hazardous substance, process, or equipment with something safer. This involves replacing the hazard with a less dangerous alternative.

Engineering Controls: Engineering controls involve modifying the workplace or equipment to reduce exposure to hazards. Examples include installing machine guards, ventilation systems, or noise enclosures to reduce the risk of accidents and exposure to harmful substances.

Administrative Controls: Administrative controls are procedures and policies that help minimise risk. This includes measures such as training, job rotation, and establishing safe work practices. While important, they are not as effective as the previous measures.

Personal Protective Equipment (PPE): When all other control measures have been exhausted, or while waiting for more effective solutions to be implemented, workers may be required to use PPE to protect themselves from hazards. PPE can also be used as an immediate control to protect worker until other higher order controls can be implemented. PPE alone must not be relied upon as any failure of this control may result in worker exposure.

In the case of this particular project, eliminating the risk was virtually impossible. You simply cannot remove all of the lead dust from the ceiling due to a large number of access constraints.

As we worked through the hierarchy a few things became clear:

- Only a small number of trained people ever need to enter the space.
- When they do enter the space it is for a short period of time.
- Physically accessible areas had relatively low levels of dust loading.
- Wearing the appropriate PPE combined with the above would be enough to fall within an acceptable level of risk and unlikely to result in elevated blood lead levels.

This gave us the opportunity to consider the risk in a totally different way than had been done before and importantly offered the client a more cost-effective solution, while still adhering to the risk management that is necessary in this situation.

Read on to learn more about the details of the project and our approach to it.

BACKGROUND

Prior to 1970, lead was used widely in industry, added to petrol and paints. Lead-containing dust accumulation and generation is related to industrial pollution, car exhausts, breakdown of old lead paint or emissions from burning coal or lead-painted wood. It is most common in ceiling spaces where it has built up over many years.

Localised studies have also included other sources such as the local geology, or proximity to mines, smelters and ports that handle materials that may contain traces of lead.

Lead is a naturally occurring metal and is a toxic substance that affects numerous systems/organs and bioaccumulates in the body is the level of absorption is greater than the rate of excretion. Therefore, even small amounts of lead can pose a health hazard over time. It is generally more toxic to pregnant women, the foetus, and infants due to differences in bone structure and bioavailability.

The duties contained in the Work Health and Safety Regulations apply to workplaces where lead processes are undertaken. A lead process is a process that generates lead dust, fumes or mist.

Table 1: Sources of Lead Hazards

Approximate date of construction	Sources of lead hazards
1920-1990s [ongoing]	Paint, [mining, smelting]
1920-1978	Plumbing,
1923-1986	Automobile exhaust (may accumulate as ceiling dust)

‡Source: Code of Practice Demolition Work, SafeWork NSW (September 2016)

HEALTH EFFECTS

Lead is a toxic substance that can affect people of any age. Lead can be hazardous when taken into the body by ingestion or inhalation of lead or materials contaminated with lead.

The health effects associated with lead occur via an accumulative effect within the human body. Depending on the amount of exposure, side effects of lead poisoning would not be apparent for many years.

Young children are particularly vulnerable to the toxic effects of lead and can suffer profound and permanent adverse health effects, particularly affecting the development of the brain and nervous system.

Lead also causes long-term harm in adults, including increased risk of high blood pressure and kidney damage. Exposure of pregnant women to high levels of lead can cause miscarriage, stillbirth, premature birth and low birth weight, as well as minor malformations.

Adults are most often exposed to lead if they work in a job which involves lead processes. It is therefore recommended that workers associated with lead processes have regular medical examinations to monitor the amount of lead in their system.

Lead processes generally relates to abrading or burning lead or lead painted surfaces. Other common sources of lead dust or fumes are as follows:

- Lead based paints, when removing paint by sanding or heat (e.g. creating dust), or when welding or cutting steel coated with lead or lead based paints.
- Welding, oxy cutting of steel coated with lead-based paint or primer.
- Dismantling of equipment containing lead-based paint.

LEAD PROCESS DEFINITION

Critical understanding for this project was to anticipate if the works within the ceiling cavity would constitute a lead process. This would trigger the following actions and controls required under the WHS legislation. The Regulations, Clause 392, defines a lead process as consisting of any of the following carried out at a workplace:

- work that exposes a person to lead dust or lead fumes arising from the manufacture or handling of dry lead compounds,
- work in connection with the manufacture, assembly, handling, or repair of, or parts of, batteries containing lead that involves the manipulation of dry lead compounds, or pasting or casting lead,
- breaking up or dismantling batteries containing lead, or sorting, packing, and handling plates or other parts containing lead that are removed or recovered from the batteries,
- spraying molten lead metal or alloys containing more than 5% by weight of lead metal,
- melting or casting lead alloys containing more than 5% by weight of lead metal in which the temperature of the molten material exceeds 450°C,
- recovering lead from its ores, oxides, or other compounds by thermal reduction process,
- dry machine grinding, discing, buffing, or cutting by power tools alloys containing more than 5% by weight of lead metal,
- machine sanding or buffing surfaces coated with paint containing more than 1% by dry weight of lead,
- a process by which electric arc, oxyacetylene, oxy gas, plasma arc or a flame is applied for welding, cutting, or cleaning, to the surface of metal coated with lead or paint containing more than 1% by dry weight of lead metal,
- radiator repairs that may cause exposure to lead dust or lead fumes,
- fire assays if lead, lead compounds or lead alloys are used,
- hand grinding and finishing lead or alloys containing more than 50% by dry weight of lead,
- spray painting with lead paint containing more than 1% by dry weight of lead,
- melting lead metal or alloys containing more than 50% by weight of lead metal if the exposed surface area of the molten material exceeds 0.1 square metre and the temperature of the molten material does not exceed 450°C,

- using a power tool, including abrasive blasting and high pressure water jets, to remove a surface coated with paint containing more than 1% by dry weight of lead and handling waste containing lead resulting from the removal,
- a process that exposes a person to lead dust or lead fumes arising from manufacturing or testing detonators or other explosives that contain lead,
- a process that exposes a person to lead dust or lead fumes arising from firing weapons at an indoor firing range,
- foundry processes involving:
- melting or casting lead alloys containing more than 1% by weight of lead metal in which the temperature of the molten material exceeds 450°C, or
- dry machine grinding, discing, buffing, or cutting by power tools lead alloys containing more than 1% by weight of lead metal,
- a process decided by the regulator to be a lead process under clause 393.

SUMMARY OF LEAD DUST CRITERIA

There is very little guidance either domestically or internationally as to acceptable levels of lead in settled dusts. Information within Australian Standard (AS)4361.2:1998 was rescinded when the updated standard was published in 2017. Furthermore, this information was explicitly to be used for validation of post surface upon completion of lead abatement work and not to be used for acceptability of settled dust in workplaces.

Australian Standard (AS) 4874:2000, Guide to the Investigation of Potentially Contaminated Soil and Deposited Dust as a Source of Lead Available to Humans (AS4874:2000) discusses the risk assessment process but does not offer any specific guidance levels or suggest acceptable criteria.

Values for lead content in soil are frequently adopted from the National Environment Protection Measure (NEPM) Guideline on the Health Based Investigation Levels (HSL's) contained with Schedule B7; however, applying the soil criteria alone should not substitute the requirement for a detailed task and environmental risk assessment as the exposure profiles between dust and soils are different.

NEPM provides thresholds based upon concentration (mg/kg) which can then be translated into a percentage weight for weight lead content. For example, a sample of lead dust that contains lead at, or greater than 10,000 mg/kg could be described as lead at or above 1% dry weight for weight. In such circumstances, it would be concluded that working with dust of this nature would constitute a lead process as per the Regulations. Conservative trigger values of 1,200 mg/kg (0.012 %) (NEPM Residential - B), or 1,500 mg/kg (0.15%) (Commercial / Industrial – D) may be used to initiate qualitative risk assessments.

John H. Lange of Envirosafe Training and Consultants (Pittsburgh) authored a study titled "A suggested lead surface concentration standard for final clearance of floors on commercial and industrial buildings" within the Indoor Built Environment publication (2001). This report suggested levels of lead in dust on floors, upon completion of remedial work in commercial and industrial buildings that were occupied by adults (not child related or public housing). This publication also discussed estimated BLL increases in relation to surface dusts loading with a nominal gastrointestinal absorption rate (ingestion) of 35%.

Other international guidance is commonly referred to in lieu of any domestic guidance. Information published by the Brookhaven National Laboratory in IH75190 – Surface Wipe Sampling for Metals, Attachment 9.3 – Required and Recommended Surface Wipe Criteria is frequently referred to.The Brookhaven Values have been adopted from the American Occupational Safety and Health Administration.

Table 2 summarises the evaluated domestic and international lead dust thresholds. Unit values have been harmonised from their respective sources for ease of interpretation.

Table 2: Summary of reviewed lead dust levels.

Referenced Lead CriteriaLevel (µg/100cm2)	Reference Source
1.1	US EPA dust-lead clearance levels (DLCL) - Floors
11	US EPA dust-lead clearance levels (DLCL) - Windowsills
10	Australian Standard (AS)4361.2:1998 – Clearance level for floors
50	Australian Standard (AS)4361.2:1998 – Clearance level for windowsills
80	Australian Standard (AS)4361.2:1998 – Clearance level for external surfaces
22	Brookhaven National Laboratory in IH75190 - OSHA 1926.62 Construction Sites: change areas, storage facilities, & lunchrooms [Housekeeping]
107.6	John H. Lange of Envirosafe Training and Consultants (Pittsburgh) - buildings where there are other lead containing materials
118.4	John H. Lange of Envirosafe Training and Consultants (Pittsburgh) - buildings where there are NO other lead containing materials

THE PROJECT

The site our client asked us to inspect was a shopping centre complex with several tenants and common areas. There had been various additions, refits and tenant movements over several years with ceilings being removed and replaced at different times.

As required by the state legislation, the site has an asbestos and hazardous materials register. Furthermore, other supporting asbestos and hazardous materials registers were developed by tenants prior to refurbishment and demolition work commencing.

During these assessments dust within the ceiling cavities had been sampled and analysed for lead content. Varying levels of lead have been identified within the ceiling cavity dusts and often correlated to estimated replacement of ceilings.

In response to the lead containing dusts, the client had commissioned and implemented a LDMP to assist with the ongoing management and to prevent, or minimise so far as reasonably practicable, the exposure of workers and other stakeholders, to lead containing dust.

THE OBJECTIVE

The objective of the report was to review all available documentation relating to lead dust at the site, compare results to relevant legislative requirements, subordinate guidance material and where appropriate, other supporting documentation and best practice advice as detailed in Table 2.

Upon review of the previous sampling reports, QED conducted a qualitative risk assessment based upon workers who were likely to encounter settled dust within the ceiling cavity. This group of workers were the primary receptors. Secondary receptors were also considered within the risk assessment as being any other occupancy of the site.

THE FINDINGS

Part 7.2 of the SafeWork WA Work Health and Safety (General) Regulations (Regulations), details information relating to lead processes and lead risk work; however, there is little agreement, or specific information with respect to acceptable levels of lead in dusts.

The current Workplace Exposure Standard (WES) is set by SafeWork Australia at 0.05mg/m3 (dust by inhalation); however, a lead risk task is determined by the potential for an increase in blood lead levels (BLL) as described within the Regulations.

The former National Occupational Health and Safety Committee (NOSHC) had previously provided guidance between airborne lead concentrations and observed BLL increases. This information was updated to current BLL levels and used as a component of this risk assessment.

There is little guidance on other exposure pathways such as ingestion, which may also lead to accumulation of lead and an increase of the BLL.

Dermal absorption is not of significant concern as the skin provides a suitable barrier to prevent lead absorption.

The risk of lead exposure through inhalation is dependent on an understanding of the concentration of lead within the dusts, volume of dust present in the ceiling cavities, and the potential of the dust to become airborne in significant concentrations.

As the ‘dose’ of an agent is directly related to the concentration and duration of exposure, consideration was also given to the frequency and duration of the tasks within the ceiling cavity where a worker may be exposed; along with the training and Personal Protective Equipment (PPE) used.

Exposure through ingestion was considered unlikely as all works within the ceiling cavity are subjected to the requirements of the LDMP which prescribes documentation, procedural and PPE controls.

Based upon the results and scenarios detailed within the risk assessment report, it was considered unlikely that workers conducting routine and ad-hoc maintenance works within the ceiling cavity would be exposed to lead levels that would qualify as a lead risk task.

With consideration to surface recontamination, any lead dust remediation work would require a complete decontamination of all surfaces, equipment, services etc within the ceiling cavity; partial remediation (as previously recommended) would provide a temporary reduction in lead levels only as recontamination has been shown to occur. Dilution by resuspension of lead dusts may occur; however, the variance in lead concentration would not be deemed significant.

The LDMP adopted threshold of 22µg/100cm2 (Brookhaven Laboratory) would be ideal for generally occupied spaces; however, may not be suitable for ceiling cavities where potential exposure is limited to contractors requiring a permit to work under the LDMP. Furthermore, the works were reported to be short duration and intermittent. As such, the adopted threshold should be considered a trigger for a risk assessment and not a trigger for remedial action.

RECOMMENDATIONS

Based upon the findings of our qualitative risk assessment, the following recommendations were presented by QED:

- Continue to implement the site LDMP and hazardous materials register with periodic reviews as required, with particular emphasis upon the following:
    - Ensuring all contractors undertaking works in the ceiling cavity have undergone lead dust awareness training and understand the risks, controls and processes required.
    - Requirements for PPE and RPE - including respiratory fit testing.
    - Ensuring good housekeeping and work area (below ceiling) is cleaned upon completion.
    - Ensure good personal hygiene practices including washing of face and hands.
- Ensure any further dust samples are collated and documented as per the LDMP. Samples may be collected as 10x10cm templates reported as µg/100cm2 or as bulk dust samples reported as mg/kg.
- Consideration given to supplementing this qualitative risk assessment with personal exposure monitoring during any routine maintenance works within the ceiling cavity.

CONCLUSION

The risk of lead exposure through inhalation is dependent on an understanding of the lead concentration within bulk dust accumulations, the volume of dust present in the ceiling cavities, and the potential of the dust to become airborne in significant concentrations.

As the 'dose' of an agent is directly related to the concentration and duration of exposure, consideration was given to the frequency and duration of the tasks within the ceiling cavity where a worker may be exposed; along with the training and Personal Protective Equipment (PPE) used.

Exposure through ingestion is also considered unlikely as all works within the ceiling cavity are subjected to the requirements of the LDMP when gloves and personal hygiene practices are required.

The adopted lead criteria threshold of 22µg/100cm2 would be ideal for generally occupied spaces; however, may not be suitable for ceiling cavities where potential exposure is limited to contractors requiring a permit to work under the LDMP, works are reported to be short duration and intermittent.

As such, the adopted threshold should be considered a trigger for a risk assessment and not a trigger for remedial action.

Based upon the results and scenarios detailed within this report, it is unlikely that workers conducting routine and ad-hoc maintenance works within the ceiling cavity would be exposed to lead levels that would qualify as a lead risk task.