1.0 INTRODUCTION

This Technical Bulletin contains information on inorganic lead and inorganic lead compounds, its health effects, what industries it may be used in. This bulletin also covers certain aspects of the current Health and Safety legislation (to 1 February 2000) and the requirements of employers when employees are ‘significantly’ exposed to inorganic lead, and the requirements of a Respiratory Protective Equipment (RPE) programme for protection against inorganic lead. Lead alkyls (organic lead) are not covered in this bulletin.

This Bulletin provides general guidance only. Appropriate specialist advice should always be sought where necessary.

2.0 LEAD

Inorganic lead and lead compounds (to be known as lead) are used extensively throughout industry. However, some processes may generate lead dust, fumes or vapours which are hazardous to health. Examples of industries and processes in which individuals may be exposed to lead include:

- Lead smelting, refining, alloying and casting
- Lead acid batteries manufacture and breaking
- Manufacturing lead compounds
- Working with metallic lead and alloys containing lead, for example soldering
- Manufacturing leaded-glass
- Some painting of buildings and bridges; some spray-painting of vehicles
- Hot cutting of demolition and dismantling operations and recovering lead from scrap and waste
- Manufacturing pigments and colours
- Manufacturing and using ceramic glazes and colours
- Manufacturing ceramic transfers
- Jewellery and badge enamelling
- Furniture restoration

3.0 HEALTH EFFECTS OF LEAD

There are two forms of lead and lead compounds, Inorganic Lead and Lead Alkyls. This bulletin deals only with inorganic lead and its compounds. Lead alkyls are used as additives in the petrochemical industry.

3.1 Routes of Exposure

The primary route of exposure for lead is individuals inhaling dusts, fumes or vapours. Once in the lungs lead may pass into the blood stream where it will be transported around the body finally being deposited mainly in bones.

The secondary route of exposure is through ingestion. Lead may enter the stomach as a result of individuals eating, drinking, smoking or biting their nails when their hands are contaminated with lead.

Only lead alkyls (organic lead) can enter the body through Skin Absorption.

All Lead is slowly metabolised over time and excreted in the urine.
### 3.2 Occupational Exposure Limits

The Occupational Exposure Limit (OEL) for lead is:
- Inorganic lead - 0.15 milligrams per cubic metre (mg/m³) 8 hour Time Weighted Average (TWA).

### 3.3 Health Effects of Lead Exposure

The short term (Acute) and long term (Chronic) health effects of lead exposure are presented in Table 1.

#### HEALTH EFFECTS OF INORGANIC LEAD

<table>
<thead>
<tr>
<th>Acute Health Effects</th>
<th>Chronic Health Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-specific with lassitude (weariness)</td>
<td>Peripheral motor neuropathy (especially wrist drop)</td>
</tr>
<tr>
<td>Abdominal cramps and constipation</td>
<td>Anaemia</td>
</tr>
<tr>
<td>Myalgia (muscle pain)</td>
<td></td>
</tr>
<tr>
<td>Anorexia</td>
<td></td>
</tr>
</tbody>
</table>

### 3.4 Tasks Prohibited for Woman and Young Persons

In pregnant woman lead in blood can pass across the placenta and into the blood of the foetus affecting the foetus’s development. Under the Control of Lead at Work Regulations 1998 (CLAW) women (of reproductive capacity) and young persons are prohibited from carrying out certain tasks. Young persons (those under 18 years) are also prohibited as they generally have less experience working with substances as hazardous as lead. These prohibited tasks are presented in Table 2.

#### TASKS PROHIBITED FOR WOMEN* AND YOUNG PERSONS**

<table>
<thead>
<tr>
<th>Process</th>
<th>Tasks</th>
</tr>
</thead>
</table>
| Lead Smelting and Refining Processes         | ● Handling, treatment, smelting or refining of ores or material > 5% lead  
                                       | ● Cleaning of any of the above places                                   |
| Lead-Battery Manufacturing Process          | ● Manipulation of lead oxides                                         |
                                       | ● Mixing/ pasting in manufacture or repair                            |
                                       | ● Melting or casting                                                  |
                                       | ● Trimming, abrasiding or cutting pasted plates                       |
                                       | ● Cleaning of any of the above places                                 |

Notes:  
* Woman of reproductive capacity.  
** Young person under 18.

### 3.5 Lead in Blood Levels

To reduce the probability of individuals developing adverse health effects, CLAW prescribes two blood-lead concentration limits called the ‘Action Level’ and the ‘Suspension Level’. Table 3 illustrates the blood-lead concentration in microgram per decilitre (µg/dl) of the two levels.

#### INORGANIC LEAD BLOOD-LEAD CONCENTRATION LEVELS

<table>
<thead>
<tr>
<th></th>
<th>Action Level</th>
<th>Suspension Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women*</td>
<td>25 µg/dl</td>
<td>30 µg/dl</td>
</tr>
<tr>
<td>Young people**</td>
<td>40 µg/dl</td>
<td>50 µg/dl</td>
</tr>
<tr>
<td>Men</td>
<td>50 µg/dl</td>
<td>60 µg/dl</td>
</tr>
</tbody>
</table>

Notes:  
* Woman of reproductive capacity.  
** Young person under 18.
CONTROL OF LEAD AT WORK REGULATIONS 1998 (CLAW)

4.0

Risk Assessment

Before an employer commences any work which may be liable to expose their employees to lead, they must carry out a suitable and sufficient Risk Assessment. The risk assessment should allow the employer to determine whether the work will result in employees being ‘significantly’ exposed to lead and to identify the measures needed to adequately prevent or control exposure.

The risk assessment should:
- Identify the lead compounds and in which form (dust, fume, etc.).
- Determine the potential health effects of exposure.
- Consequences of possible failure of control measures.
- Air monitoring results.
- Blood or Urinary Lead Concentrations.

4.1

Significant Exposure

Significant exposure is defined as:
- Employees who are exposed to more than half the OEL for lead.
- Where there is a substantial risk of any employee ingesting lead.
- Blood Lead concentrations exceed:
  - 35 µg/dl (Others)
  - 20 µg/dl (Women)

Table 4 illustrates tasks likely to cause significant exposure.

| TABLE 4 |
| TASKS LIKELY TO CAUSE SIGNIFICANT EXPOSURE UNLESS EXPOSURE IS ADEQUATELY CONTROLLED |
| Tasks | Industries and processes |
| High temperature lead work (>500°C) e.g., smelting, melting, refining, casting and recovery processes, lead burning, welding and cutting | Lead smelting and refining |
| | Casting of certain non-ferrous metals (e.g., gun metal) |
| | Lead sheet manufacture |
| | Ship building, breaking and repairing |
| | Chemical industry |
| | Miscellaneous industry |
| Work with lead compounds which give rise to dust in air (other than low solubility lead compounds) | Manufacture of lead acid batteries and breaking |
| | Painting and colour manufacture |
| | Mixing and melting process in glass industry |
| | Colour preparation and glazing in pottery industry |
| | Work with low solubility lead compounds where poor working practises and standards of cleanliness exist |
| Abrasion of lead, e.g., dry discing, grinding, cutting by power tools | Miscellaneous industry |
| Spraying of lead paint and lead compounds | Painting of bridges, buildings with lead paint |
| Work with low solubility inorganic lead compounds | Work poorly controlled |
| Craft work | Furniture restoration |
4.2 Prevention or Control of Exposure

If employees are exposed to “significant” levels, employers are required to prevent or control exposure by means other than Personal Protective Equipment (PPE) or Respiratory Protective Equipment (RPE).

However, where prevention or controls do not prevent or adequately control exposure RPE and PPE may be used in addition. Control of exposure shall only be treated as adequate if the OEL is not exceeded. Table 5 illustrates examples of prevention and control measures.

4.2.1 Maintenance of Control Measures

Every employer who provides control measures, e.g., engineering controls or PPE, shall ensure it is maintained in efficient state.

The controls measures must be:
- Visually examined once a shift.
- Exhaust ventilation must be thoroughly maintained and tested at least 14 monthly.
- RPE must undergo monthly maintenance and inspections.
- Routine air monitoring compared to determine if they are effective.

4.3 Lead in Air Monitoring

Where it has been determined that exposure is “significant”, air monitoring should be carried out to show compliance with the lead OEL. Monitoring should be carried out within the breathing zone of the employees, with the effect of any RPE taken into account. Personal exposure monitoring must be carried out at least 3 monthly.

Static sampling should not be used to determine personal exposure, but may be used to supplement personal sampling, e.g., to check on the effectiveness of engineering control measures. Guidance should be sought from an Occupational Hygienist before any monitoring is undertaken. Records of the monitoring must be kept for a minimum of 5 years.

4.4 Eating, Drinking and Smoking

As there is a substantial risk of ingesting lead, employers are required to ensure that employees do not:
- Eat, drink, smoke in any place liable to be contaminated with lead.
- And they must make suitable arrangements to provide facilities for eating, etc.

Employees have a duty not to eat, etc., where they believe it to be contaminated.
5.0 MEDICAL SURVEILLANCE

Those who are, or likely to be significantly exposed to lead, are required to undergo Medical Surveillance. This section gives an outline of a medical surveillance required by CLAW.

5.1 Initial Assessment

An initial assessment must be carried out on all new employees likely to be significantly exposed to lead, by a suitable doctor within 14 days of commencing work. The assessment will include:
- Biological monitoring - measurement of blood lead concentration. If significant, the employee must be placed under medical surveillance.
- Details of their occupation record.
- Clinical assessment of medical history.
- Measurement of baseline blood level and haemoglobin.

5.2 Periodic Assessment

Following the initial assessment, employees will be required to undergo subsequent biological monitoring of not more than 12 months. The frequency of the biological monitoring will depend on the past results, or the initial assessment. Table 6 illustrates the frequency of the periodic assessment.

<table>
<thead>
<tr>
<th>Category</th>
<th>Blood-lead Concentration (µg/dl)</th>
<th>Maximum Interval Between Blood Lead Measurements</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&lt; 30</td>
<td>12 months</td>
<td>Indicates lead absorption is reasonably well controlled. Intervals between blood levels should not be longer than 6 months unless on the two previous occasions the air monitoring was exposed to &lt; 0.1 mg/m³.</td>
</tr>
<tr>
<td>B</td>
<td>≥30 to &lt;40</td>
<td>6 months</td>
<td>Lead is being absorbed due to occupational exposure. Other suitable tests may be undertaken other than blood, provided that a blood lead measurement is carried out at least 6 monthly.</td>
</tr>
<tr>
<td>C</td>
<td>≥40 to &lt;50</td>
<td>3 months</td>
<td>Also indicates lead is absorbed due to occupational exposure but at a higher rate than B and blood lead concentrations may be approaching Action Level. Other suitable biological tests may be appropriate as for Category B.</td>
</tr>
<tr>
<td>D</td>
<td>≥50 to &lt;60</td>
<td>3 months</td>
<td>Indicates that employees have breached the Action Level and employer should carry out investigation. This also is the range where employees should come under direct medical surveillance in that a clinical assessment and any other relevant biological tests will be carried out at ASAP after the blood lead levels have been confirmed. The clinical examination may be deferred until a measurement of the blood-lead concentration carried out at a time determined by the doctor shows that the action level of 50 µg/dl continues to be breached.</td>
</tr>
<tr>
<td>E</td>
<td>60 +</td>
<td>At the doctor’s discretion, but not more than 3 months</td>
<td>Represents the level above which the medical person will certify the person unfit for work which exposes him to lead.</td>
</tr>
</tbody>
</table>

5.2.1 Medical Surveillance - Record Keeping

Employers are required to keep an adequate health record of all employees for a minimum of 40 years, from date of last entry.
5.3 Blood Lead Concentrations Exceeding Action Level

If an employee’s blood-lead concentration exceeds the Action Level the employer should investigate the reasons why this has been breached to prevent the employees blood-lead concentration from reaching the Suspension Level. The employer should:

- Check that work practices are being followed.
- Check on the effectiveness of control measures. If recent air monitoring has not been conducted then the employer should consider undertaking personal exposure monitoring.
- Ensure if RPE is in use that it is used correctly.
- Check hygiene procedures are followed.
- Consult with the doctor to agree whether any additional protective or preventative measures should be introduced.

5.4 Blood Lead Concentrations Exceeding Suspension Level

If an employee’s blood-lead concentration exceeds the appropriate Suspension Level (SL) the test should be repeated urgently. If the result of the second test is equal to or greater than the SL, the doctor should certify that the employee be taken off work which further exposes the employee to lead. Employers must take steps to determine reason(s) for the high levels blood-lead levels and take action, see section 5.3.

Employers, who are aggrieved by the doctor’s decision can contact the Health and Safety Executive (HSE) within 28 days to apply for the suspension decision to be reviewed.

5.4.1 Employees Suspended from Work

When a doctor certifies an employee should be suspended from work exposing them to lead, the employer is responsible to make sure there is compliance with the certificate. The employer must make every effort to preserve the employee’s employment terms and conditions and re-deploy the employee to suitable alternative work that complies with any conditions certified by the doctor.

5.4.2 Individuals with Higher Suspension Levels

Some individuals, excluding woman of reproductive capacity, who have worked a long time in the lead industry may have built up a high body lead burden which could take a long time to fall below the suspension level. These individuals are those who have:

1. Been employed on work that has exposed them to lead for more than 20 years.
2. Are aged 40 years or more and may have been employed on work involving exposures to lead for at least 10 years.

For employees who fell into categories 1 or 2) before CLAW was revised in 1998, they may continue to work as long as their blood-lead concentration is less than 80µg/dl.

For individuals who fell into categories 1 or 2) after the introduction of CLAW in 1998, they may continue to work as long as their blood lead concentration is less than 70 µg/dl.

6.0 RESPIRATORY PROTECTIVE EQUIPMENT (RPE)

CLAW states that employers shall prevent, or where this is not reasonably practicable, adequately control exposure to lead other than through the use of PPE.11

However, if despite the use of control measures, personal exposure to lead is likely to exceed the OEL, employers shall provide the employees with suitable RPE to adequately control exposure.

6.1 Selection of RPE

The RPE selected must be suitable for the wearers and the work to be undertaken, the environment and the anticipated maximum exposure.
6.1.1 Some Factors Affecting Performance of RPE

- **Face size and shape:** facial features tend to vary with build, ethnic origin and sex. For tight fitting facepieces an effective seal between the face and respirator is essential - without it the respirator will not give adequate protection.

- **Facial characteristics:** Facial hair (beards and side burns) and spectacles interfere with the seal and reduce the effectiveness of filtering respirators.

- **Work rate and work environment:** Heat can build up which may cause the wearer to loosen the RPE. Sweat can also cause the faceseal to slip.

- **Medical fitness:** Individuals with cardiovascular problems or asthma may find it difficult to draw air through a filtering respirator.

- **Visibility, Mobility and Communication:** important issues to consider.

- **Compatibility with other forms of Personal Protective Equipment.**

Table 7 provides examples of suggested 3M RPE used within the lead industry.

For further guidance please contact the 3M Health & Safety helpline on 0870 6080060 (UK) and 1800 320 500 (Ire).

7.0 INFORMATION, INSTRUCTION AND TRAINING

Employers must provide employees who may be exposed to lead with suitable and sufficient information, instruction and training. Employees must be informed of:

- The health hazards associated with lead.

- How precautions, e.g., engineering control measures, work methods, RPE and PPE, can reduce their exposure and the spread of lead.

- The importance of maintaining control measures, RPE, etc., and reporting defects.

- The results of any personal air monitoring results and medical surveillance.

- Their duties under CLAW.

**TABLE 7**

**SUGGESTED 3M RPE USED WITHIN THE LEAD INDUSTRY**

**Suggested 3M RPE**

**Powered Air**

- Airstream™ AH4/AH4-A
- Dustmaster™ DM1/DM4/DM12
- Breathe Easy™ Plus DM1/BE4/BE1 (+ filters)

**Full Face Mask + Particulate filters, or ABE1 filter and Particulate filter**

- 6000 Full Face Mask (shown opposite) + 2125 (P2) or 2138 (P3), or 6067 (ABE1) + 5935 (P3)
- 7000 Full Face Mask + 2125 (P2) or 2138 (P3), or 6067 (ABE1) + 5935 (P3)

**Half Face Mask + Particulate filters, or ABE1 filter and Particulate filter**

- 6000 Half Face Mask (shown opposite) 2125 (P2) or 2138 (P3), or 6067 (ABE1) + 5935 (P3)
- 7000 Half Face Mask + 2125 (P2) or 2138 (P3), or 6067 (ABE1) + 5935 (P3)

**Filtering Facepiece Respirators (FFP3S/SL)**

- 8835 - (FFP3SL)
- 8832 - (FFP3S)
- 9332 - (FFP3S)

**Filtering Facepiece Respirators (FFP2S/SL)**

- 8822 - (FFP2S)
- 9925 - (FFP2S)
- 9926 - (FFP2S)
- 9320 - (FFP2S)
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HSE Books
Telephone: 01787 881165  Fax: 01787 313995  Website: www.hsebooks.co.uk

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2 Regulation 2 - The Control of Lead at Work Regulations 1998
3 Regulation 5 - The Control of Lead at Work Regulations 1998
4 Regulation 6(2) - The Control of Lead at Work Regulations 1998
5 Regulation 9(1) - The Control of Lead at Work Regulations 1998
6 MDHS 6/3 - Lead and inorganic compounds of lead in air
7 Regulation 10(1) - The Control of Lead at Work Regulations 1998
8 Regulation 10(2) - The Control of Lead at Work Regulations 1998
9 Schedule 2 - The Control of Lead at Work Regulations 1998
10 Regulation 10(3) - The Control of Lead at Work Regulations 1998
11 Regulation 6(4) - The Control of Lead at Work Regulations 1998