# 2024 Report

# *Adult Blood Lead Epidemiology and Surveillance (ABLES) Program*

## *January 1, 2024 – December 31, 2024*

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## EXECUTIVE SUMMARY

This is the summary of the twenty-seventh year of the results of elevated blood lead levels (BLLs) among individuals 16 years and older who live in Michigan. This report covers blood leads tested in 2024. In 2022, the level of blood lead considered elevated was lowered from ≥5 to ≥3.5 µg/dL.

- In Michigan from 1/1/2024 to 12/31/2024, 19,247 adults, who were ≥16 years old, had 20,943 blood lead tests reported to the Michigan Department of Health and Human Services (MDHHS). One thousand one hundred and ninety-nine (6.2%) adults had 1,939 blood tests ≥3.5 µg/dL. Among the 1,199 adults with elevated BLLs, 314 (26.2%) adults had BLLs 3.5–4.9 µg/dL, 515 (43.0%) adults had BLLs 5–9 µg/dL, 278 (23.2%) adults had BLLs 10–19 µg/dL, 68 (5.7%) adults had BLLs 20–29 µg/dL, 16 (1.3%) adults had BLLs 30–39 µg/dL, 5 (0.4%) adults had BLLs 40–49 µg/dL, and 3 (0.3%) adults had BLLs ≥50 µg/dL. The highest BLL was 66 µg/dL.

- In 2022, case follow-up was expanded to identify the source of all BLLs ≥3.5 µg/dL, whereas in previous years case follow-up was focused on BLLs ≥10 µg/dL. In 2024, the source of blood lead was identified in 1,115 (93.0%) of 1,199 adults with BLLs ≥3.5 µg/dl. Follow up is still underway to identify the source of exposure in the remaining 84 (7.0%) adults.

- Among adults with BLLs ≥ 3.5 µg/dL, lead exposure at work was the most common source of exposure (71.4%); including abrasive blasting to remove lead paint on outdoor metal structures such as bridges, or water towers; recycling or refurbishing batteries; fabricating metal products; or exposure to lead fumes or dust from firing guns or retrieving spent bullets at firing ranges. Among the 28.6% with non-work-related exposure, 37.9% of lead exposure was from recreational shooting at firing ranges, reloading, or casting of bullets.

- Thirteen of the 14 laboratories performing blood lead testing on adults have adopted the updated CDC adult blood lead reference value of 3.5µg/dL.

- For the 27 years that BLL surveillance has been conducted in Michigan there has been a downward trend of adults with elevated BLLs, although there has been little decrease since 2020.

- In 2024, six companies inspected by MIOSHA received ten lead related citations.

## BACKGROUND

This report contains data on blood lead tests from the twenty-seventh year of surveillance of BLLs in adults in Michigan. It provides detailed data on individuals, who were ≥16 years old, who had BLLs ≥3.5 µg/dL, whose permanent address was in Michigan in 2024 or those who were exposed to lead while working on a jobsite located in Michigan.

The State of Michigan health department (called the Michigan Department of Community Health until May 2015 when it was renamed the Department of Health and Human Services (MDHHS)) promulgated regulations effective October 11, 1997, that required laboratories to submit reports of both children and adults for any blood testing for lead to the MDHHS. Coincident with the promulgation of this regulation in 1997, Michigan received federal funding from the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC) to monitor adult BLLs as part of the NIOSH Adult Blood Lead and Epidemiological Surveillance (ABLES) program. The NIOSH ABLES surveillance program defines “adults” as individuals 16 years or older. The Michigan ABLES program adopted the NIOSH ABLES definition of an adult.

On 10/28/2021, the CDC lowered the Blood Lead Reference Value (BLRV) from 5.0 µg/dL to 3.5 µg/dL based on the recommendation from the Lead Exposure Prevention and Advisory Committee (LEPAC) (1). This value is based on the 97.5th percentile of the blood lead distribution in U.S. children ages 1–5 years. The calculated 97.5 percentile for adults was also calculated to be 3.5 µg/dL (2). In 2022, the Michigan ABLES program received funding from the State of Michigan to conduct case follow up of blood lead levels (BLLs) ≥3.5 µg/dL.

Recommendations for medical management of adults exposed to lead from the California Department of Public health (CDPH) are in Appendix A and from the Counsel of State and Territorial Epidemiologists (CSTE) are in Appendix B.

Surveillance for lead exposure in adults has focused on occupational exposure because 70 - 80% of adults with elevated BLLs have had exposure to lead at work. In 2018, MIOSHA updated two legal standards related to employer responsibilities for preventing lead exposure in employees: one for general industry and one for construction. The MIOSHA rules require that employees be removed from lead exposure when their BLL is ≥30ug/dL, or if the average of the last three BLLs is ≥20ug/dl, or if the average of all BLLs in the previous 6 months is ≥20ug/dL. An employee may return to work when they have two consecutive BLLs <15ug/dL. The 2018 MIOSHA standard also eliminated the requirement to perform blood testing for zinc protoporphyrin (ZPP), a hemoglobin precursor increased after exposure to lead. All other requirements of the lead standard remain unchanged and are identical to the Federal OSHA standard. In 2024, California lowered allowable BLLs for workers (3). All other states use the Federal OSHA standard of 50 µg/dL (construction) and 60 µg/dL (general industry), with return to work at 40 µg/dL.

If air monitoring shows lead levels above 30 micrograms per cubic meter of air (µg/$m^3$) calculated as an 8-hour time-weighted average (TWA) (MIOSHA/OSHA's action limit) ,

an employer must implement routine air monitoring; training; medical surveillance, including blood testing for lead, medical exams and consultation. See Appendix C and D for a more detailed description of the workplace requirements.

## METHODS

*Reporting Regulations and Mechanism*

Since October 11, 1997, laboratories performing blood lead analyses have been required to report the results of all blood lead tests to the MDHHS. These rules were amended in 2015 to cover blood lead testing in doctors' offices (R 325.9081- 325.9086). Prior to 1997, few reports of elevated BLLs among adults were received.

Laboratories are required to report blood sample analysis results, patient demographics, and employer information electronically. The healthcare provider ordering the blood lead analysis is responsible for completing the patient information, the physician/provider information, and the specimen collection information. Upon receipt of the blood sample for lead analysis, the clinical laboratory is responsible for completion of the laboratory information. All clinical laboratories conducting business in Michigan that analyze blood samples for lead must report all adult and child blood lead results electronically to the MDHHS Childhood Lead Poisoning Prevention Program (CLPPP) within five working days.

Since October 1, 2018, OSHA eliminated the requirement that employers providing blood lead analysis of their employees use a laboratory that met OSHA proficiency testing for blood lead analysis (4). Employers can now use any clinical laboratory which is defined as "any facility that examines materials derived from the human body for the purpose of providing information for the diagnosis, prevention or treatment of any disease or impairment of, or the assessment of the health of, human being. Any facility that meets this definition must have the appropriate CLIA certificate to perform laboratory tests. If a facility is only collecting specimens, a CLIA certificate is not required" (5).

*Data Management*

The electronic record of all blood lead levels ≥3.5 µg/dL on adults ≥16 years old were forwarded from MDHHS CLPPP to the ABLES program at Michigan State University, the bona fide agent of the State for adult blood lead surveillance, where they were uploaded to a Microsoft Access database. The database included demographics, information about source of exposure to lead, and name/address of employer for work-related exposures. Only venous blood leads were entered into the database. Urine, hair, and capillary lead level results were excluded.

When BLL reports were received, they were reviewed for completeness. For blood lead reports ≥3.5 µg/dL that were incomplete, requests were sent to the provider who ordered the test to provide the missing information. No follow-up was performed for BLLs <3.5 µg/dL. Each record entered into the database had a visual quality control check monthly for any data entry errors, duplicate entries, missing data, and illogical data.

*Case Follow-Up*

Provider requests were sent for all BLL's received ≥3.5 µg/dL, unless the source of exposure was already identified or if the report was from an occupational clinic and the name of the employer was identified on the lab report or from previous follow-up in the last five years. Additionally, as of December 2022, postcards requesting the source of lead exposure were sent to all adults with BLL's ≥3.5 µg/dL whose source of exposure was unknown, along with a brochure on take home lead exposure. All adults who had a BLL ≥15 µg/dL were contacted for an interview if the individual had not been interviewed in the last 5 years. Interviews were also conducted for adults with BLLs ranging from 3.5 to 15 µg/dL if the source of their lead exposure could not be identified from the laboratory report, provider request, or postcard. A letter was sent to these adults explaining Michigan's lead surveillance program and inviting them to answer a 15–20-minute telephone questionnaire about their exposures to lead and any symptoms they may be experiencing. The "Working Safely with Lead" brochure was sent with each initial interview letter. The questionnaire collected patient demographic data, work exposure and history information, symptoms related to lead exposure, information on potential lead-using hobbies, source of drinking water and non-work-related activities, and the presence of young children in the household to assess possible take-home lead exposures among these children. Trained interviewers administered the questionnaire. Five attempts to call an individual at various times and days were attempted before an individual was considered unreachable.

Upon completion of the interview, participants were sent a thank you letter with educational brochures that varied on the source of the individual's exposure to lead: one on working safely with lead, the second on controlling lead exposure in firing ranges, and a third on reducing lead exposure when reloading firearms or casting lead as a hobby (available at www.oem.msu.edu under Resources for Adult Blood Lead (ABLES)). These three brochures were updated in August 2022 to reflect the new 97.5$^{th}$ percentile of 3.5 µg/dL. The brochures can be found at:

Working Safely with Lead:
https://oem.msu.edu/images/resources/ABLES/WorkingSafelyWithLead.pdf

Lead Hazards from Casting and Reloading:
https://oem.msu.edu/images/resources/ABLES/LEAD_HAZARDS_FROM_CASTING_BULLETS.pdf

Lead Hazards at Indoor Firing Ranges:
https://oem.msu.edu/images/resources/ABLES/IndoorFiringRanges.pdf

Two brochures provided by the MDHHS CLPPP were sent to individuals, who identified there were children under the age of six in their household or were pregnant or had a pregnant woman living in the same house. Providers identified by participants as the ordering provider outside of company screenings were mailed a letter informing them of their patient's participation in the interview and links to recommendations for managing adults with elevated blood lead.

Exposure source for individuals was assigned by MSU based on a review of information collected in the past five years, or new information provided by the laboratory report, the heath care provider, the postcard, or the interview. For those adults with BLLs ≥25 µg/dL whose exposure was work, MIOSHA decided on the utility of conducting a workplace follow-up. Beginning in September 2024, the threshold for a MIOSHA referral was lowered to ≥20 µg/dL.

## RESULTS

This is the third full year report of BLL laboratory reporting in Michigan since the CDC lowered the Blood Lead Reference Value (BLRV) to 3.5 µg/dL from 5 µg/dL in 2021.

*Laboratory Outreach Data*

Table 1 shows the laboratory name and the adult blood reference value that laboratories are using on the laboratory report that is provided to the ordering provider and the adult tested. Thirteen of the 14 laboratories are using the reference value of 3.5 µg/dL for adults.

Table 1. Reference Range used by the 14 Laboratory Testing BLL on adults in Michigan

| Laboratory Name | Adult BLRV (µg/dL) |
|---|---|
| DMC University Labs | 3.5 |
| LabCorp of America, NC | 3.5 |
| Mayo Medical Lab | 3.5 |
| MI Dept. of Health and Human Lab | 3.5 |
| Priva Path Labs | 3.5 |
| Quest Diagnostics, Dallas | 3.5 |
| Quest Diagnostics Nichols Institute of Valencia | 3.5 |
| Quest Diagnostics, IL | 3.5 |
| Quest Tampa, FL | 3.5 |
| Specialty Laboratories | 3.5 |
| Spectrum Health Toxicology Regional Lab | 3.5 |
| St Francis Hospital | 3.5 |
| Tamarac Medical | Unable to determine |
| Warde Medical Lab | 3.5 |

*Number of Reports and Adults*

Between 1/1/2024 and 12/31/2024, the State of Michigan received 20,943 blood lead tests, including 1,939 blood lead test reports ≥3.5 µg/dL, for adults ≥16 years old. Because an individual may be tested more than once each year, the 1,939 reports received were for 1,199 adults. Only the highest BLL reported from 1/1/2024 to 12/31/2024 for each individual was used for analysis.

In 2024, 314 (26.2%) of the 1,199 adults reported with a BLL ≥3.5 µg/dL had a BLL 3.5 µg/dL to 4.9 µg/dL; 515 (43.0%) of the 1,199 had BLLs 5 to 9.9 µg/dL; and 370 (30.9%) of the 1,199 had BLLs ≥10 µg/dL, three (0.3%) of which had BLLs ≥50 µg/dL (Table 2).

Table 2: Adults with Elevated Blood Lead Levels by highest BLL in Michigan: 1/1/2024-12/31/2024

| **BLL** | **All Adults** | |
|---|---|---|
| (µg/dL) | Number | Percent |
| 3.5–4.9 | 314 | 26.2% |
| 5–9 | 515 | 43.0% |
| 10–19 | 278 | 23.2% |
| 20–29 | 68 | 5.7% |
| 30–39 | 16 | 1.3% |
| 40–49 | 5 | 0.4% |
| ≥ 50 | 3 | 0.3% |
| Total | 1,199 | 100% |

1998–2024 Trends: There was an initial increase in the late 1990's in the number of adults tested each year, which was due to better compliance by the laboratories with the 1997 reporting regulation (Figure 1). Since 2004 the number of tests showed little variability until the marked increase in 2016 due to increased testing for lead in the City of Flint (Genesee County) in response to concern about elevated lead in the Flint drinking water. After 2016, the number of adults tested decreased until 2023 when the number began to increase by about 3,000-4,000 individuals per year.

Figure 1: Number of Adults Reported with Tests for Blood Lead, Michigan 1998-2024

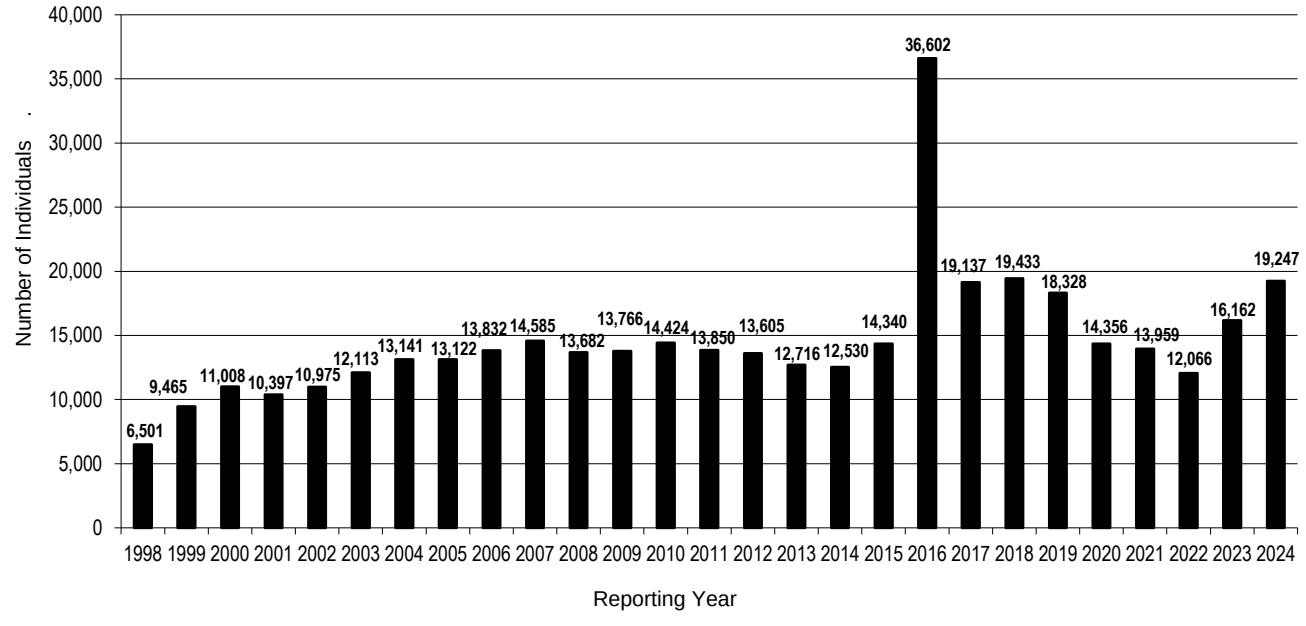


Figure 2: Number of Adults Reported with Tests for Blood Lead ≥5 µg/dL, Michigan 1998-2024

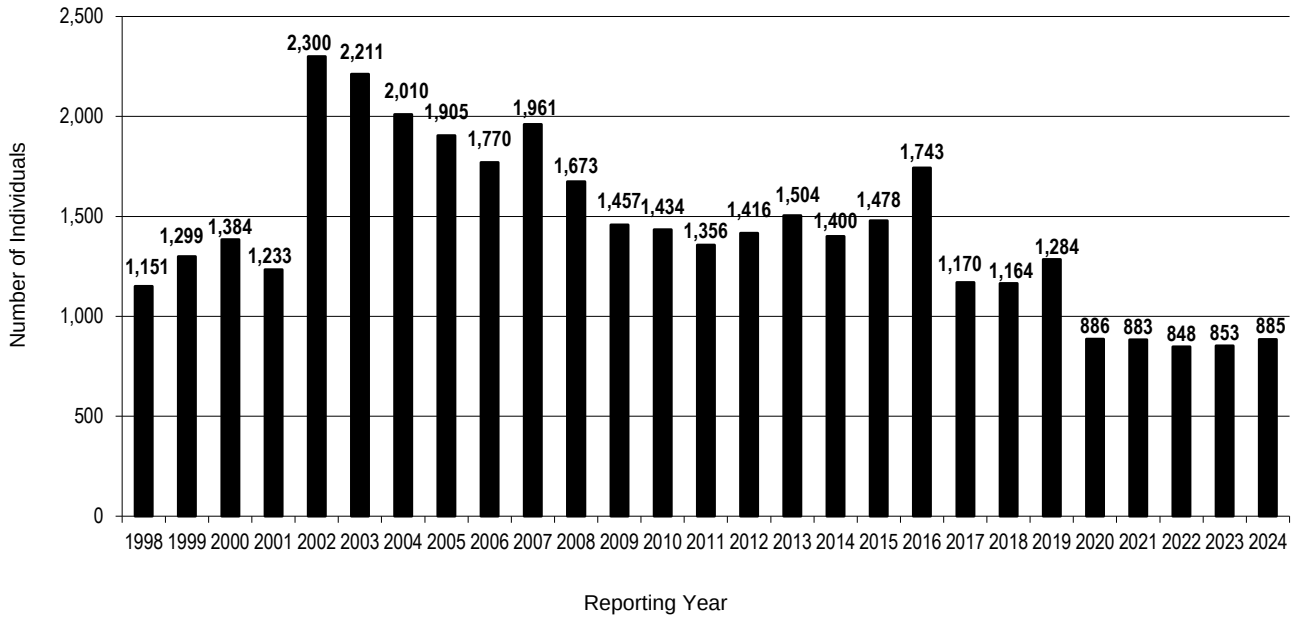
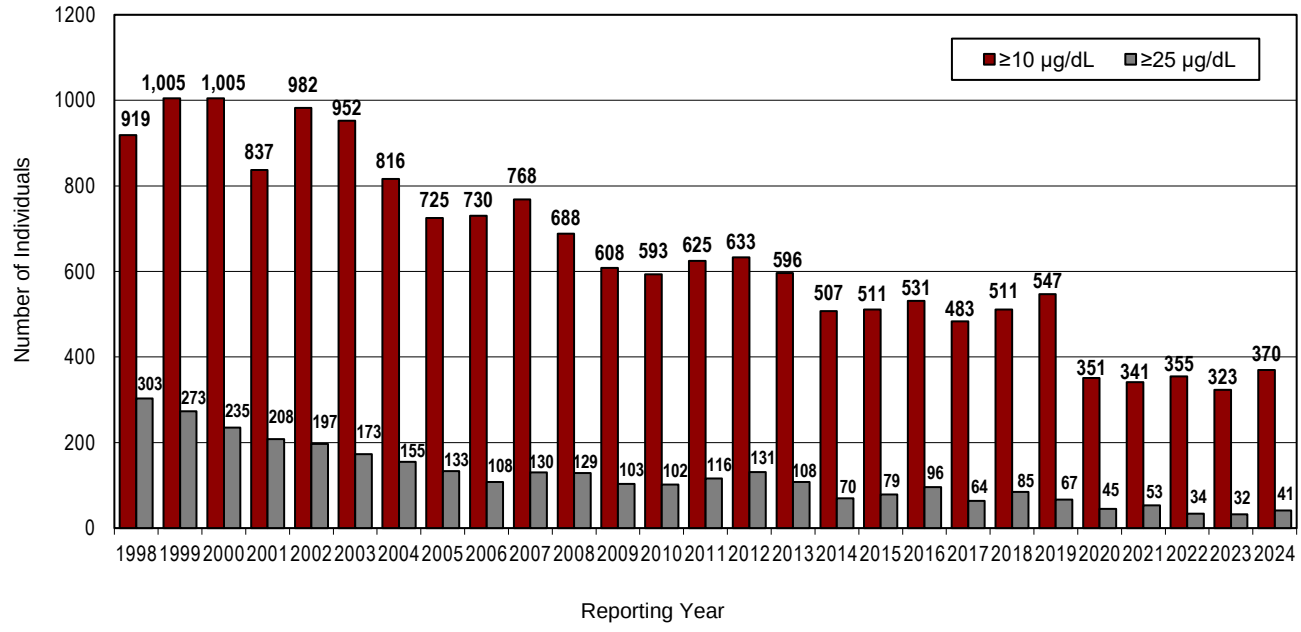



Figure 3. Number of Adults BLLs ≥10 µg/dL and ≥25 µg/dL, Michigan 1998-2024



Although there has been some variability between years, for the last 26 years there has been an overall decline in BLLs ≥5, ≥10, and ≥25 µg/dL, with a plateau in the decrease since 2020 (Figures 2 and 3). The number of adults with BLLs 3.5 to 4.9 µg/dL was similar in 2022 and 2023 with 280 and 286, respectively. This number then increased to 314 adults in 2024.

Prior to 2022, the 829 (69.1%) individuals with BLLs 3.5–9 µg/dL would not have been contacted; information was only recorded for BLLs 5–9 µg/dL when the source of lead exposure was identified on the lab report. Following the methods described in this report, these individuals are now contacted when a source cannot be determined through lab reports, provider information, or postcards. Of the 756 adults with BLLs 3.5–9 µg/dL and an identified source of lead exposure, 522 (69.0%) adults had their source of lead exposure identified as occupational as compared to the 274 of 359 (76.3%) adults with BLLs ≥10 µg/dL. There were 84 adults with an unknown source of exposure. We are still attempting to determine the source of the lead exposure for 64 of these individuals. For the other 20 we have been unable to contact the individual and the health care provider who ordered the test does not know the source.

Table 3. Distribution of Highest Blood Lead Levels among Adults and Source of Exposure in Michigan: 1/1/2024 - 12/31/2024

| | **Work** | | **Non-Work** | | **Source Not Yet Identified** | |
|---|---|---|---|---|---|---|
| **BLLs (µg/dL)** | **Number** | **Percent** | **Number** | **Percent** | **Number** | **Percent** |
| 3.5–4.9 | 173 | 63.8 | 98 | 36.2 | 43 | - |
| 5–9.9 | 349 | 72.0 | 136 | 28.0 | 30 | - |
| 10–19 | 207 | 77.2 | 61 | 22.8 | 10 | - |
| 20–29 | 51 | 75.0 | 17 | 25.0 | 0 | - |
| 30–39 | 11 | 73.3 | 4 | 26.7 | 1 | - |
| 40–49 | 4 | 80.0 | 1 | 20.0 | 0 | - |
| >50 | 1 | 33.3 | 2 | 66.7 | 0 | - |
| **Total** | **796** | **71.4** | **319** | **28.6** | **84** | **-** |

## SEX AND AGE

Eighty-six percent of the adults reported were male, and 14% were female (Table 4). The mean age was 47.2 and the median age was 46. The age distribution is shown in Table 5.

Table 4. Distribution of Sex among Adults Tested for BLLs in Michigan: 1/1/2024-12/31/2024

| Sex | BLLs ≥ 3.5 µg/dL | |
|---|---|---|
| | Number | Percent |
| Male | 1040 | 85.6 |
| Female | 159 | 14.4 |
| Total | 1,199 | 100.0 |

Table 5. Distribution of Age Among Adults Tested for BLLs in Michigan: 1/1/2024-12/31/2024

| Age Range | BLLs ≥ 3.5 µg/dL | |
|---|---|---|
| | Number | Percent |
| 16–19 | 26 | 2.2 |
| 20–29 | 159 | 13.3 |
| 30–39 | 246 | 20.5 |
| 40–49 | 250 | 20.9 |
| 50–59 | 224 | 18.7 |
| 60–69 | 166 | 13.8 |
| 70–79 | 99 | 8.3 |
| 80–89 | 24 | 2.0 |
| 90–99 | 5 | 0.4 |
| ≥100 | 0 | 0 |
| Total | 1,199 | 100.0 |

## SEX DISTRIBUTION

*Males:* The overall incidence rate for males was seven times higher than that for females (25.8/100,000 vs. 3.8/100,000). The source of exposure was unknown for 56 of the 1,040 males.

*Females*: The source of exposure was unknown for 28 of the 159 women.

Forty-five females (33.6%) with elevated blood lead were exposed at work: eight at a motor vehicle parts manufacturer, six at a shooting range, four at a battery manufacturer, four at a stained-glass manufacturer, three at a construction operation, two at an electric power generation plant, two at an aluminum and brass foundry, two at environmental remediation services, two in public safety, two at a fire equipment manufacturer, one at a recyclable material merchant wholesaler, one at a food production operation, and one at an electronic component manufacturer. Seven were work-related but the industry was unable to be determined.

Eighty-six females (66.4%) with elevated blood leads had non-work exposures: eighteen were refugees screened for lead but the specific source of exposure was unknown, sixteen from remodeling and older homes, twelve from firearms, nine presumed from drinking water, five from a gunshot wound, seven from food/pottery/ceramics/cosmetics, three from making stained glass as a hobby, and one from dust released into the air by a neighboring concrete crushing operation (https://planetdetroit.org/2025/03/detroit-concrete-crusher-settlement). Fifteen were not work-related but the specific source of exposure was unable to be identified.

## RACE DISTRIBUTION

Although laboratories were required to report the patient's race, this information was frequently not provided. Race was missing for 590 (49.2%) of the 1,199 adults reported. Among the 609 individuals where race was known, 447 (73.4%) were reported as White, 113 (18.6%) were reported as Black/African American, 20 (3.3%) were reported as Middle Eastern/North African (MENA), 16 (2.6%) were Asian, 9 (1.5%) were reported as American Indian/Alaska Native, three (0.5%) were Hawaiian/Pacific Islander, and one (0.2%) was reported as Other race alone. Information on Hispanic ethnicity was missing for an even higher percentage, 667 (55.6%) of the 1,199 adults. In the 532 individuals where information was known on Hispanic ethnicity, 53 (10.0%) were Hispanic.

Rates of elevated blood lead by race and ethnicity were calculated using the 2023 American Community Survey (ACS) data.[15] Among individuals where race information was available, the rate of elevated blood lead was 1.5 times as high among Black/African American adults, 1.2 times as high among American Indian/Alaska Native adults, and 0.7 times lower among Asian adults when compared to White adults. Where ethnicity information was available, the rate among Hispanic adults was 2.1 times as high as the rate among non-Hispanic adults.

Among individuals with non-work-related exposures where race information was

available, the rate of elevated blood lead was 2.3 times as high among Black/African American adults, 1.4 times as high among Asian adults, and 0.5 times lower among American Indian/Alaska Native adults when compared to White adults. Where ethnicity information was available, the rate among Hispanic adults was 1.4 times as high as the rate of elevated blood lead among non-Hispanic adults.

Among workers where race information was available, the rate of elevated blood lead was 1.5 times as high among American Indian/Alaska Native workers, 1.3 times as high among Black/African American workers, and 0.4 times lower among Asian workers when compared to White workers. Where information on ethnicity was available, the rate among Hispanic workers was 2.2 times as high as the rate of elevated blood lead among non-Hispanic adults.

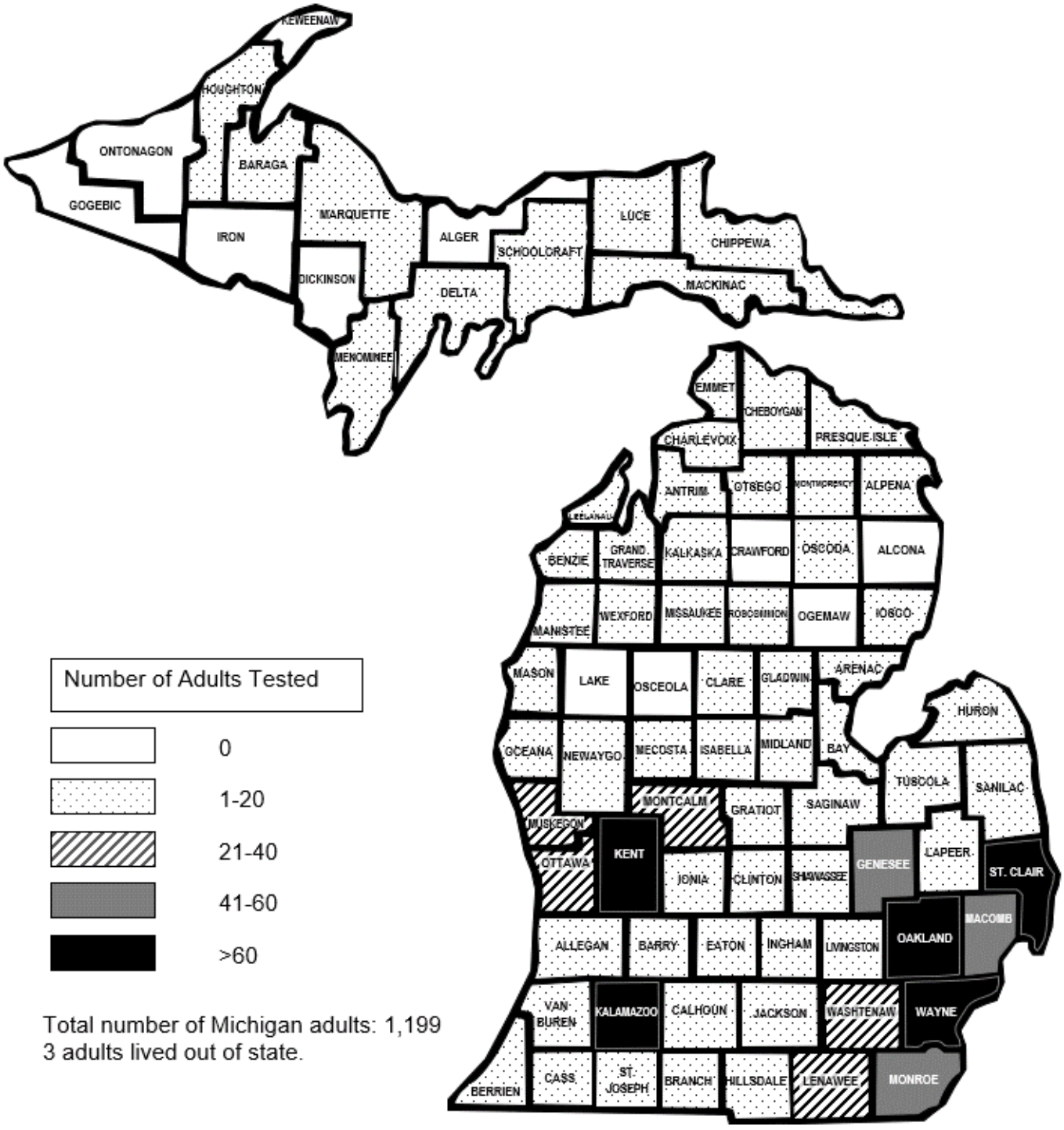
If the distribution of race and ethnicity among the 398 workers with unknown race and the 460 workers with unknown ethnicity was the same as the distribution of race and ethnicity among all workers in Michigan, the disparity of elevated blood lead between White workers and Black/African American, American Indian/Alaska Native, and Asian workers and Hispanic and non-Hispanic workers would still be present.

Individuals of different racial and ethnic backgrounds are unevenly represented in different Michigan industries and occupations.[14] Further work is needed to determine how these differences in place of employment and job duties may contribute to the differences found in the rates of elevated blood lead levels by race and ethnicity.

## GEOGRAPHIC DISTRIBUTION

County of residence was determined for 1,196 of the 1,199 (99.7%) adults reported. These adults lived in 72 of Michigan's 83 counties. The largest number of adults tested lived in Wayne County (227, 18.9%), followed by Oakland County (111, 9.3%), and St. Clair County (104, 8.6%). Three adults lived out of state (two in Ohio and one in Canada) but were exposed to lead while working in Michigan (Figure 4 and Table 6).

Figure 4. Geographic Distribution of Adults Tested with BLLs ≥3.5 µg/dL
In Michigan by County of Residence, 1/1/2024-12/31/2024




Total number of Michigan adults: 1,199
3 adults lived out of state.

Table 6. Number and Percent of Adults with Blood Lead Levels (BLLs) ≥3.5 µg/dL by County of Residence and Percent of Adults with BLLs ≥3.5 µg/dL among All Adults Tested for BLL in each County of Residence in Michigan: 1/1/2024-12/31/2024

| County | Number Reported | Percent | County | Number Reported | Percent |
|---|---|---|---|---|---|
| Alcona | 0 | - | Lake | 0 | - |
| Alger | 0 | - | Lapeer | 6 | 0.5 |
| Allegan | 15 | 1.3 | Leelanau | 2 | 0.2 |
| Alpena | 2 | 0.2 | Lenawee | 22 | 1.8 |
| Antrim | 1 | 0.1 | Livingston | 16 | 1.3 |
| Arenac | 3 | 0.3 | Luce | 2 | 0.2 |
| Baraga | 1 | 0.1 | Mackinac | 5 | 0.4 |
| Barry | 2 | 0.2 | Macomb | 59 | 4.9 |
| Bay | 4 | 0.3 | Manistee | 7 | 0.6 |
| Benzie | 1 | 0.1 | Marquette | 2 | 0.2 |
| Berrien | 18 | 1.5 | Mason | 4 | 0.3 |
| Branch | 2 | 0.2 | Mecosta | 5 | 0.4 |
| Calhoun | 3 | 0.3 | Menominee | 1 | 0.1 |
| Cass | 3 | 0.3 | Midland | 6 | 0.5 |
| Charlevoix | 1 | 0.1 | Missaukee | 1 | 0.1 |
| Cheboygan | 3 | 0.3 | Monroe | 55 | 4.6 |
| Chippewa | 20 | 1.7 | Montcalm | 29 | 2.4 |
| Clare | 6 | 0.5 | Montmorency | 2 | 0.2 |
| Clinton | 7 | 0.6 | Muskegon | 23 | 1.9 |
| Crawford | 0 | - | Newaygo | 7 | 0.6 |
| Delta | 3 | 0.3 | Oakland | 111 | 9.3 |
| Dickinson | 0 | - | Oceana | 1 | 0.1 |
| Eaton | 15 | 1.2 | Ogemaw | 0 | - |
| Emmet | 6 | 0.5 | Ontonagon | 0 | - |
| Genesee | 42 | 3.5 | Osceola | 0 | - |
| Gladwin | 2 | 0.2 | Oscoda | 1 | 0.1 |
| Gogebic | 0 | - | Otsego | 1 | 0.1 |
| Grand Traverse | 4 | 0.3 | Ottawa | 21 | 1.8 |
| Gratiot | 5 | 0.4 | Presque Isle | 3 | 0.3 |
| Hillsdale | 10 | 0.8 | Roscommon | 3 | 0.3 |
| Houghton | 1 | 0.2 | Saginaw | 15 | 1.3 |
| Huron | 8 | 0.7 | Saint Clair | 104 | 8.6 |
| Ingham | 20 | 1.7 | Saint Joseph | 8 | 0.7 |
| Ionia | 13 | 1.1 | Sanilac | 7 | 0.6 |
| Iosco | 4 | 0.3 | Schoolcraft | 1 | 0.1 |
| Iron | 0 | - | Shiawassee | 6 | 0.5 |
| Isabella | 10 | 0.8 | Tuscola | 4 | 0.3 |
| Jackson | 13 | 1.1 | Van Buren | 9 | 0.8 |
| Kalamazoo | 62 | 5.2 | Washtenaw | 26 | 2.2 |
| Kalkaska | 4 | 0.3 | Wayne | 227 | 18.9 |
| Kent | 78 | 6.5 | Wexford | 1 | 0.1 |
| Keweenaw | 0 | - | **Total** | **1,196[a]** | **100.0** |

[a]Three individuals lived out of state.

## SOURCE OF EXPOSURE

For 796 (71.4%) individuals with BLLs ≥3.5 µg/dL, work was the identified source, and for 319 (28.6%) individuals, non-occupational activities were identified as the source of exposure (Table 7). Exposure due to a hobby related to firearms predominated for the 319 non-occupationally exposed individuals with 121 (37.9%) individuals with BLLs ≥3.5 µg/dL. Exposure due to remodeling and older homes accounted for 42 (13.2%) adults tested. Eighteen (5.6%) individuals were presumed exposed to lead in drinking water and reported no other source of lead exposure. For an additional 64 individuals, the source of exposure is still being investigated.

Table 7. Source of Exposure among Adults with BLLs ≥ 3.5 µg/dL: Michigan 1/1/2024-12/31/2024

| Exposure Source Description | Number | Percent | Percent Non-Work |
|---|---|---|---|
| Work-Related | 796 | 71.4 | |
| Non-Work | 319 | 28.6 | |
| Hobby: Firearms, Reloading, Casting | 121 | 10.9 | 37.9 |
| Screening Refugee | 47 | 4.2 | 14.7 |
| Remodeling and Older Home | 42 | 3.8 | 13.2 |
| Source Unknown, Not Work-Related | 36 | 3.2 | 11.3 |
| Gun Shot Wound | 24 | 2.2 | 7.5 |
| Drinking Water | 18 | 1.6 | 5.6 |
| Hobby: Other | 14 | 1.3 | 4.4 |
| Food/Pottery/Ceramics/Cosmetics | 11 | 1.0 | 3.4 |
| Stained Glass | 3 | 0.3 | 0.9 |
| PICA | 2 | 0.2 | 0.6 |
| Environmental | 1 | 0.1 | 0.3 |
| Total | 1115* | 100.0 | 100.0 |

*Source unknown in 84 individuals

## NON-OCCUPATIONAL EXPOSURES

*Hobby: Firearms, Reloading, Casting*

Firearms, reloading, and casting accounted for the largest percentage (37.9%) of non-work exposures. One hundred and three of 121 were from shooting firearms, twelve of 121 were from reloading, and six of 121 were from casting. Lead levels ranged from 3.5 µg/dL to 56 µg/dL. The age range was 17 to 82 years of age. Females accounted for twelve of the 121 exposures from firearms, reloading, and casting.

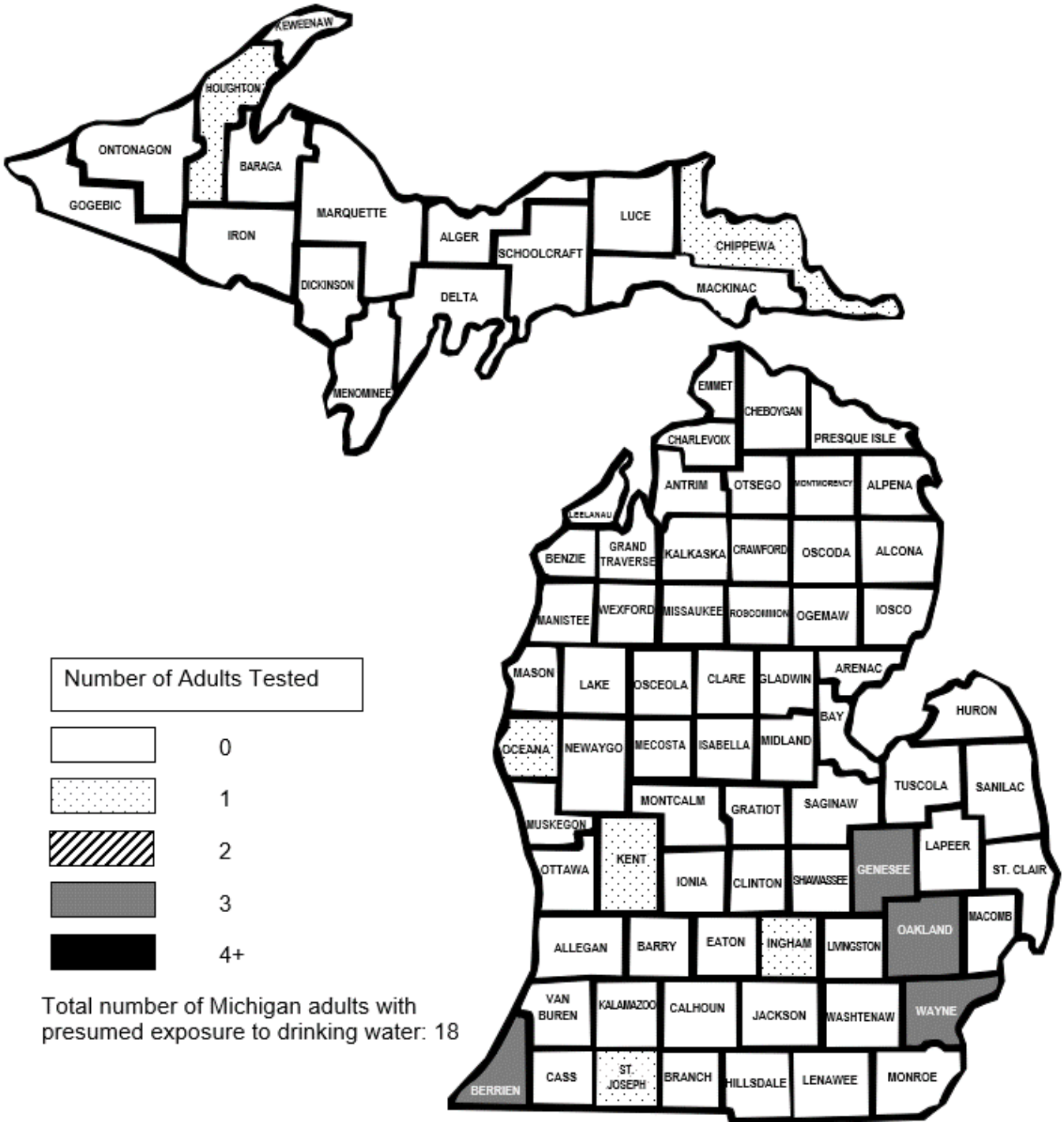
*Refugee Screening*

Refugee screening accounted for 47 of the 319 (14.7%) non-work exposures. The 47 individuals had lead levels that ranged from 3.5 µg/dL to 32 µg/dL. The age range was 16 to 77 years of age. Females accounted for 18 of the 47 refugee screenings. Fifteen individuals were from the Afghanistan, 11 were from the Democratic Republic of the Congo, three were from Syria, two were from Central African Republic, two were from Venezuela, one was from Burundi, one was from Colombia, one was from Cuba, one was from Ethiopia, one was from Guatemala, one was from Honduras, one was from Lebanon, one was from Pakistan, one was from Rwanda, one was from Tanzania, and 4 were from an unknown country. Contact information for these 47 individuals was sent to MDHHS for additional follow up.

*Exposure from Drinking Water*

For 18 of 319 (5.6%) adults with BLLs $\geq$3.5 µg/dL and non-work exposure, no source of exposure could be identified, therefore the source of exposure was categorized as from their drinking water. The BLLs ranged from 3.5 µg/dL to 10 µg/dL. Geographic location was determined for all 18 adults (Figure 5): three were located in Genesee County with ZIP codes 48504 and 48505. Three were located in Wayne County with ZIP codes 48152, 48212, and 48219. Three were located in Oakland County with ZIP codes 48009 and 48326. One was located in Chippewa County with ZIP code 49725, one was located in Houghton County with ZIP code 49916, one was located in Ingham County with ZIP code 48840, one was located in Kent County with ZIP code 49507, one was located in Oceana County with ZIP code 49449, and one was located in St. Joseph County with ZIP code 49093. Contact information for these 18 individuals was sent to MDHHS for additional follow up for water testing.

Figure 5. Geographic Distribution of Exposure Presumed to be from Drinking Water in Adults with BLLs ≥ 3.5 µg/dL in Michigan by County of Residence, 1/1/2024-12/31/2024




Total number of Michigan adults with presumed exposure to drinking water: 18

*Remodeling and Home Exposure*

Remodeling and home exposures accounted for 42 of the 319 (13.2%) non-work exposures. The 42 individuals had lead levels that ranged from 3.5 µg/dL to 44 µg/dL. The age range was 16 to 84 years of age. Males accounted for 26 of the 42 exposures from remodeling and home exposure.

Case Descriptions of Remodeling and Home Exposure:

A male in his 40's with a BLL of 44 µg/dL was exposed to lead paint while helping friends remodel 100-year-old houses.

A male in his 70's with a BLL of 12 µg/dL was exposed to lead while removing lead paint from cabinets in his older home.

A male in his 60's with a BLL of 12 µg/dL was exposed to lead paint from remodeling his older home.

A male in his 60's with a BLL of 12 µg/dL was exposed to lead paint from remodeling his older home.

A male in his 40's with a BLL of 10 µg/dL was exposed to lead paint from remodeling his older home.

A female in her 50's with a BLL of 10 µg/dL was exposed to lead from remodeling her older home.

A female in her 40's with a BLL of 9 µg/dL was exposed to lead while removing lead paint from the windows of her older home.

A male in his 50's with a BLL of 8 µg/dL was exposed to lead while removing lead paint from his older home.

A male in his 30's with a BLL of 8 µg/dL was exposed to lead from his older home.

A male in his 80's with a BLL of 7 µg/dL was exposed to lead from his older home.

A male in his 20's with a BLL of 7 µg/dL was exposed to lead from his 1850's home.

A female in her 30's with a lead level of 7 µg/dL was exposed to lead from removing lead paint from her older home.

A male in his 60's with a BLL of 6 µg/dL was exposed to lead paint from his older home.

A male in his 60's with a BLL of 6 µg/dL was exposed to lead while removing lead paint from his older home.

A male in his 60’s with a BLL of 6 µg/dL was exposed to lead while removing lead paint from a family member's home.

A female in her 50’s with a BLL of 6 µg/dL was exposed to lead from her older home.

A male in his 70’s with a BLL of 5 µg/dL was exposed to lead from his older home.

A male in his 70’s with a BLL of 5 µg/dL was exposed to lead while removing lead paint from his older home.

A male in his 60’s with a BLL of 5 µg/dL was exposed to lead paint from his older home.

A female in her 70’s with a BLL of 5 µg/dL was exposed to lead from her older home.

A female in her 60’s with a BLL of 5 µg/dL was exposed to lead from her older home.

A female in her 60’s with a BLL of 5 µg/dL was exposed to lead from her older home.

A female in her 20’s with a BLL of 5 µg/dL was exposed to lead from her older home.

A female in her teens with a BLL of 5 µg/dL was exposed to lead from her older home.

A male in his 70’s with a BLL of 4 µg/dL was exposed to lead from his older home.

A male in his 60’s with a BLL of 4 µg/dL was exposed to lead from his older home.

A male in his 60’s with a BLL of 4 µg/dL was exposed to lead paint from his older home.

A male in his 60’s with a BLL of 4 µg/dL was exposed to lead paint from sanding lead paint in his older home.

A male in his 50’s with a BLL of 4 µg/dL was exposed to lead from his 1920's home.

A male in his 50’s with a BLL of 4 µg/dL was exposed to lead while removing lead paint from his older home.

A male in his 40’s with a BLL of 4 µg/dL was exposed to lead paint from remodeling his older home.

A female in her 70’s with a BLL of 4 µg/dL was exposed to lead from her older home.

A female in her 70’s with a BLL of 4 µg/dL was exposed to lead from remodeling her older home.

A female in her 60’s with a BLL of 4 µg/dL was exposed to lead from her 1920's home.

A female in her 50's with a BLL of 4 µg/dL was exposed to lead from remodeling her old Victorian home.

A male in his 60's with a BLL of 3.5 µg/dL was exposed to lead paint from remodeling his older home.

A male in his 50's with a BLL of 3.5 µg/dL was exposed to lead paint from remodeling his older home.

A male in his 30's with a BLL of 3.5 µg/dL was exposed to lead from his older home.

A male in his teens with a BLL of 3.5 µg/dL was exposed to lead from renovations of his older home.

A female in her 60's with a BLL of 3.5 µg/dL was exposed to lead from remodeling her older home.

A female in her 60's with a BLL of 3.5 µg/dL was exposed to lead from her older home.

A female in her 60's with a lead level of 3.5 µg/dL was exposed to lead from remodeling her older home.

*Gunshot Wound*

Gunshot wounds accounted for 24 of the 319 (7.5%) non-work exposures. The 24 adults had lead levels that ranged from 3.5 µg/dL to 33 µg/dL. The age range was 22 to 85 years of age. Females accounted for five of the 24 exposures from gunshot wounds.

*Source Unknown, Not Work-Related*

Thirty-six of the 319 (11.3%) were confirmed as nonwork-related cases but the source of exposure was unable to be determined. Thirty-four of the 36 individuals had lead levels ranging from 3.5 µg/dL to 12 µg/dL and the remaining two had BLLs of 15 µg/dL and 20 µg/dL. The healthcare providers for these 36 individuals were unable to provide the source of exposure, and the individuals were either unable to be reached for an interview or no source of exposure was identified during the interview.

*Food/Pottery/Ceramics/Cosmetics*

Food, pottery, ceramics, and cosmetics account for 11 of the 319 (3.4%) non-work exposures. The 11 individuals had lead levels that ranged from 3.5 µg/dL to 27 µg/dL. The age range was 28 to 76 years of age. Females accounted for seven of the eleven exposures from food/pottery/ceramics/cosmetics.

<u>Case Descriptions of Food/Pottery/Ceramics/Cosmetics:</u>

A male in his 60's with a BLL of 27 µg/dL was exposed to lead by using a ceramic drinking glass that contained lead.

A female in her 30's with a BLL of 14 µg/dL was exposed to lead from consuming turmeric that contained lead.

A male in his 40's with a BLL of 13 µg/dL was exposed to lead from consuming imported foods.

A female in her 30's with a BLL of 8 µg/dL was exposed to lead from the use of traditional Afghani eyeliner.

A male in his 30's with a BLL of 8 µg/dL was exposed to lead by using spices from his home country. The source country was unknown

A female in his 20's with a BLL of 6 µg/dL was exposed to lead by using spices from her home country. The source country was unknown

A female in her 30's with a BLL of 5 µg/dL was exposed to lead while traveling in India.

A female in his 60's with a BLL of 4 µg/dL was exposed to lead from consuming cinnamon that contained lead.

A female in her 70's with a BLL of 4 µg/dL was exposed to lead from consuming applesauce that contained lead.[16]

A male in his 70's with a BLL of 3.5 µg/dL was exposed to lead by using ceramic dishes that contained lead for over 25 years. The glaze on one ceramic plate was tested and found to contain 7% lead.

A female in her 70's with a BLL of 3.5 µg/dL was exposed to lead from consuming wild game that had been killed with bullets.

*Hobby: Other*

Hobbies not related to guns accounted for 14 of the 319 (4.4%) non-work exposures. The 14 individuals had lead levels that ranged from 4 µg/dL to 18 µg/dL and ages ranged from 22 to 78 years of age. All 14 were men.

<u>Case Descriptions of Hobbies not Related to Guns:</u>

A male in his 50's with a BLL of 18 µg/dL was exposed to lead from grinding lead keel for his boat.

A male in his 70's with a BLL of 11 µg/dL was exposed to lead from melting lead to make fishing lures.

A male in his 60's with a BLL of 10 µg/dL was exposed to lead from making fishing tackle using lead.

A male in his 60's with a BLL of 10 µg/dL was exposed to lead from an unspecified lead-

using hobby.

A male in his 60's with a BLL of 9 µg/dL was exposed to lead from collecting civil war artifacts as a hobby.

A male in his 40's with a BLL of 6 µg/dL was exposed to lead from exploring old lead mines.

A male in his 50's with a BLL of 6 µg/dL was exposed to lead from an unspecified lead-using hobby.

A male in his 60's with a BLL of 6 µg/dL was exposed to lead from reusable stainless steel water bottles made in China. He tested the water bottle for lead and then discarded them when the tests were positive for lea.

A male in his 60's with a BLL of 5 µg/dL was exposed to lead from making lead fishing lures.

A male in his 70's with a BLL of 5 µg/dL was exposed to lead from an unspecified lead-using hobby.

A male in his 70's with a BLL of 5 µg/dL was exposed to lead from making lead fishing lures.

A male in his 20's with a BLL of 5 µg/dL was exposed to lead from restoring an old tractor.

A male in his 60's with a BLL of 4 µg/dL was exposed to lead from recycling scrap metal as a hobby.

A male in his 70's with a BLL of 4 µg/dL was exposed to lead from making fishing tackle using lead.

*Stained Glass*

Case Description of Stained Glass:

A female in her 40's with a BLL of 14 µg/dL was exposed to lead from using lead solder to make stained glass.

A female in her 60's with a BLL of 7 µg/dL was exposed to lead from using lead solder to make stained glass.

A female in her 70's with a BLL of 6 µg/dL was exposed to lead from using lead solder to make stained glass.

*PICA*

Case Description of PICA:

A male in his teens with a BLL of 66 µg/dL was exposed to lead from eating paint chips.

A male in his teens with a BLL of 19 µg/dL was exposed to lead from ingestion of an unknown lead-contaminated, non-food item.

## OCCUPATIONAL EXPOSURES

There was an overall decline in elevated BLLs from work exposures (Figures 6 and 7). There were three reported BLLs ≥50 µg/dL in 2024. In 2024, the third year that adults with lead levels from 3.5 to 9 µg/dL received follow-up, there were 522 adults with BLLs 3.5–9 µg/dL who were exposed to lead at work, compared to 545 adults in 2023.

Figure 6. Number of Adults with Elevated BLLs ≥ 10 µg/dL due to WORK Exposure, Michigan 1998-2024

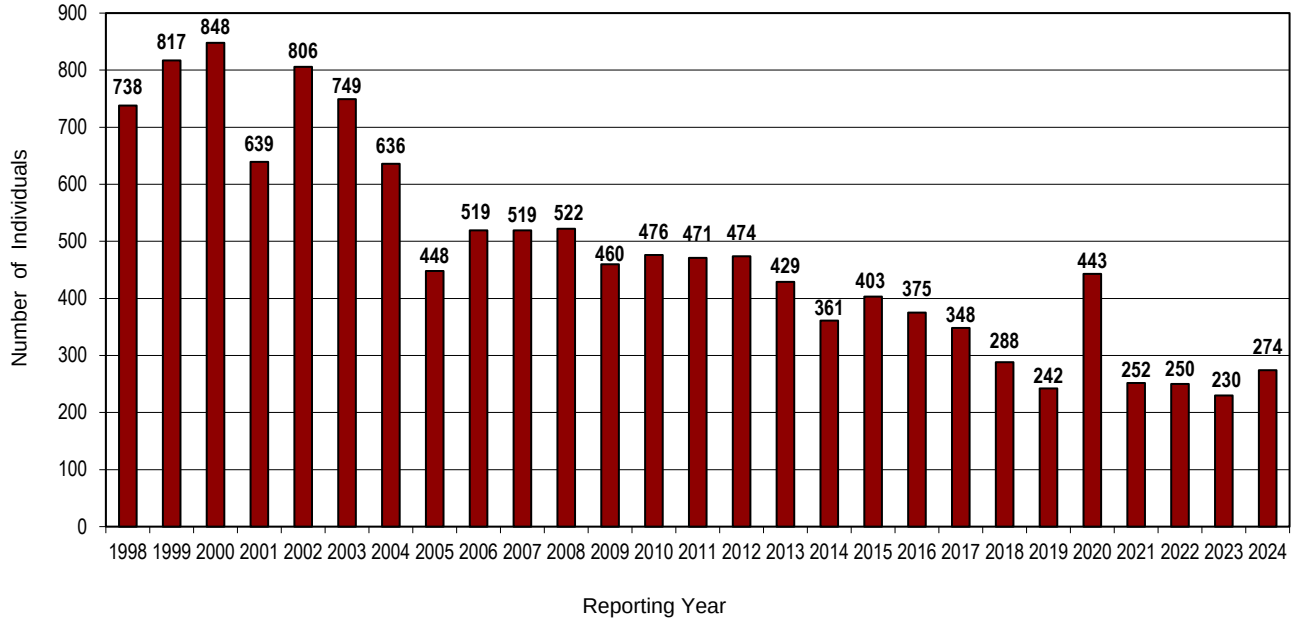


Figure 7. Number of Adults with Elevated BLLs ≥ 25 µg/dL and ≥ 50 µg/dL due to WORK Exposure, Michigan 1998-2024

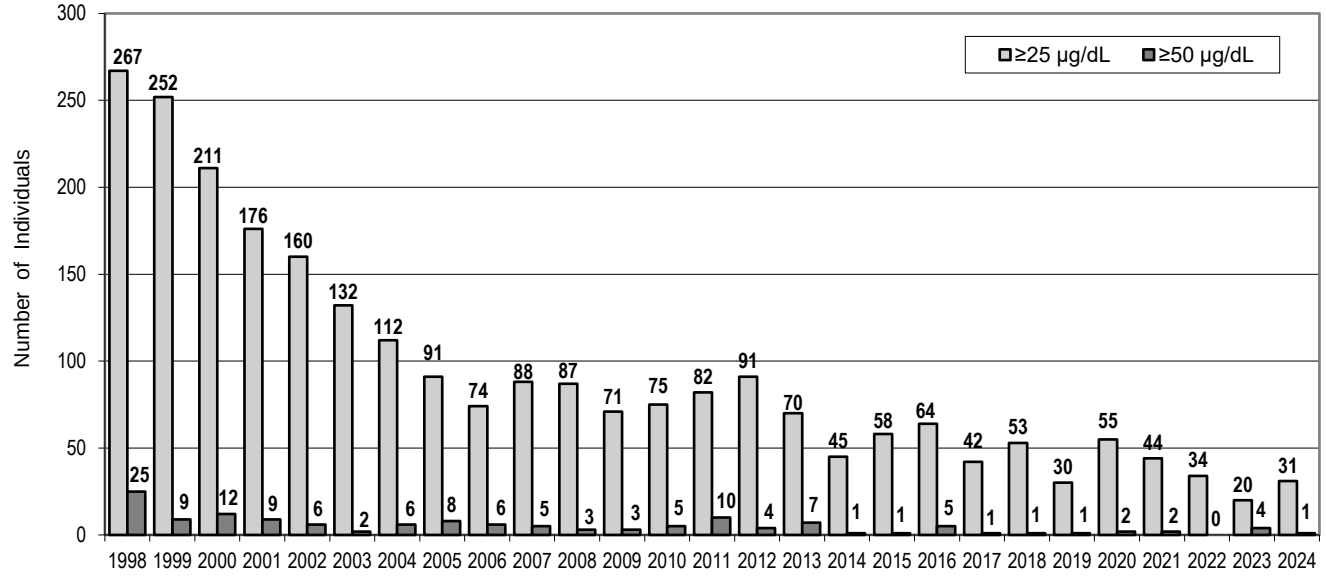



Table 8 shows the sources of lead by industry. The most common source of elevated lead levels in 2024 were among individuals in the manufacturing (33.3%) and services, excluding public safety, (23.6%) industries.

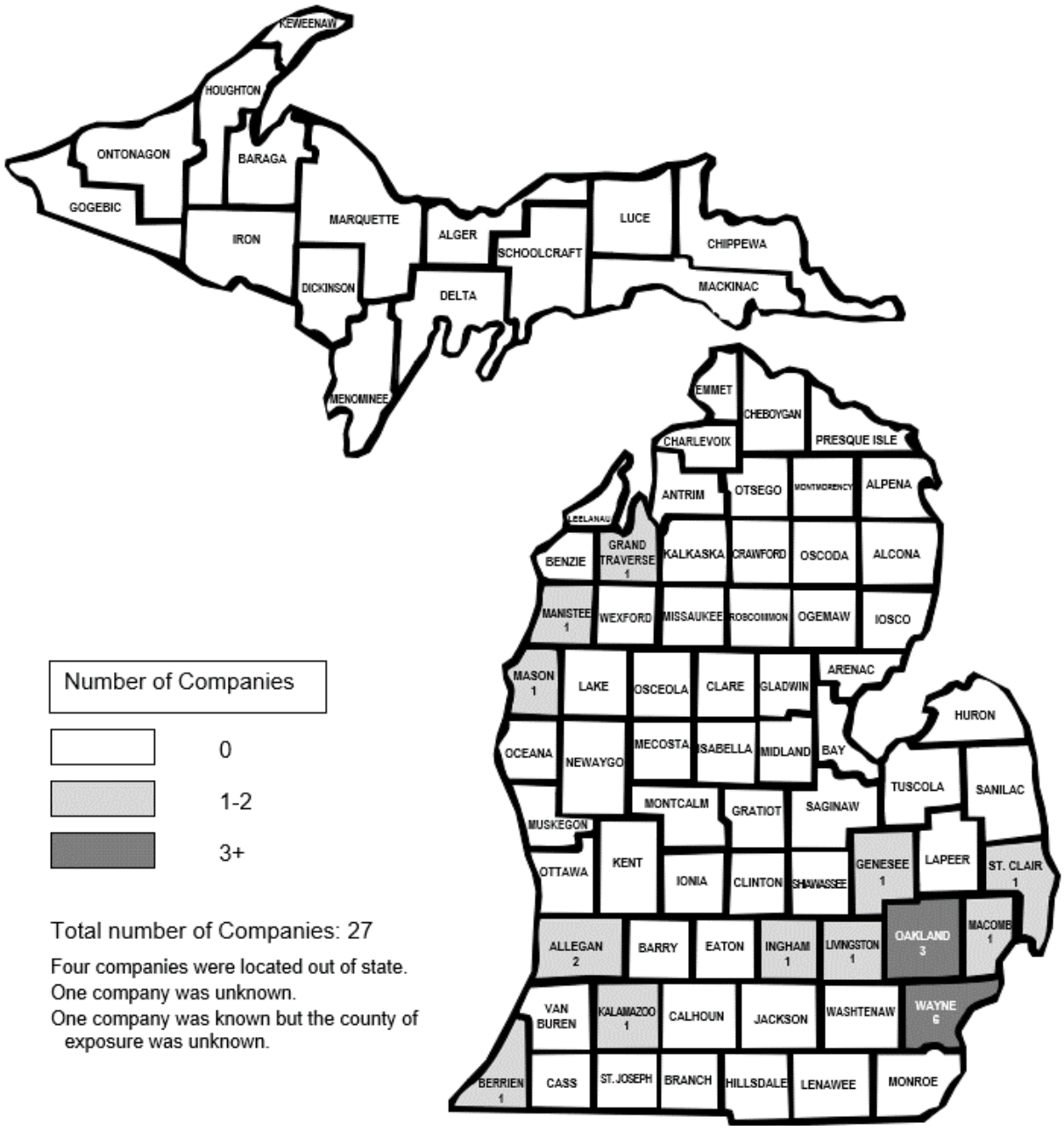
Table 8. Industry Source of Exposure among Adults with BLLs ≥ 3.5 µg/dL: Michigan 2024

| NORA Sector Group[a] | NAICS Code[b] | Number | Percent |
|---|---|---|---|
| Agriculture, Forestry & Fishing (except Wildland Firefighting) | 11 | 0 | — |
| Construction | 23 | 160 | 21.4 |
| Healthcare & Social Assistance | 62, 54194, 81291 | 0 | — |
| Manufacturing | 31-33 | 249 | 33.3 |
| Mining (except Oil & Gas Services) | 21 | 0 | — |
| Oil & Gas Extraction | 211, 213111, 213112 | 0 | — |
| Public Safety (including Wildland Firefighting) | 92212, 92214, 92216, 62191 | 18 | 2.4 |
| Services (except Public Safety) | 51, 52, 53, 54, 55, 56, 61, 71, 72, 81, 92 | 177 | 23.7 |
| Transportation, Warehousing & Utilities | 48-49, 22 | 102 | 13.6 |
| Wholesale & Retail Trade | 42, 44-45 | 42 | 5.6 |
| **Total** | | 748[c] | 100.0 |

[a] National Occupational Research Agenda (NORA).
[b] North American Industry Classification System (NAICS).
[c] Another 48 were work-related; however, the industry was unknown.

Figure 8 shows the geographic distribution of the twenty-seven non-construction companies that reported at least one adult with a BLL of ≥20 µg/dL in Michigan during 2024. These twenty-seven companies included sporting goods stores with firing ranges, stained glass manufacturers, non-ferrous aluminum and brass foundries, electric power generation operations, recyclable materials wholesalers, industrial battery manufacturers, metal heat treating operations, an environmental remediation service, an electronic component manufacturer, and a utility company. One individual declined to provide employer information, and this information was unable to be obtained from the healthcare provider.

Figure 8. Geographic Distribution of Non-Construction Companies Reporting Adult BLLs ≥20 µg/dL in Michigan, 1/1/2024-12/31/2024



## OUTREACH ACTIVITY

Outreach and intervention activities included follow-up interviews with 55 individuals, distribution of resources on diagnosis and management of lead exposure to twenty-four health care providers whose patients had an elevated BLL, and providing educational materials with postcard letters, interview letters, and thank you letters. Up to four educational brochures were distributed depending on the source of the individual's exposure to lead: one on working safely with lead, the second on controlling lead exposure in firing ranges, a third on reducing lead exposure when reloading firearms or casting lead as a hobby (available at www.oem.msu.edu under Resources for Adult Blood Lead (ABLES)) and a fourth, a "how to" guide for home maintenance and renovation from the U.S. Department of Housing and Urban Development. Private gun clubs and ranges that are run by members and volunteers are not under the jurisdiction of the Michigan Occupational Safety and Health Administration (MIOSHA) program. Outreach efforts to educate the group of lead-exposed hobbyists who use private clubs remained a challenge.

## SUMMARY OF INDUSTRIAL HYGIENE INSPECTIONS CONDUCTED FOR BLOOD LEAD LEVELS ≥ 20 µg/dL, 2024

In 2024, fifteen companies were referred to MIOSHA for an industrial hygiene enforcement inspection. Of the 15 companies referred to MIOSHA, four companies are pending determination for the utility of an inspection and five companies were referred but no inspection was conducted. Of the six completed inspections, one was conducted by the MIOSHA Construction Safety and Health Division (CSHD) and five inspections were conducted by the MIOSHA General Industry Safety and Health Division (GISHD). The results of the six completed inspections are below.

### MIOSHA Construction Safety and Health Division Inspections Completed in 2024

1) Construction Site Preparation Contractor

The inspection was initiated because two employees had elevated BLLs: one of 19 µg/dL and one of 23 µg/dL.

The company was cited for one Serious lead violation: 1) The employer failed to initially determine whether employees would be exposed to lead at or above the action level while working on a project site and exposure monitoring was not conducted for the duration of the project.

### MIOSHA General Industry Safety and Health Division Inspections Completed in 2024

2) Glass and Glazing Contractor

The inspection was initiated because one employee had a BLL of 26 µg/dL.

The company was cited for one Other-than-Serious non-lead violation: 1) Employees were provided with filtering face piece respirators to be used voluntarily, however, the

employer did not provide the information contained in GISHD Standard Part 451 Appendix D, “Information for Employees Using Respirators When Not Required Under the Standard (Mandatory).”

3) Nonferrous Metal Foundry

The inspection was initiated because one employee had a BLL of 30 µg/dL.

The company was cited for three Serious lead violations and one Other-than-Serious non-lead violation: 1) Employees were exposed to airborne concentrations of lead that exceeded the permissible exposure limit (PEL). Additionally, biological monitoring in the form of blood lead analysis was not conducted at the frequency required by the standard. Blood lead testing was provided once every six months instead of once every two months for employees whose BLLs were at or above 15 µg/dL. 2) A review of previous blood lead analysis data indicated that three employees had an average BLL (averaged over the last three blood lead tests) that exceeded the medical removal threshold of 20 µg/dL, and these employees were not removed from work. Additionally, the employer had not updated the company’s written compliance program for controlling exposures since 2020, therefore the blood lead level requirements under the medical surveillance section were out of date. 3) Two employees were exposed to airborne concentrations of lead that exceeded the 9-hour adjusted PEL of 44 µg/$m^3$. Despite the use of a respirator, one employee’s lead exposure exceeded the assigned protection factor of the respirator. Additionally, the respirator used was inappropriate for the lead exposures present during the work operation. 4) The employer failed to report the three employees who met the criteria for medical removal on the MIOSHA 300 Log and associated 301 forms.

4) Shooting Range

The inspection was initiated because one employee had a BLL of 26 µg/dL.

The company was cited for two Other-than-Serious lead violations and one Other-than-Serious non-lead violation: 1) The employer failed to perform initial exposure determination to identify whether any employee may be exposed to lead at or above the action level while performing work duties. Employees were not provided access to a copy of the Part 310 Lead in General Industry standard. And exposure monitoring records excluded required information, including the name of the employee, duration of testing, location of the test, and the type of respiratory protection worn, if any. 2) The written respiratory protection program was missing information, such as procedures for proper use of respirators and selecting respirators that protect against lead. Additionally, records of employee medical evaluations were not retained for evaluations conducted prior to the inspection. 3) The employer failed to provide the required detail for at least one recordable injury on the MIOSHA 300 Log and associated 301 forms.

5) Shooting Range

The inspection was initiated because one employee had two BLLs: one of of 30 µg/dL and one of 22 µg/dL.

The company was cited for one Serious lead violation, one Other-than-Serious lead violation, and one Other-than-Serious non-lead violation: 1) The employer failed to conduct additional monitoring after firing lanes were added to the business in 2019, as

well as after monitoring results from March 2024 were found to exceed the PEL. Additionally, at least one employee who had a BLL greater than 15 µg/dL was not provided with continued biological monitoring and one employee who had an average BLL (averaged over the previous two blood lead tests) that exceeded the medical removal threshold of 20 µg/dL was not removed from work. Finally, at least one employee had a BLL that exceeded the threshold for medical removal and was not provided with a follow up test within two weeks. 2) Records of medical evaluations for respiratory protection were not maintained, despite employees regularly using tight fitting elastomeric respirators. 3) Employees were not notified in writing of the representative employee exposure that exceeded the PEL along with a description of the corrective action that was taken or that would be taken to reduce exposure. The employer failed to notify at least one employee, in writing, that their BLL was at or above 15 µg/dL nor were they removed from work. The employers also did not provide employees with a copy of written medical recommendations from each consulting or examining physician nor were warning signs posted in the business that warned employees of areas that may exceed the PEL.

6) Shooting Range

The inspection was initiated because three employees had BLLs ranging from 20 µg/dL to 31 µg/dL.

The company was cited for one Serious lead violation, one Other-than-Serious lead violation, and one Other-than-Serious non-lead violation: 1) The employer failed to develop a written respiratory protection program and provide a medical evaluation and fit testing for an employee who was required to use a 3M half-face elastomeric respirator. 2) Air sampling records collected from MIOSHA during an inspection in 2016 were not maintained. 3) The written hazard communication program did not include sections about labels and safety data sheets in accordance with the Globally Harmonized System of Classification and Labeling of Chemicals implemented in the United States in 2015.

## CASE NARRATIVES FOR THE SIXTEEN INDIVIDUALS WITH A BLL ≥30 µg/dL FROM WORKPLACE EXPOSURE IN 2024

A male in his 40's, employed as a firearms instructor, had an elevated BLL of 30 µg/dL.

A male in his 60's, employed at a shooting range, had an elevated BLL of 30 µg/dL.

A female in her 60's, employed at a shooting range, had an elevated BLL of 30 µg/dL.

A male in his teens, employed at an industrial painting contractor, had an elevated BLL of 30 µg/dL.

A male in his 50's, who was a self-employed contractor, had an elevated BLL of 32 µg/dL.

A male in his 20's, employed at an industrial painting contractor, had an elevated BLL of 34 µg/dL.

A male in his 40's, employed at an industrial painting contractor, had an elevated BLL of 34 µg/dL.

A male in his 20's, employed at an electric power generation facility, had an elevated BLL of 34 µg/dL.

A male in his 30's, employed at a shooting range, had an elevated BLL of 35 µg/dL.

A male in his 40's, employed at a remediation service, had an elevated BLL of 36 µg/dL.

A female in her 40's, employed at an unknown company, had an elevated BLL of 36 µg/dL.

A male in his 50's, employed at an industrial painting contractor, had an elevated BLL of 40 µg/dL.

A male in his 40's, employed at a shooting range, had an elevated BLL of 41 µg/dL.

A male in his 20's, employed at a shooting range, had an elevated BLL of 42 µg/dL.

A male in his 20's, employed at a shooting range, had an elevated BLL of 49 µg/dL.

A male in his 40's, employed at a utility company, had an elevated BLL of 57 µg/dL.

**INTERVIEWS**

To date, interviews have been attempted with 212 adults ≥16 years of age. Interviews have not been completed for 157 of the 212 adults: attempts to contact 42 adults are still underway, 86 adults could not be contacted despite five attempts to call them, and 29 adults refused to complete all or part of the questionnaire.

*Interviews with Adults with BLLs ≥ 3.5 µg/dL Regarding their Children's Potential Exposure to "Take Home" Lead*

There were 55 questionnaires completed over the telephone with adults with BLLs 3.5 µg/dL to 66 µg/dL. Eight of the 55 completed questionnaires identified children <6 years old in the household who were potentially exposed to take home lead.

One adult with a BLL of 19 µg/dL, who was exposed to lead while working at a construction company, had two children who were tested for lead and both had lead levels of 1 µg/dL.

One adult with a BLL of 23 µg/dL, who was exposed to lead while working at a construction company, had two children who were tested for lead and both had levels below 2 µg/dL.

One adult with a BLL of 8 µg/dL, who was exposed to lead from recreational firearms use, had one child who was tested for lead, but the BLL was unknown.

One adult with a BLL of 6 µg/dL, who was exposed to lead from casting and reloading lead bullets, had two children who had not been tested for lead.

One adult with a BLL of 19 µg/dL, who was exposed to lead while working at an electric power generation facility, had one child who had not been tested for lead.

One adult with a BLL of 3.5 µg/dL, who was exposed to lead while working at a construction company, had one child who was tested for lead and had a level of 10 µg/dL.

One adult with a BLL of 20 µg/dL, who was exposed to lead while working at a firing range, had one child who was tested for lead, but the BLL was unknown.

One adult with a BLL of 9 µg/dL, who had a non-work related exposure but the specific source of exposure was unable to be determined, had a child with an elevated BLL of 13 µg/dL that led to the adult getting tested themself.

Contact information for adults reporting young children in their household was forwarded to MDHHS so that a letter could be sent encouraging adults to test the children in those households for lead. Additionally, a brochure about take-home lead prevention created by MDHHS was mailed with the thank-you letter to the interviewed adult. Further effort to encourage adults with elevated BLLs to test their children <6 years is needed. Ways to couple this effort with Michigan's new law requiring all children <6 years to have blood lead testing should be explored.

*Interviews with Adults with BLLs ≥3.5 µg/dL that are Pregnant or Breastfeeding or their Partner is Pregnant or Breastfeeding*

Of the 55 questionnaires completed, the ten females who were interviewed were not pregnant or breastfeeding. None of the 45 males interviewed had partners that were pregnant or breastfeeding.

## DISCUSSION

An individual may have a blood lead test performed as part of an employer medical-screening program or as part of a diagnostic evaluation by their personal physician. Whatever the reason for testing, the results were then sent by the testing laboratories to MDHHS as required by law. If the individual tested was ≥16 years, the report was then forwarded to MSU and maintained in the ABLES program lead registry. Individuals with a blood lead level ≥15 µg/dL were contacted by mail and then contacted by a trained interviewer for a telephone interview. Individuals with BLLs of 3.5–14 µg/dL, where the lead exposure source could not be determined by the provider or postcard sent to the individual were contacted by a trained interviewer for a telephone interview. The interview included detailed demographic information, exposure history and the presence and nature of lead-related symptoms. When an individual with a blood lead value ≥20 µg/dL was occupationally exposed at a company that has not had a recent MIOSHA inspection, MIOSHA conducted an enforcement inspection to assess that company's compliance

with the lead standard.

From 1/1/2024 to 12/31/2024, there were 1,199 adults with BLLs ≥3.5 µg/dL. Among individuals with a BLL ≥3.5 µg/dL, 85.6% were men. The mean age was 47.2 years. They most frequently lived in Wayne (18.9%), Oakland (9.3%), and St. Clair (8.6%) counties. The source of exposure to lead among the 1,115 individuals where exposure was determined at the time of this report was predominately work (71.4%). The most common non-work exposures to lead occurred from having a hobby related to guns; using an indoor firing range and/or casting or reloading bullets (37.9%), followed by refugee screening (14.7%), remodeling and older homes (13.2%), retained bullet from a gunshot wound (7.5%), and presumed drinking water (5.6%; Table 7). Three individuals in 2024 had a BLL ≥50 µg/dL; one exposure was from consumption of paint chips due to PICA, one was from firearms use, and one was from working for a utility company.

Lead exposure remains an important public health concern in the U.S. Environmental Protection Agency (EPA) regulations have required the removal of lead from commercial products such as gasoline, house paint and solder in plumbing pipes and food cans. As a result of these regulations, environmental lead exposure has been reduced in the general population.

Unlike occupational exposure to lead, which is regulated by OSHA, there is no governmental agency that regulates environmental lead exposure to adults caused by hobbies and personal activities except that the Michigan Department of Environment Great Lakes and Energy regulates the amount of lead that is permitted in public water supplies. Individuals who use firing ranges, particularly private gun clubs without employees, and individuals remodeling their own homes are not covered by workplace protections. Some of the highest blood leads are now seen in those with environmental rather than occupational exposure.

Six percent of the elevated blood lead levels in adults were presumed to be secondary to drinking water contamination after no other source of lead exposure could be identified. Testing of the drinking water of these 18 adults is needed to confirm whether water is the source of their elevated lead level.

Over thirty years of lead toxicity research has demonstrated that lead exposure at levels previously thought to be safe can result in an increased risk of adverse chronic health effects, especially if the exposure is maintained for many years, thereby resulting in a progressively larger cumulative dose (6,7-9). The CDC BLRV of 3.5 µg/dL is not a health-based standard or toxicity threshold but was adopted to be useful to prioritize communities that need additional primary prevention and determine if medical or environmental efforts are needed to promote health equity (10).

Both the International Agency for Research on Cancer (IARC) and the National Toxicology Program have classified lead to be a probable human carcinogen (11,12), primarily based on findings for lung and stomach cancer, with brain and kidney cancer also being elevated in some studies. Other studies show that lead exposure increases blood pressure in adults (6), making both mortality from stroke and heart disease outcomes of interest. High lead exposure is known to cause non-malignant kidney disease (13), but it is not known if lower levels contribute to this outcome.

Regulations of occupational exposure lead at the federal level have not been updated in over 40 years. In 2018, the Michigan OSHA program, revised and updated their administrative rules and lowered acceptable blood lead levels in the workplace. In 2024, the California OSHA program also lowered acceptable blood lead levels in the workplace (3). Despite Federal OSHA allowing BLLs as high as 50 µg/dL and Michigan OSHA allowing BLLs as high as 30 µg/dL, recommendations for medical management on lead exposed adults begins at 3.5 µg/dL (Appendices A and B) and interpretative language and reference ranges on laboratory reports reviewed by the healthcare provider who ordered the blood lead needs to be compatible with these recommendations on medical management since laboratory reports are often the main source of information for the healthcare providers who ordered the blood lead test.

Continued outreach is planned to the medical community to promote recognition and management of potential lead-related medical problems. Systematic approaches to address environmental lead exposure to lead among adults are needed as well addressing how these environmental exposures may affect young family members in their household.

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## APPENDICES

Appendix A. California Department of Public Health. Health-Based Guidelines for Blood Lead Levels in Adults

Appendix B. CSTE Management Guidelines for Blood Lead Levels in Adults
https://cdn.ymaws.com/www.cste.org/resource/resmgr/occupationalhealth/publications/ManagementGuidelinesforAdult.pdf

Appendix C. Michigan's Construction Safety and Health Standard
https://www.michigan.gov/documents/leo/leo_miosha_part603_665496_7.pdf

Appendix D. Michigan's General Industry Safety and Health Standard
https://www.michigan.gov/documents/CIS_WSH_part310_35615_7.pdf

# APPENDIX A

Council for State and Territorial Epidemiologists Management Guidelines for Blood Lead Levels in Adults

# MANAGEMENT GUIDELINES FOR BLOOD LEAD LEVELS IN ADULTS

The following categories represent general guidelines. Blood lead level (BLL) monitoring should be done on a schedule based on an individual's risk of exposure to lead. **Primary management of lead poisoning is source identification and the elimination or reduction of further exposure.** A single BLL does not reflect cumulative body burden, nor predict long-term effects. Recent evidence suggests that chronic low-level lead exposure has adverse health effects in adults and no blood lead threshold level for these effects has been identified. Treatment decisions, including chelation, should be made in consultation with a physician knowledgeable about lead poisoning medical management. The most recent NHANES data show that 97.5 percentile for BLL in adults for US adults age 16 years and older is 3.46 μg/dL.

| Blood Lead Level (μg/dL) | Management Recommendations |
|---|---|
| <3.5 | No action needed<br>Monitor BLL if ongoing exposure |
| 3.5-9 | Discuss health risks<br>Minimize exposure<br>Consider removal for pregnancy and certain medical conditions<br>Monitor BLL |
| 10-19 | Decrease exposure<br>Remove from exposure for pregnancy<br>Consider removal for certain medical conditions or BLL ≥ 10 for an extended period of time<br>Monitor BLL |
| 20-29 | Remove from exposure for pregnancy<br>Remove from exposure if repeat BLL in 4 weeks remains ≥ 20<br>Annual lead medical exam recommended |
| 30-49 | Remove from exposure<br>Prompt medical evaluation |
| 50-79 | Remove from exposure<br>Prompt medical evaluation<br>Consider chelation with significant symptoms |
| ≥ 80 | Remove from exposure<br>Urgent medical evaluation<br>Chelation may be indicated |

**Note**:The above management guidelines recommend removal from lead exposure at blood lead levels that are lower than those at which Medical Removal Protection is required under the current OSHA lead standards. However, OSHA job protections also apply whenever a licensed health care provider removes an individual from lead exposure, whatever the patient's blood lead level, if the individual has a lead related problem or has a medical condition that places the worker at greater risk from lead exposure. Because of the complexity in recommending medical removal below levels required by OSHA, a physician making such a recommendation may want to review the OSHA regulations, consult with a physician familiar with the regulatory process and discuss with their patient how this may affect their employment. For further information on this topic, please see the medical removal protection provisions of the OSHA lead standards.

**Medical Guidelines** for the Lead-Exposed Worker

Association of Occupational and Environmental Clinics (AOEC) Medical management guidelines for lead-exposed adults, revised 4/24/2007 Washington, D.C. http://www.aoec.org/documents/positions/MMG_FINAL.pdf

California Department of Public Health. Health-based guidelines for blood lead levels in adults 2019.Richmond, CA. https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/OLPPP/CDPH%20Document%20Library/AdultMgtGuide.pdf

## For Additional Information

See below for additional information on related topics such as OSHA offices, occupational and environmental medicine clinics, childhood lead poisoning, environmental exposure assessments or take-home lead poisoning identification/prevention (Note that lead dust from a job can be taken home and expose other household members to lead when work clothes and shoes are worn home):

- Screening and Case Management Guidelines for Children - http://www.cdc.gov/nceh/lead/publications/#screening

- To Find an OSHA Office in Your State - http://www.osha.gov/html/RAmap.html
- Online directory of member clinics of the Association of Occupational and Environmental Clinics (AOEC) - http://www.aoec.org/directory.htm

# APPENDIX B

California Department of Public Health. Health-Based Guidelines for Blood Lead Levels in Adults

# HEALTH-BASED GUIDELINES FOR BLOOD LEAD LEVELS IN ADULTS

These guidelines are for the care of adults aged 18 and older and adolescents exposed to lead at work. The mean blood lead level (BLL) for U.S. adults is less than 1 µg/dL, and the 97.5 percentile for BLL is 3.5 µg/dL (CDC, CSTE 2021[1]); thus, CDPH recommends clinical action and follow-up for adult BLLs 3.5 µg/dL and greater. Chronic adverse health effects have no threshold, so clinicians should monitor patients with elevated BLL until below 3.5 µg/dL. For occupational lead exposure, these CDPH guidelines are more stringent and health protective than the current Cal/OSHA or federal OSHA lead standards.

Identification and removal from lead exposure is the primary treatment of elevated BLL and most cases of symptomatic lead toxicity. Chelation therapy is reserved for patients with severe symptoms of toxicity, which typically occur at BLL greater than 80 µg/dL, or in any patient with an extremely high BLL (e.g. > 100 µg/dL). Consult with a specialist experienced in treating lead toxicity for symptomatic patients.

<table>
<tr><th>Blood Lead Level</th><th>Action Needed</th><th>Timing of recheck BLL</th><th>CLINICAL EVALUATION</th></tr>
<tr><td>3.5–9 µg/dL</td><td>Obtain history on lead exposure and minimize contact.</td><td>Repeat BLL every 3 months until < 3.5 µg/dL.</td><td rowspan="2">Obtain history on potential sources of lead exposure at work and home at all BLLs ≥ 3.5 µg/dL and minimize lead contact.<br>A venous blood lead sample should be used for diagnosis and monitoring. Testing of hair, urine, or capillary blood and provocation testing are not recommended.<br>Laboratory tests (CBC, BUN/Cr, and urinalysis) should be obtained within two weeks of a BLL result > 30 µg/dL and urgently if > 80 µg/dL. Consider labs at BLL ≥ 10 µg/dL if no baseline results are available from the past 12 months.<br>Monitor blood pressure at least annually for lead-exposed adults.</td></tr>
<tr><td>10–19 µg/dL</td><td>Check baseline labs if none in past 12 months.</td><td>Repeat BLL every 2 months until < 10 µg/dL.</td></tr>
<tr><td>20–29 µg/dL</td><td>Conduct physical exam and labs if not done in prior 12 months.</td><td>Repeat BLL monthly until < 10 µg/dL.</td><td>IF OCCUPATIONAL EXPOSURE<br>Remove from work or reassign to job duties that do not involve lead if the last two BLLs are ≥ 20 µg/dL or if the average of all BLLs in the last 6 months is ≥ 20 µg/dL.</td></tr>
<tr><td>30+ µg/dL</td><td>Conduct physical exam and labs within 2 weeks of BLL result.</td><td>Repeat BLL monthly until < 10 µg/dL.</td><td>Remove from work or reassign to job duties that do not involve lead if one BLL is ≥ 30 µg/dL.</td></tr>
<tr><td>80+ µg/dL</td><td colspan="3">Prompt physical exam, labs, and consultation with an occupational medicine specialist or toxicologist.</td></tr>
<tr><td colspan="4">In pregnancy, BLL should be as low as possible to protect the fetus. Identify and stop lead exposure, remove from work at BLL ≥ 3.5 µg/dL, and repeat BLL at least every 4 weeks until < 3.5 µg/dL. Refer to the American College of Obstetricians and Gynecologists guidelines and CDC guidelines on lead in pregnancy and lactation for additional recommendations.</td></tr>
</table>

Consider returning patients to work who have been removed due to occupational lead exposure after two BLLs checked at least 30 days apart are < 15 µg/dL.

OSHA job protections apply when a physician performing occupational medical surveillance exams removes an employee from lead work at any BLL due to toxicity, pregnancy, or a comorbidity that increases health risk from lead. If removing from lead work at levels lower than required by Cal/OSHA, providers may wish to review the standards and discuss with patients how removal may impact their employment.

Submit a Doctor's First Report to the employer's Workers' Compensation insurance carrier within 5 days of evaluating a patient for work-related lead toxicity that requires medical care beyond routine medical surveillance.

**CLINICIANS:**
For questions call (510) 620-5714 or
e-mail: adultlead@cdph.ca.gov

**OCCUPATIONAL LEAD POISONING PREVENTION PROGRAM:** www.cdph.ca.gov/olppp

*To obtain a copy of this document in an alternate format, please contact (510) 620-5757 and allow at least ten (10) working days to coordinate alternate format services.*

[1]NHANES 2015-2018 data, weighted percentile per methodology used in children (Ruckart PZ, et al. MMWR 2021;70:1509-1512), adopted by the Council of State and Territorial Epidemiologists Dec. 2021.

# APPENDIX C

Michigan’s Construction Safety and Health Standard

MIOSHA-STD-1403 (03/21)
40 Pages

For further information
Ph: 517-284-7740
www.michigan.gov/mioshastandards

**DEPARTMENT OF LABOR AND ECONOMIC OPPORTUNITY**

**CONSTRUCTION STANDARD**

Filed with the Secretary of State on October 18, 1993 (as amended October 18, 1999**)**
(as amended February 6, 2014) (as amended December 11, 2018) **(as amended March 29, 2021)**

These rules take effect immediately upon filing with the secretary of state unless adopted under section 33, 44, or 45a(6) of the administrative procedures act of 1969, 1969 PA 306, MCL 24.233, 24.244, or 24.245a.

Rules adopted under these sections become effective 7 days after filing with the Secretary of State.

(By authority conferred on the director of the department of labor and economic opportunity by sections 14 and 24 of the Michigan occupational safety and health act, 1974 PA 154, MCL 408.1014 and 408.1024, and Executive Reorganization Order Nos. 1996-1, 1996-2, 2003-1, 2008-4, 2011 4, and 2019-3, MCL 330.3101, 445.2001, 445.2011, 445.2025, 445.2030, and 125.1998)

R 325.51983 of the Michigan Administrative Code is amended, and R 325.51984 and R 325.51985 are rescinded, as follows:

# PART 603, LEAD EXPOSURE IN CONSTRUCTION

Table of Contents:

**R 325.51983 Scope, application, adoption, and availability of standards.**

**Rule 83**. (1) These rules apply to all construction work as defined by the Michigan occupational safety and health act (MIOSHA), 1974 PA 154, MCL 408.1001 to 408.1094. Construction work includes all of the following:

(a) Demolition or salvage of structures where lead or materials containing lead are present.

(b) Removal or encapsulation of materials containing lead.

(c) New construction, alteration, repair, painting, decorating, or renovation of structures, substrates, or portions thereof that contain lead or materials containing lead.

(d) Installation of products containing lead.

(e) Lead contamination or emergency cleanup.

(f) Transportation, disposal, storage, or containment of lead or materials containing lead on the site or location at which construction activities are performed.

(g) Maintenance operations associated with the construction activities described in this rule.

(2) The federal Occupational Safety and Health Administration (OSHA) regulation 29 CFR 1926.62, "Lead," as amended on February 18, 2020, is adopted by reference in these rules.

(3) The adopted federal regulations have the same force and effect as a rule promulgated under the Michigan occupational safety and health act (MIOSHA), 1974 PA 154, MCL 408.1001 to 408.1094.

(4) The following provisions of the OSHA regulation adopted in these rules are not adopted by reference:

(a) 1926.62(d)(2)(v) is replaced by R 325.51986.

(b) 1926.62(j)(1) is replaced by R 325.51987.

(c) 1926.62(j)(2)(i) is replaced by R 325.51988.

(d) 1926.62(j)(2)(iv) is replaced by R 325.51989.

(e) 1926.62(j)(3)(i) is replaced by R 325.51990.

(f) 1926.62(j)(3)(ii) is replaced by R 325.51991.

(g) 1926.62(k)(1)(i) is replaced by R 325.51992.

(h) 1926.62(k)(1)(iii) is replaced by R 325.51993.

(5) A reference to 1926.51 "Sanitation," means Construction Safety and Health Standard Part 1. "General Rules," R 408.40101 to R 408.40134.

(6) A reference to 1910.133 "Eye and face protection," means Construction Safety and Health Standard Part 6. "Personal Protective Equipment," R 408.40601 to R 408.40660.

(7) A reference to 1910.134 "Respiratory Protection," means General Industry and Construction Safety and Health Standard Part 451. "Respiratory Protection," R 325.60051 to R 325.60052.

(8) A reference to 1910.1020 "Access to employee exposure and medical records," means General Industry and Construction Safety and Health Standard Part 470. "Employee Medical Records and Trade Secrets," R 325.3451 to R 325.3476.

(9) A reference to 1910.1025 "Lead," means General Industry Safety and Health Standard Part 310. "Lead in General Industry," R 325.51901 to 325.51958.

(10) A reference to 1910.1200 "Hazard Communication," means Construction Safety and Health Standard Part 42. "Hazard Communication," R 408.44201 to R 408.44204.

(11) The OSHA regulation adopted in these rules is available from the United States Department of Labor, Occupational Safety and Health Administration website, www.osha.gov, at no charge, as of the time of adoption of these rules.

(12) The regulation adopted in these rules is available for inspection at the Department of Labor and Economic Opportunity, MIOSHA Standards and FOIA Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909 8143.

(13) The regulation adopted in these rules may be obtained from the publisher or may be obtained from the Department of Labor and Economic Opportunity, MIOSHA, Standards and FOIA Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909 8143, at the cost charged in this rule, plus $20.00 for shipping and handling.

(14) The following Michigan occupational safety and health administration (MIOSHA) standards are referenced in these rules. Up to 5 copies of these standards may be obtained at no charge from the Department of Labor and Economic Opportunity, MIOSHA, Standards and FOIA Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909 8143 or via the internet at website: www.michigan.gov/mioshastandards. For quantities greater than 5, the cost, as of the time of adoption of these rules, is 4 cents per page.

(a) Construction Safety and Health Standard Part 1. "General Rules," R 408.40101 to R 408.40134.

(b) Construction Safety and Health Standard Part 6. "Personal Protective Equipment," R 408.40601 to R 408.40660.

(c) Construction Safety and Health Standard Part 42. "Hazard Communication," R 408.44201 to R 408.44204.

(d) General Industry Safety and Health Standard Part 310. "Lead in General Industry," R 325.51901 to R 325.51958.

(e) General Industry and Construction Safety and Health Standard Part 451. "Respiratory Protection," R 325.60051 to R 325.60052.

(f) General Industry and Construction Safety and Health Standard Part 470. "Employee Medical Records and Trade Secrets," R 325.3451 to R 325.3476.

**R 325.51984 Rescinded.**

**R 325.51985 Rescinded.**

# 1926.62 LEAD

Table of Contents:

# 1926.62 LEAD

**1926.62(a) SCOPE.**

This section applies to all construction work where an employee may be occupationally exposed to lead. All construction work excluded from coverage in the general industry standard for lead by 29 CFR 1910.1025(a)(2) is covered by this standard. Construction work is defined as work for construction, alteration and/or repair, including painting and decorating. It includes but is not limited to the following:

1926.62(a)(1) Demolition or salvage of structures where lead or materials containing lead are present;

1926.62(a)(2) Removal or encapsulation of materials containing lead;

1926.62(a)(3) New construction, alteration, repair, or renovation of structures, substrates, or portions thereof, that contain lead, or materials containing lead;

1926.62(a)(4) Installation of products containing lead;

1926.62(a)(5) Lead contamination/emergency cleanup;

1926.62(a)(6) Transportation, disposal, storage, or containment of lead or materials containing lead on the site or location at which construction activities are performed, and

1926.62(a)(7) Maintenance operations associated with the construction activities described in this paragraph.

**1926.62(b) DEFINITIONS.**

Action level means employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air (30 ug/$m^3$) calculated as an 8-hour time-weighted average (TWA).

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Competent means one who is capable of identifying existing and predictable lead hazards in the surroundings or working conditions and who has authorization to take prompt corrective measures to eliminate them.

Director means the Director, National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health and Human Services, or designee.

Lead means metallic lead, all inorganic lead compounds, and organic lead soaps. Excluded from this definition are all other organic lead compounds.

This section means this standard.

**1926.62(c) PERMISSIBLE EXPOSURE LIMIT.**

1926.62(c)(1) The employer shall assure that no employee is exposed to lead at concentrations greater than fifty micrograms per cubic meter of air (50 ug/$m^3$) averaged over an 8-hour period.

1926.62(c)(2) If an employee is exposed to lead for more than 8 hours in any work day the employees' allowable exposure, as a time weighted average (TWA) for that day, shall be reduced according to the following formula:

| Allowable employee exposure (in µg/$m^3$) = 400 divided by hours worked in the day. |
|---|

1926.62(c)(3) When respirators are used to limit employee exposure as required under paragraph (c) of this section and all the requirements of paragraphs (e)(1) and (f) of this section have been met, employee exposure may be considered to be at the level provided by the protection factor of the respirator for those periods the respirator is worn. Those periods may be averaged with exposure levels during periods when respirators are not worn to determine the employee's daily TWA exposure.

**1926.62(d) EXPOSURE ASSESSMENT.**

**1926.62(d)(1) General.**

1926.62(d)(1)(i) Each employer who has a workplace or operation covered by this standard shall initially determine if any employee may be exposed to lead at or above the action level.

1926.62(d)(1)(ii) For the purposes of paragraph (d) of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.

1926.62(d)(1)(iii) With the exception of monitoring under paragraph (d)(3), where monitoring is required under this section, the employer shall collect personal samples representative of a full shift including at least one sample for each job classification in each work area either for each shift or for the shift with the highest exposure level.

1926.62(d)(1)(iv) Full shift personal samples shall be representative of the monitored employee's regular, daily exposure to lead.

**1926.62(d)(2) Protection of employees during assessment of exposure.**

1926.62(d)(2)(i) With respect to the lead related tasks listed in this paragraph (d)(2)(i) of this section, where lead is present, until the employer performs an employee exposure assessment as required in paragraph (d) of this section and documents that the employee performing any of the listed tasks is not exposed above the PEL, the employer shall treat the employee as if the employee were exposed above the PEL, and not in excess of ten (10) times the PEL, and shall implement employee protective measures prescribed in paragraph (d)(2)(v) of this section. The tasks covered by this requirement are:

1926.62(d)(2)(i)(A) Where lead containing coatings or paint are present: Manual demolition of structures (e.g, dry wall), manual scraping, manual sanding, heat gun applications, and power tool cleaning with dust collection systems;

1926.62(d)(2)(i)(B) Spray painting with lead paint

1926.62(d)(2)(ii) In addition, with regard to tasks not listed in paragraph (d)(2)(i), where the employer has any reason to believe that an employee performing the task may be exposed to lead in excess of the PEL, until the employer performs an employee exposure assessment as required by paragraph (d) of this section and documents that the employee's lead exposure is not above the PEL the employer shall treat the employee as if the employee were exposed above the PEL and shall implement employee protective measures as prescribed in paragraph (d)(2)(v) of this section.

1926.62(d)(2)(iii) With respect to the tasks listed in this paragraph (d)(2)(iii) of this section, where lead is present, until the employer performs an employee exposure assessment as required in this paragraph (d), and documents that the employee performing any of the listed tasks is not exposed in excess of 500 µg/m$^3$, the employer shall treat the employee as if the employee were exposed to lead in excess of 500 µg/m$^3$ and shall implement employee protective measures as prescribed in paragraph (d)(2)(v) of this section. Where the employer does establish that the employee is exposed to levels of lead below 500 µg/m$^3$, the employer may provide the exposed employee with the appropriate respirator prescribed for such use at such lower exposures, in accordance with paragraph (f) of this section. The tasks covered by this requirement are:

1926.62(d)(2)(iii)(A) Using lead containing mortar; lead burning

1926.62(d)(2)(iii)(B) Where lead containing coatings or paint are present: rivet busting; power tool cleaning without dust collection systems; cleanup activities where dry expendable abrasives are used; and abrasive blasting enclosure movement and removal.

1926.62(d)(2)(iv) With respect to the tasks listed in this paragraph (d)(2)(iv), where lead is present, until the employer performs an employee exposure assessment as required in this paragraph (d) and documents that the employee performing any of the listed tasks is not exposed to lead in excess of 2,500 µg/m$^3$ (50×PEL), the employer shall treat the employee as if the employee were exposed to lead in excess of 2,500 µg/m3 and shall implement employee protective measures as prescribed in paragraph (d)(2)(v) of this section. Where the employer does establish that the employee is exposed to levels of lead below 2,500 µg/m$^3$, the employer may provide the exposed employee with the appropriate respirator prescribed for use at such lower exposures, in accordance with paragraph (f) of this section. Interim protection as described in this paragraph is required where lead containing coatings or paint are present on structures when performing:

1926.62(d)(2)(iv)(A) Abrasive blasting,

1926.62(d)(2)(iv)(B) Welding,

1926.62(d)(2)(iv)(C) Cutting, and

1926.62(d)(2)(iv)(D) Torch burning.

**R 325.51986 Interim protection.**

**Rule 86. (1) This rule replaces OSHA 1926.62(d)(2)(v).**

(2) Until the employer performs an employee exposure assessment as required under 1926.62(d) and determines actual employee exposure, the employer shall provide to employees performing the tasks described in 1926.62(d)(2)(i), (ii), (iii), and (iv) with interim protection as follows:

(a) Appropriate respiratory protection in accordance with 1926.62(f).

(b) Appropriate personal protective clothing and equipment in accordance with 1926.62(g).

(c) Change areas in accordance with 1926.62(i)(2).

(d) Hand washing facilities in accordance with 1926.62(i)(5).

(e) Biological monitoring in accordance with R 325.51987(2) of these rules, to consist of blood sampling and analysis for lead levels.

(f) Training as required by the following:

(i) Under 1926.62(l)(1)(i) regarding “Hazard Communication.”

(ii) Under 1926.62(l)(2)(iii) regarding use of respirators.

(iii) Training in accordance with Construction Safety and Health Standard Part 1 “General Rules,” as referenced in R 325.51985.

**1926.62(d)(3) Basis of initial determination.**

1926.62(d)(3)(i) Except as provided under paragraphs (d)(3)(iii) and (d)(3)(iv) of this section the employer shall monitor employee exposures and shall base initial determinations on the employee exposure monitoring results and any of the following, relevant considerations:

1926.62(d)(3)(i)(A) Any information, observations, or calculations which would indicate employee exposure to lead;

1926.62(d)(3)(i)(B) Any previous measurements of airborne lead; and

1926.62(d)(3)(i)(C) Any employee complaints of symptoms which may be attributable to exposure to lead.

1926.62(d)(3)(ii) Monitoring for the initial determination where performed may be limited to a representative sample of the exposed employees who the employer reasonably believes are exposed to the greatest airborne concentrations of lead in the workplace.

1926.62(d)(3)(iii) Where the employer has previously monitored for lead exposures, and the data were obtained within the past 12 months during work operations conducted under workplace conditions closely resembling the processes, type of material, control methods, work practices, and environmental conditions used and prevailing in the employer's current operations, the employer may rely on such earlier monitoring results to satisfy the requirements of paragraphs (d)(3)(i) and (d)(6) of this section if the sampling and analytical methods meet the accuracy and confidence levels of paragraph (d)(9) of this section.

1926.62(d)(3)(iv) Where the employer has objective data, demonstrating that a particular product or material containing lead or a specific process, operation or activity involving lead cannot result in employee exposure to lead at or above the action level during processing, use, or handling, the employer may rely upon such data instead of implementing initial monitoring.

1926.62(d)(3)(iv)(A) The employer shall establish and maintain an accurate record documenting the nature and relevancy of objective data as specified in paragraph (n)(4) of this section, where used in assessing employee exposure in lieu of exposure monitoring.

1926.62(d)(3)(iv)(B) Objective data, as described in this paragraph (d)(3)(iv) of this section, is not permitted to be used for exposure assessment in connection with paragraph (d)(2) of this section.

**1926.62(d)(4) Positive initial determination and initial monitoring.**

1926.62(d)(4)(i) Where a determination conducted under paragraphs (d)(1), (2) and (3) of this section shows the possibility of any employee exposure at or above the action level the employer shall conduct monitoring which is representative of the exposure for each employee in the workplace who is exposed to lead.

1926.62(d)(4)(ii) Where the employer has previously monitored for lead exposure, and the data were obtained within the past 12 months during work operations conducted under workplace conditions closely resembling the processes, type of material, control methods, work practices, and environmental conditions used and prevailing in the employer's current operations, the employer may rely on such earlier monitoring results to satisfy the requirements of paragraph (d)(4)(i) of this section if the sampling and analytical methods meet the accuracy and confidence levels of paragraph (d)(9) of this section.

**1926.62(d)(5) Negative initial determination.**

Where a determination, conducted under paragraphs (d) (1), (2), and (3) of this section is made that no employee is exposed to airborne concentrations of lead at or above the action level the employer shall make a written record of such determination. The record shall include at least the information specified in paragraph (d)(3)(i) of this section and shall also include the date of determination, location within the worksite, and the name of each employee monitored.

**1926.62(d)(6) Frequency.**

1926.62(d)(6)(i) If the initial determination reveals employee exposure to be below the action level further exposure determination need not be repeated except as otherwise provided in paragraph (d)(7) of this section.

1926.62(d)(6)(ii) If the initial determination or subsequent determination reveals employee exposure to be at or above the action level but at or below the PEL the employer shall perform monitoring in accordance with this paragraph at least every 6 months. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the action level at which time the employer may discontinue monitoring for that employee except as otherwise provided in paragraph (d)(7) of this section.

1926.62(d)(6)(iii) If the initial determination reveals that employee exposure is above the PEL the employer shall perform monitoring quarterly. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are at or below the PEL but at or above the action level at which time the employer shall repeat monitoring for that employee at the frequency specified in paragraph (d)(6)(ii) of this section, except as otherwise provided in paragraph (d)(7) of this section. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the action level at which time the employer may discontinue monitoring for that employee except as otherwise provided in paragraph (d)(7) of this section.

**1926.62(d)(7) Additional exposure assessments.**

Whenever there has been a change of equipment, process, control, personnel or a new task has been initiated that may result in additional employees being exposed to lead at or above the action level or may result in employees already exposed at or above the action level being exposed above the PEL, the employer shall conduct additional monitoring in accordance with this paragraph.

**1926.62(d)(8) Employee notification.**

1926.62(d)(8)(i) The employer must, as soon as possible but no later than 5 working days after the receipt of the results of any monitoring performed under this section, notify each affected employee of these results either individually in writing or by posting the results in an appropriate location that is accessible to employees.

1926.62(d)(8)(ii) Whenever the results indicate that the representative employee exposure, without regard to respirators, is at or above the PEL the employer shall include in the written notice a statement that the employees exposure was at or above that level and a description of the corrective action taken or to be taken to reduce exposure to below that level.

**1926.62(d)(9) Accuracy of measurement.**

The employer shall use a method of monitoring and analysis which has an accuracy (to a confidence level of 95 percent) of not less than plus or minus 25 percent for airborne concentrations of lead equal to or greater than 30 ug/m(3).

**1926.62(e) METHODS OF COMPLIANCE.**

**1926.62(e)(1) Engineering and work practice controls.**

The employer shall implement engineering and work practice controls, including administrative controls, to reduce and maintain employee exposure to lead to or below the permissible exposure limit to the extent that such controls are feasible. Wherever all feasible engineering and work practices controls that can be instituted are not sufficient to reduce employee exposure to or below the permissible exposure limit prescribed in paragraph (c) of this section, the employer shall nonetheless use them to reduce employee exposure to the lowest feasible level and shall supplement them by the use of respiratory protection that complies with the requirements of paragraph (f) of this section.

**1926.62(e)(2) Compliance program.**

1926.62(e)(2)(i) Prior to commencement of the job each employer shall establish and implement a written compliance program to achieve compliance with paragraph (c) of this section.

1926.62(e)(2)(ii) Written plans for these compliance programs shall include at least the following:

1926.62(e)(2)(ii)(A) A description of each activity in which lead is emitted; e.g. equipment used, material involved, controls in place, crew size, employee job responsibilities, operating procedures and maintenance practices; 1926.62(e)(2)(ii)(B) A description of the specific means that will be employed to achieve compliance and, where engineering controls are required engineering plans and studies used to determine methods selected for controlling exposure to lead;

1926.62(e)(2)(ii)(C) A report of the technology considered in meeting the PEL;

1926.62(e)(2)(ii)(D) Air monitoring data which documents the source of lead emissions;

1926.62(e)(2)(ii)(E) A detailed schedule for implementation of the program, including documentation such as copies of purchase orders for equipment, construction contracts, etc.;

1926.62(e)(2)(ii)(F) A work practice program which includes items required under paragraphs (g), (h) and (i) of this section and incorporates other relevant work practices such as those specified in paragraph (e)(5) of this section;

1926.62(e)(2)(ii)(G) An administrative control schedule required by paragraph (e)(4) of this section, if applicable;

1926.62(e)(2)(ii)(H) A description of arrangements made among contractors on multi-contractor sites with respect to informing affected employees of potential exposure to lead and with respect to responsibility for compliance with this section as set-forth in 1926.16.

1926.62(e)(2)(ii)(I) Other relevant information.

1926.62(e)(2)(iii) The compliance program shall provide for frequent and regular inspections of job sites, materials, and equipment to be made by a competent person.

1926.62(e)(2)(iv) Written programs shall be submitted upon request to any affected employee or authorized employee representatives, to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary and the Director.

1926.62(e)(2)(v) Written programs must be revised and updated at least annually to reflect the current status of the program.

**1926.62(e)(3) Mechanical ventilation.**

When ventilation is used to control lead exposure, the employer shall evaluate the mechanical performance of the system in controlling exposure as necessary to maintain its effectiveness.

**1926.62(e)(4) Administrative controls.**

If administrative controls are used as a means of reducing employees TWA exposure to lead, the employer shall establish and implement a job rotation schedule which includes:

1926.62(e)(4)(i) Name or identification number of each affected employee;

1926.62(e)(4)(ii) Duration and exposure levels at each job or work station where each affected employee is located; and

1926.62(e)(4)(iii) Any other information which may be useful in assessing the reliability of administrative controls to reduce exposure to lead.

**1926.62(e)(5)**

The employer shall ensure that, to the extent relevant, employees follow good work practices such as described in Appendix B of this section.

**1926.62(f) RESPIRATORY PROTECTION.**

**1926.62(f)(1) General.**

For employees who use respirators required by this section, the employer must provide each employee an appropriate respirator that complies with the requirements of this paragraph. Respirators must be used during:

1926.62(f)(1)(i) Periods when an employee's exposure to lead exceeds the PEL.

1926.62(f)(1)(ii) Work operations for which engineering and work-practice controls are not sufficient to reduce employee exposures to or below the PEL.

1926.62(f)(1)(iii) Periods when an employee requests a respirator.

1926.62(f)(1)(iv) Periods when respirators are required to provide interim protection of employees while they perform the operations specified in paragraph (d)(2) of this section.

**1926.62(f)(2) Respirator program.**

1926.62(f)(2)(i) The employer must implement a respiratory protection program in accordance with §1910.134(b) through (d) (except (d)(1)(iii)), and (f) through (m), which covers each employee required by this section to use a respirator.

1926.62(f)(2)(ii) If an employee has breathing difficulty during fit testing or respirator use, the employer must provide the employee with a medical examination in accordance with paragraph (j)(3)(i)(B) of this section to determine whether or not the employee can use a respirator while performing the required duty.

**1926.62(f)(3) Respirator selection.**

1926.62(f)(3)(i) Employers must:

1926.62(f)(3)(i)(A) Select, and provide to employees, the appropriate respirators specified in paragraph (d)(3)(i)(A) of 29 CFR 1910.134.

1926.62(f)(3)(i)(B) Provide employees with a full facepiece respirator instead of a half mask respirator for protection against lead aerosols that may cause eye or skin irritation at the use concentrations.

1926.62(f)(3)(i)(C) Provide HEPA filters for powered and non-powered air-purifying respirators.

1926.62(f)(3)(ii) The employer must provide a powered air-purifying respirator when an employee chooses to use such a respirator and it will provide adequate protection to the employee.

**1926.62(g) PROTECTIVE WORK CLOTHING AND EQUIPMENT.**

**1926.62(g)(1) Provision and use.**

Where an employee is exposed to lead above the PEL without regard to the use of respirators, where employees are exposed to lead compounds which may cause skin or eye irritation (e.g. lead arsenate, lead azide), and as interim protection for employees performing tasks as specified in paragraph (d)(2) of this section, the employer shall provide at no cost to the employee and assure that the employee uses appropriate protective work clothing and equipment that prevents contamination of the employee and the employee's garments such as, but not limited to:

1926.62(g)(1)(i) Coveralls or similar full-body work clothing;

1926.62(g)(1)(ii) Gloves, hats, and shoes or disposable shoe coverlets; and

1926.62(g)(1)(iii) Face shields, vented goggles, or other appropriate protective equipment which complies with 1910.133 of this chapter.

**1926.62(g)(2) Cleaning and replacement.**

1926.62(g)(2)(i) The employer shall provide the protective clothing required in paragraph (g)(1) of this section in a clean and dry condition at least weekly, and daily to employees whose exposure levels without regard to a respirator are over 200 ug/m(3) of lead as an 8-hour TWA.

1926.62(g)(2)(ii) The employer shall provide for the cleaning, laundering, and disposal of protective clothing and equipment required by paragraph (g)(1) of this section.

1926.62(g)(2)(iii) The employer shall repair or replace required protective clothing and equipment as needed to maintain their effectiveness.

1926.62(g)(2)(iv) The employer shall assure that all protective clothing is removed at the completion of a work shift only in change areas provided for that purpose as prescribed in paragraph (i)(2) of this section.

1926.62(g)(2)(v) The employer shall assure that contaminated protective clothing which is to be cleaned, laundered, or disposed of, is placed in a closed container in the change area which prevents dispersion of lead outside the container.

1926.62(g)(2)(vi) The employer shall inform in writing any person who cleans or launders protective clothing or equipment of the potentially harmful effects of exposure to lead.

1926.62(g)(2)(vii)(A) The employer shall ensure that the containers of contaminated protective clothing and equipment required by paragraph (g)(2)(v) of this section are labeled as follows:

DANGER: CLOTHING AND EQUIPMENT CONTAMINATED WITH LEAD.
MAY DAMAGE FERTILITY OR THE UNBORN CHILD.
CAUSES DAMAGE TO THE CENTRAL NERVOUS SYSTEM.
DO NOT EAT, DRINK OR SMOKE WHEN HANDLING.
DO NOT REMOVE DUST BY BLOWING OR SHAKING.
DISPOSE OF LEAD CONTAMINATED WASH WATER IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, OR FEDERAL REGULATIONS.

1926.62(g)(2)(vii)(B) Prior to June 1, 2015, employers may include the following information on bags or containers of contaminated protective clothing and equipment required by paragraph (g)(2)(v) in lieu of the labeling requirements in paragraph (g)(2)(vii)(A) of this section:

Caution: Clothing contaminated with lead.
Do not remove dust by blowing or shaking.
Dispose of lead contaminated wash water in accordance with applicable local, state, or federal regulations.

1926.62(g)(2)(viii) The employer shall prohibit the removal of lead from protective clothing or equipment by blowing, shaking, or any other means which disperses lead into the air.

**1926.62(h) HOUSEKEEPING.**

1926.62(h)(1) All surfaces shall be maintained as free as practicable of accumulations of lead.

1926.62(h)(2) Clean-up of floors and other surfaces where lead accumulates shall wherever possible, be cleaned by vacuuming or other methods that minimize the likelihood of lead becoming airborne.

1926.62(h)(3) Shoveling, dry or wet sweeping, and brushing may be used only where vacuuming or other equally effective methods have been tried and found not to be effective.

1926.62(h)(4) Where vacuuming methods are selected, the vacuums shall be equipped with HEPA filters and used and emptied in a manner which minimizes the reentry of lead into the workplace.

1926.62(h)(5) Compressed air shall not be used to remove lead from any surface unless the compressed air is used in conjunction with a ventilation system designed to capture the airborne dust created by the compressed air.

## 1926.62(i) HYGIENE FACILITIES AND PRACTICES.

**1926.62(i)(1)**

The employer shall assure that in areas where employees are exposed to lead above the PEL without regard to the use of respirators, food or beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied.

**1926.62(i)(2) Change areas.**

1926.62(i)(2)(i) The employer shall provide clean change areas for employees whose airborne exposure to lead is above the PEL, and as interim protection for employees performing tasks as specified in paragraph (d)(2) of this section, without regard to the use of respirators.

1926.62(i)(2)(ii) The employer shall assure that change areas are equipped with separate storage facilities for protective work clothing and equipment and for street clothes which prevent cross-contamination.

1926.62(i)(2)(iii) The employer shall assure that employees do not leave the workplace wearing any protective clothing or equipment that is required to be worn during the work shift.

**1926.62(i)(3) Showers.**

1926.62(i)(3)(i) The employer shall provide shower facilities, where feasible, for use by employees whose airborne exposure to lead is above the PEL.

1926.62(i)(3)(ii) The employer shall assure, where shower facilities are available, that employees shower at the end of the work shift and shall provide an adequate supply of cleansing agents and towels for use by affected employees.

**1926.62(i)(4) Eating facilities.**

1926.62(i)(4)(i) The employer shall provide lunchroom facilities or eating areas for employees whose airborne exposure to lead is above the PEL, without regard to the use of respirators.

1926.62(i)(4)(ii) The employer shall assure that lunchroom facilities or eating areas are as free as practicable from lead contamination and are readily accessible to employees.

1926.62(i)(4)(iii) The employer shall assure that employees whose airborne exposure to lead is above the PEL, without regard to the use of a respirator, wash their hands and face prior to eating, drinking, smoking or applying cosmetics.

1926.62(i)(4)(iv) The employer shall assure that employees do not enter lunchroom facilities or eating areas with protective work clothing or equipment unless surface lead dust has been removed by vacuuming, downdraft booth, or other cleaning method that limits dispersion of lead dust.

**1926.62(i)(5) Hand Washing facilities.**

1926.62(i)(5)(i) The employer shall provide adequate handwashing facilities for use by employees exposed to lead in accordance with 29 CFR 1926.51(f).

1926.62(i)(5)(ii) Where showers are not provided the employer shall assure that employees wash their hands and face at the end of the work-shift.

## 1926.62(j) MEDICAL SURVEILLANCE.

**R 325.51987 Medical surveillance, general.**

**Rule 87**. **(1) This rule replaces OSHA 1926.62(j)(1).**

(2) An employer shall make available initial medical surveillance to employees occupationally exposed on any day to lead at or above the action level. Initial medical surveillance consists of biological monitoring in the form of blood sampling and analysis for lead levels.

(3) An employer shall institute a medical surveillance program in accordance with 1926.62(j)(2), R 325.51988, R 325.51989, R 325.51990, R 325.51991, and 1926.62(j)(3) for all employees who are or may be exposed by the employer at or above the action level for more than 30 days in any consecutive 12 months.

(4) An employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician.

(5) An employer shall make available the required medical surveillance including multiple physician review under 1926.62(j)(3)(iii) without cost to employees and at a reasonable time and place.

**1926.62(j)(2) Biological monitoring.**

**R 325.51988 Blood lead level sampling and analysis.**
**Rule 88. (1) This rule replaces OSHA 1926.62(j)(2)(i).**

(2) An employer shall make available biological monitoring in the form of blood sampling and analysis for lead levels to each employee covered under R 325.51987 (2) and (3) of these rules on the following schedule:

(a) For each employee covered under R 325.51987(3) of these rules, at least every 2 months for the first 6 months and every 6 months thereafter.

(b) For each employee covered under R 325.51987 (2) or (3) of these rules whose last blood sampling and analysis indicated a blood lead level at or above 15 µg/dL, at least every 2 months. This frequency shall continue until 2 consecutive blood samples and analyses indicate a blood lead level below 15 µg/dL.

(c) For each employee who is removed from exposure to lead due to an elevated blood lead level at least monthly during the removal period.

**1926.62(j)(2)(ii) Follow-up blood sampling tests.**

Whenever the results of a blood lead level test indicate that an employee's blood lead level is at or above the numerical criterion for medical removal under paragraph (k)(1)(i) of this section, the employer shall provide a second (follow-up) blood sampling test within two weeks after the employer receives the results of the first blood sampling test.

**1926.62(j)(2)(iii) Accuracy of blood lead level sampling and analysis.**

Blood lead level sampling and analysis provided pursuant to this section shall have an accuracy (to a confidence level of 95 percent) within plus or minus 15 percent or 6 ug/dl, whichever is greater, and shall be conducted by a laboratory approved by OSHA.

**R 325.51989 Employee notification.**
**Rule 89. (1) This rule replaces OSHA 1926.62(j)(2)(iv).**

(2) Within 5 working days after the receipt of biological monitoring results, the employer shall notify each employee in writing of his or her blood lead level.

(3) An employer shall notify each employee whose blood lead level is at or above 15 µg/dL that these rules require temporary medical removal with Medical Removal Protection benefits when an employee's blood lead level is at or above the numerical criterion for medical removal under R 325.51992 of these rules.

**1926.62(j)(3) Medical examinations and consultations.**

**R 325.51990 Medical examinations and consultations, frequency.**
**Rule 90. (1) This rule replaces OSHA 1926.62(j)(3)(i).**

(2) An employer shall make available medical examinations and consultations to each employee covered under R 325.51987(3) of these rules on the following schedule:

(a) At least annually for each employee for whom a blood lead sampling test conducted at any time during the preceding 12 months indicated a blood lead level at or above 15 µg/dL.

(b) As soon as possible, upon notification by an employee either that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice concerning the effects of current or past exposure to lead on the employee's ability to procreate a healthy child, that the employee is pregnant, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during use.

(c) As medically appropriate for each employee either removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited pursuant to a final medical determination.

**R 325.51991 Content of medical examinations.**

**Rule 91. (1) This rule replaces OSHA 1926.62(j)(3)(ii).**

(2) The content of medical examinations made available pursuant to R 325.51990(2) (b) and (c) of these rules shall be determined by an examining physician and, if requested by an employee, shall include pregnancy testing or laboratory evaluation of male fertility.

(3) Medical examinations made available pursuant to R 325.51990(2)(a) of these rules include all of the following elements:

(a) A detailed work history and a medical history, with particular attention to past occupational and non-occupational lead exposure in all of the following:

(i) Personal habits, such as smoking and hygiene.
(ii) Past gastrointestinal.
(iii) Hematologic.
(iv) Renal.
(v) Cardiovascular.
(vi) Reproductive.
(vii) Neurological problems.

(b) A thorough physical examination, with particular attention to all of the following:

(i) Teeth.
(ii) Gums.
(iii) Hematologic.
(iv) Gastrointestinal.
(v) Renal.
(vi) Cardiovascular.
(vii) Neurological systems.
(viii) Pulmonary status should be evaluated if respiratory protection will be used.

(c) A blood pressure measurement.

(d) A blood sample and an analysis which determines all of the following:

(i) Blood lead level.
(ii) Hemoglobin and hematocrit determinations, red cell indices, and examination of peripheral smear morphology.
(iii) Blood urea nitrogen.
(iv) Serum creatinine.

(e) A routine urinalysis with microscopic examination.

(f) Any laboratory or other test relevant to lead exposure which the examining physician deems necessary by sound medical practice.

**1926.62(j)(3)(iii) Multiple physician review mechanism.**

1926.62(j)(3)(iii)(A) If the employer selects the initial physician who conducts any medical examination or consultation provided to an employee under this section, the employee may designate a second physician:

1926.62(j)(3)(iii)(A)(1) To review any findings, determinations or recommendations of the initial physician; and

1926.62(j)(3)(iii)(A)(2) To conduct such examinations, consultations, and laboratory tests as the second physician deems necessary to facilitate this review.

1926.62(j)(3)(iii)(B) The employer shall promptly notify an employee of the right to seek a second medical opinion after each occasion that an initial physician conducts a medical examination or consultation pursuant to this section. The employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee doing the following within fifteen (15) days after receipt of the foregoing notification, or receipt of the initial physician's written opinion, whichever is later:

1926.62(j)(3)(iii)(B)(1) The employee informing the employer that he or she intends to seek a second medical opinion, and

1926.62(j)(3)(iii)(B)(2) The employee initiating steps to make an appointment with a second physician.

1926.62(j)(3)(iii)(C) If the findings, determinations or recommendations of the second physician differ from those of the initial physician, then the employer and the employee shall assure that efforts are made for the two physicians to resolve any disagreement.

1926.62(j)(3)(iii)(D) If the two physicians have been unable to quickly resolve their disagreement, then the employer and the employee through their respective physicians shall designate a third physician:

1926.62(j)(3)(iii)(D)(1) To review any findings, determinations or recommendations of the prior physicians; and

1926.62(j)(3)(iii)(D)(2) To conduct such examinations, consultations, laboratory tests and discussions with the prior physicians as the third physician deems necessary to resolve the disagreement of the prior physicians.

1926.62(j)(3)(iii)(E) The employer shall act consistent with the findings, determinations and recommendations of the third physician, unless the employer and the employee reach an agreement which is otherwise consistent with the recommendations of at least one of the three physicians.

**1926.62(j)(3)(iv) Information provided to examining and consulting physicians.**

1926.62(j)(3)(iv)(A) The employer shall provide an initial physician conducting a medical examination or consultation under this section with the following information:

1926.62(j)(3)(iv)(A)(1) A copy of this regulation for lead including all Appendices;

1926.62(j)(3)(iv)(A)(2) A description of the affected employee's duties as they relate to the employee's exposure;

1926.62(j)(3)(iv)(A)(3) The employee's exposure level or anticipated exposure level to lead and to any other toxic substance (if applicable);

1926.62(j)(3)(iv)(A)(4) A description of any personal protective equipment used or to be used;

1926.62(j)(3)(iv)(A)(5) Prior blood lead determinations; and

1926.62(j)(3)(iv)(A)(6) All prior written medical opinions concerning the employee in the employer's possession or control.

1926.62(j)(3)(iv)(B) The employer shall provide the foregoing information to a second or third physician conducting a medical examination or consultation under this section upon request either by the second or third physician, or by the employee.

**1926.62(j)(3)(v) Written medical opinions.**

1926.62(j)(3)(v)(A) The employer shall obtain and furnish the employee with a copy of a written medical opinion from each examining or consulting physician which contains only the following information:

1926.62(j)(3)(v)(A)(1) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to lead;

1926.62(j)(3)(v)(A)(2) Any recommended special protective measures to be provided to the employee, or limitations to be placed upon the employee's exposure to lead;

1926.62(j)(3)(v)(A)(3) Any recommended limitation upon the employee's use of respirators, including a determination of whether the employee can wear a powered air purifying respirator if a physician determines that the employee cannot wear a negative pressure respirator; and

1926.62(j)(3)(v)(A)(4) The results of the blood lead determinations.

1926.62(j)(3)(v)(B) The employer shall instruct each examining and consulting physician to:

1926.62(j)(3)(v)(B)(1) Not reveal either in the written opinion or orally, or in any other means of communication with the employer, findings, including laboratory results, or diagnoses unrelated to an employee's occupational exposure to lead; and

1926.62(j)(3)(v)(B)(2) Advise the employee of any medical condition, occupational or nonoccupational, which dictates further medical examination or treatment.

**1926.62(j)(3)(vi) Alternate physician determination mechanisms.**

The employer and an employee or authorized employee representative may agree upon the use of any alternate physician determination mechanism in lieu of the multiple physician review mechanism provided by paragraph (j)(3)(iii) of this section so long as the alternate mechanism is as expeditious and protective as the requirements contained in this paragraph.

**1926.62(j)(4) Chelation.**

1926.62(j)(4)(i) The employer shall assure that any person whom he retains, employs, supervises or controls does not engage in prophylactic chelation of any employee at any time.

1926.62(j)(4)(ii) If therapeutic or diagnostic chelation is to be performed by any person in paragraph (j)(4)(i) of this section, the employer shall assure that it be done under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring and that the employee is notified in writing prior to its occurrence.

## 1926.62(k) MEDICAL REMOVAL PROTECTION.

**1926.62(k)(1) Temporary medical removal and return of an employee.**

**R 325.51992 Temporary removal due to elevated blood lead level.**
**Rule 92. (1) This rule replaces OSHA 1926.62(k)(1)(i).**
(2) An employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that a periodic and a follow-up blood sampling test conducted pursuant to these rules indicate that the employee's blood lead level is at or above 30 µg/dL.

**1926.62(k)(1)(ii) Temporary removal due to a final medical determination.**

1926.62(k)(1)(ii)(A) The employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that a final medical determination results in a medical finding, determination, or opinion that the employee has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.

1926.62(k)(1)(ii)(B) For the purposes of this section, the phrase *final medical determination* means the written medical opinion on the employees' health status by the examining physician or, where relevant, the outcome of the multiple physician review mechanism or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section.

1926.62(k)(1)(ii)(C) Where a final medical determination results in any recommended special protective measures for an employee, or limitations on an employee's exposure to lead, the employer shall implement and act consistent with the recommendation.

**R 325.51993 Return of employee to former job status.**

**Rule 93. (1) This rule replaces OSHA 1926.62(k)(1)(iii).**

(2) An employer shall return an employee to his or her former job status under either of the following circumstances:

(a) For an employee removed due to a blood lead level at or above 30 µg/dL when 2 consecutive blood sampling tests indicate that the employee's blood lead level is below 15 µg/dL.

(b) For an employee removed due to a final medical determination, when a subsequent final medical determination results in a medical finding, determination, or opinion that the employee no longer has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.

(3) For the purposes of this rule, the requirement that an employer return an employee to his or her former job status is not intended to expand upon or restrict any rights an employee has or would have had, absent temporary medical removal, to a specific job classification or position under the terms of a collective bargaining agreement.

**1926.62(k)(1)(iv) Removal of other employee special protective measure or limitations.**

The employer shall remove any limitations placed on an employee or end any special protective measures provided to an employee pursuant to a final medical determination when a subsequent final medical determination indicates that the limitations or special protective measures are no longer necessary.

**1926.62(k)(1)(v) Employer options pending a final medical determination.**

Where the multiple physician review mechanism, or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section, has not yet resulted in a final medical determination with respect to an employee, the employer shall act as follows:

**1926.62(k)(1)(v)(A) Removal.**

The employer may remove the employee from exposure to lead, provide special protective measures to the employee, or place limitations upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status.

**1926.62(k)(1)(v)(B) Return.**

The employer may return the employee to his or her former job status, end any special protective measures provided to the employee, and remove any limitations placed upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status, with two exceptions.

1926.62(k)(1)(v)(B)(1) If the initial removal, special protection, or limitation of the employee resulted from a final medical determination which differed from the findings, determinations, or recommendations of the initial physician or;

1926.62(k)(1)(v)(B)(2) If the employee has been on removal status for the preceding eighteen months due to an elevated blood lead level, then the employer shall await a final medical determination.

**1926.62(k)(2) Medical removal protection benefits.**

**1926.62(k)(2)(i) Provision of medical removal protection benefits.**

The employer shall provide an employee up to eighteen (18) months of medical removal protection benefits on each occasion that an employee is removed from exposure to lead or otherwise limited pursuant to this section.

**1926.62(k)(2)(ii) Definition of medical removal protection benefits.**

For the purposes of this section, the requirement that an employer provide medical removal protection benefits means that, as long as the job the employee was removed from continues, the employer shall maintain the total normal earnings, seniority and other employment rights and benefits of an employee, including the employee's right to his or her former job status as though the employee had not been medically removed from the employee's job or otherwise medically limited.

**1926.62(k)(2)(iii) Follow-up medical surveillance during the period of employee removal or limitation.**

During the period of time that an employee is medically removed from his or her job or otherwise medically limited, the employer may condition the provision of medical removal protection benefits upon the employee's participation in follow-up medical surveillance made available pursuant to this section.

**1926.62(k)(2)(iv) Workers' compensation claims.**

If a removed employee files a claim for workers' compensation payments for a lead-related disability, then the employer shall continue to provide medical removal protection benefits pending disposition of the claim. To the extent that an award is made to the employee for earnings lost during the period of removal, the employer's medical removal protection obligation shall be reduced by such amount. The employer shall receive no credit for workers' compensation payments received by the employee for treatment-related expenses.

**1926.62(k)(2)(v) Other credits.**

The employer's obligation to provide medical removal protection benefits to a removed employee shall be reduced to the extent that the employee receives compensation for earnings lost during the period of removal either from a publicly or employer-funded compensation program, or receives income from employment with another employer made possible by virtue of the employee's removal.

**1926.62(k)(2)(vi) Voluntary removal or restriction of an employee.**

Where an employer, although not required by this section to do so, removes an employee from exposure to lead or otherwise places limitations on an employee due to the effects of lead exposure on the employee's medical condition, the employer shall provide medical removal protection benefits to the employee equal to that required by paragraph (k)(2)(i) and (ii) of this section.

**1926.62(l) COMMUNICATION OF HAZARDS.**

**1926.62(l)(1) General.**

**1926.62(l)(1)(i) Hazard communication.**

The employer shall include lead in the program established to comply with the Hazard Communication Standard (HCS) (1910.1200). The employer shall ensure that each employee has access to labels on containers of lead and safety data sheets, and is trained in accordance with the provisions of HCS and paragraph (l) of this section. The employer shall ensure that at least the following hazards are addressed:

1926.62(l)(1)(i)(A) Reproductive/developmental toxicity;

1926.62(l)(1)(i)(B) Central nervous system effects;

1926.62(l)(1)(i)(C) Kidney effects;

1926.62(l)(1)(i)(D) Blood effects; and

1926.62(l)(1)(i)(E) Acute toxicity effects.

1926.62(l)(1)(ii) The employer shall train each employee who is subject to exposure to lead at or above the action level on any day, or who is subject to exposure to lead compounds which may cause skin or eye irritation (*e.g.*, lead arsenate, lead azide), in accordance with the requirements of this section. The employer shall institute a training program and ensure employee participation in the program.

1926.62(l)(1)(iii) The employer shall provide the training program as initial training prior to the time of job assignment or prior to the start up date for this requirement, whichever comes last.

1926.62(l)(1)(iv) The employer shall also provide the training program at least annually for each employee who is subject to lead exposure at or above the action level on any day.

**1926.62(l)(2) Training program.**

The employer shall assure that each employee is trained in the following:

1926.62(l)(2)(i) The content of this standard and its appendices;

1926.62(l)(2)(ii) The specific nature of the operations which could result in exposure to lead above the action level;

1926.62(l)(2)(iii) The purpose, proper selection, fitting, use, and limitations of respirators;

1926.62(l)(2)(iv) The purpose and a description of the medical surveillance program, and the medical removal protection program including information concerning the adverse health effects associated with excessive exposure to lead (with particular attention to the adverse reproductive effects on both males and females and hazards to the fetus and additional precautions for employees who are pregnant);

1926.62(l)(2)(v) The engineering controls and work practices associated with the employee's job assignment including training of employees to follow relevant good work practices described in Appendix B of this section;

1926.62(l)(2)(vi) The contents of any compliance plan in effect;

1926.62(l)(2)(vii) Instructions to employees that chelating agents should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed physician; and

1926.62(l)(2)(viii) The employee's right of access to records under 29 CFR 1910.20.

**1926.62(l)(3) Access to information and training materials.**

1926.62(l)(3)(i) The employer shall make readily available to all affected employees a copy of this standard and its appendices.

1926.62(l)(3)(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to affected employees and their designated representatives, and to the Assistant Secretary and the Director.

**1926.62(m) SIGNS.**

**1926.62(m)(1) General.**

1926.62(m)(1)(i) The employer shall post the following warning signs in each work area where an employee's exposure to lead is above the PEL.

| |
|---|
| DANGER<br>LEAD WORK AREA<br>MAY DAMAGE FERTILITY OR THE UNBORN CHILD<br>CAUSES DAMAGE TO THE CENTRAL NERVOUS SYSTEM<br>DO NOT EAT, DRINK OR SMOKE IN THIS AREA |

1926.62(m)(1)(ii) The employer shall ensure that no statement appears on or near any sign required by this paragraph (m) that contradicts or detracts from the meaning of the required sign.

1926.62(m)(1)(iii) The employer shall ensure that signs required by this paragraph (m) are illuminated and cleaned as necessary so that the legend is readily visible.

1926.62(m)(1)(iv) The employer may use signs required by other statutes, regulations or ordinances in addition to, or in combination with, signs required by this paragraph (m).

1926.62(m)(1)(v) Prior to June 1, 2016, employers may use the following legend in lieu of that specified in paragraph (m)(1)(i) of this section:

| |
|---|
| WARNING<br>LEAD WORK AREA<br>POISON<br>NO SMOKING OR EATING |

## 1926.62(n) RECORDKEEPING

**1926.62(n)(1) Exposure assessment.**

1926.62(n)(1)(i) The employer shall establish and maintain an accurate record of all monitoring and other data used in conducting employee exposure assessments as required in paragraph (d) of this section.

1926.62(n)(1)(ii) Exposure monitoring records shall include:

1926.62(n)(1)(ii)(A) The date(s), number, duration, location and results of each of the samples taken if any, including a description of the sampling procedure used to determine representative employee exposure where applicable;

1926.62(n)(1)(ii)(B) A description of the sampling and analytical methods used and evidence of their accuracy;

1926.62(n)(1)(ii)(C) The type of respiratory protective devices worn, if any;

1926.62(n)(1)(ii)(D) Name and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent; and

1926.62(n)(1)(ii)(E) The environmental variables that could affect the measurement of employee exposure.

1926.62(n)(1)(iii) The employer shall maintain monitoring and other exposure assessment records in accordance with the provisions of 29 CFR 1926.33.

**1926.62(n)(2) Medical surveillance.**

1926.62(n)(2)(i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (j) of this section.

1926.62(n)(2)(ii) This record shall include:

1926.62(n)(2)(ii)(A) The name and description of the duties of the employee;

1926.62(n)(2)(ii)(B) A copy of the physician's written opinions;

1926.62(n)(2)(ii)(C) Results of any airborne exposure monitoring done on or for that employee and provided to the physician; and

1926.62(n)(2)(ii)(D) Any employee medical complaints related to exposure to lead.

1926.62(n)(2)(iii) The employer shall keep, or assure that the examining physician keeps, the following medical records:

1926.62(n)(2)(iii)(A) A copy of the medical examination results including medical and work history required under paragraph (j) of this section;

1926.62(n)(2)(iii)(B) A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results or references to that information;

1926.62(n)(2)(iii)(C) A copy of the results of biological monitoring.

1926.62(n)(2)(iv) The employer shall maintain or assure that the physician maintains medical records in accordance with the provisions of 29 CFR 1926.33.

**1926.62(n)(3) Medical removals.**

1926.62(n)(3)(i) The employer shall establish and maintain an accurate record for each employee removed from current exposure to lead pursuant to paragraph (k) of this section.

1926.62(n)(3)(ii) Each record shall include:

1926.62(n)(3)(ii)(A) The name of the employee;

1926.62(n)(3)(ii)(B) The date of each occasion that the employee was removed from current exposure to lead as well as the corresponding date on which the employee was returned to his or her former job status;

1926.62(n)(3)(ii)(C) A brief explanation of how each removal was or is being accomplished; and

1926.62(n)(3)(ii)(D) A statement with respect to each removal indicating whether or not the reason for the removal was an elevated blood lead level.

1926.62(n)(3)(iii) The employer shall maintain each medical removal record for at least the duration of an employee's employment.

**1926.62(n)(4) Objective data for exemption from requirement for initial monitoring.**

1926.62(n)(4)(i) For purposes of this section, objective data are information demonstrating that a particular product or material containing lead or a specific process, operation, or activity involving lead cannot release dust or fumes in concentrations at or above the action level under any expected conditions of use. Objective data can be obtained from an industry-wide study or from laboratory product test results from manufacturers of lead containing products or materials. The data the employer uses from an industry-wide survey must be obtained under workplace conditions closely resembling the processes, types of material, control methods, work practices and environmental conditions in the employer's current operations.

1926.62(n)(4)(ii) The employer shall maintain the record of the objective data relied upon for at least 30 years.

**1926.62(n)(5) Availability.**

The employer shall make available upon request all records required to be maintained by paragraph (n) of this section to affected employees, former employees, and their designated representatives, and to the Assistant Secretary and the Director for examination and copying.

**1926.62(n)(6) Transfer of records.**

1926.62(n)(6)(i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (n) of this section.

1926.62(n)(6)(ii) The employer shall also comply with any additional requirements involving the transfer of records set forth in 29 CFR 1910.1020(h).

## 1926.62(o) OBSERVATION OF MONITORING.

**1926.62(o)(1) Employee observation.**

The employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to lead conducted pursuant to paragraph (d) of this section.

**1926.62(o)(2) Observation procedures.**

1926.62(o)(2)(i) Whenever observation of the monitoring of employee exposure to lead requires entry into an area where the use of respirators, protective clothing or equipment is required, the employer shall provide the observer with and assure the use of such respirators, clothing and equipment, and shall require the observer to comply with all other applicable safety and health procedures.

1926.62(o)(2)(ii) Without interfering with the monitoring, observers shall be entitled to:

1926.62(o)(2)(ii)(A) Receive an explanation of the measurement procedures;

1926.62(o)(2)(ii)(B) Observe all steps related to the monitoring of lead performed at the place of exposure; and

1926.62(o)(2)(ii)(C) Record the results obtained or receive copies of the results when returned by the laboratory.

## 1926.62(p) APPENDICES.

The information contained in the appendices to this section is not intended by itself, to create any additional obligations not otherwise imposed by this standard nor detract from any existing obligation.

[57 FR 26627, May 4, 1993, as amended at 58 FR 34218, June 24, 1993; 61 FR 5507, Feb. 13, 1996; 63 FR 1152, Jan. 8, 1998; 70 FR 1143, Jan. 5, 2005; 71 FR 16674, April 3, 2006; 71 FR 50191, Aug. 24, 2006; 73 FR 75588, Dec. 12, 2008; 76 FR 33611, June 8, 2011; 76 FR 80741, Dec. 27, 2011; 77 FR 17890, March 26, 2012; 84 FR 21598, May 14, 2019; 85 FR 8735, February 18, 2020]

# APPENDIX A – NON-MANDATORY
# SUBSTANCE DATA SHEET FOR OCCUPATIONAL EXPOSURE TO LEAD

The information contained in this appendix is not intended to create any additional obligations or requirements not otherwise imposed by this standard nor detract from any existing obligations or requirements.

In accordance with the Administrative Procedures Act, PA 306 of 1969, these appendices "do not have the force of law." They are not mandatory and are intended for information only.

## I. SUBSTANCE IDENTIFICATION

### A. Substance:

Pure lead (Pb) is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.

### B. Compounds:

Covered by the Standard: The word "lead" when used in this interim final standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.

### C. Uses:

Exposure to lead occurs in several different occupations in the construction industry, including demolition or salvage of structures where lead or lead - containing materials are present; removal or encapsulation of lead - containing materials, new construction, alteration, repair, or renovation of structures that contain lead or materials containing lead; installation of products containing lead. In addition, there are construction related activities where exposure to lead may occur, including transportation, disposal, storage, or containment of lead or materials containing lead on construction sites, and maintenance operations associated with construction activities.

### D. Permissible Exposure:

The permissible exposure limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air (50 µg/$m^{(3)}$), averaged over an 8-hour workday.

### E. Action Level:

The interim final standard establishes an action level of 30 micrograms of lead per cubic meter of air (30 µg/$m^{(3)}$), averaged over an 8-hour workday. The action level triggers several ancillary provisions of the standard such as exposure monitoring, medical surveillance, and training.

## II. HEALTH HAZARD DATA

### A. Ways in which lead enters your body.

When absorbed into your body in certain doses, lead is a toxic substance. The object of the lead standard is to prevent absorption of harmful quantities of lead. The standard is intended to protect you not only from the immediate toxic effects of lead, but also from the serious toxic effects that may not become apparent until years of exposure have passed.

Lead can be absorbed into your body by inhalation (breathing) and ingestion (eating). Lead (except for certain organic lead compounds not covered by the standard, such as tetraethyl lead) is not absorbed through your skin. When lead is scattered in the air as a dust, fume, or mist it can be inhaled and absorbed through your lungs and upper respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. You can also absorb lead through your digestive system if lead gets into your mouth and is swallowed. If you handle food, cigarettes, chewing tobacco, or make-up which have lead on them or handle them with hands contaminated with lead, this will contribute to ingestion.

A significant portion of the lead that you inhale or ingest gets into your blood stream. Once in your blood stream, lead is circulated throughout your body and stored in various organs and body tissues. Some of this lead is quickly filtered out of your body and excreted, but some remains in the blood and other tissues. As exposure to lead continues, the amount stored in your body will increase if you are absorbing more lead than your body is excreting. Even though you may not be aware of any immediate symptoms of disease, this lead stored in your tissues can be slowly causing irreversible damage, first to individual cells, then to your organs and whole-body systems.

**B. Effects of overexposure to lead.**

**(1) Short term (acute) overexposure.**

Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy may arise which develops quickly to seizures, coma, and death from cardiorespiratory arrest. A short term large dose of lead can lead to acute encephalopathy. Fortunately, short term occupational exposures of this magnitude are highly unusual. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead, and chronic effects which take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease which arise after periods of exposure as short as days or as long as several years. Depending on the levels of exposure and lead absorption, other short-term effects may include other effects on the nervous system, cardiovascular effects such as hypertension (high blood pressure), anemia, and adverse reproductive outcomes such as miscarriage and sperm abnormalities.

**(2) Long-term (chronic) overexposure.**

Chronic overexposure to lead may result in severe damage to your blood-forming, cardiovascular, nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, high blood pressure, weakness, insomnia, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic there may be severe abdominal pain.

Damage to the central nervous system in general and the brain (encephalopathy) in particular is one of the most severe forms of lead poisoning. The most severe, often fatal, form of encephalopathy may be preceded by vomiting, a feeling of dullness progressing to drowsiness and stupor, poor memory, restlessness, irritability, tremor, and convulsions. It may arise suddenly with the onset of seizures, followed by coma, and death. There is a tendency for muscular weakness to develop at the same time. This weakness may progress to paralysis often observed as a characteristic "wrist drop" or "foot drop" and is a manifestation of a disease to the nervous system called peripheral neuropathy.

Chronic overexposure to lead also results in kidney disease with few, if any, symptoms appearing until extensive and most likely permanent kidney damage has occurred. Routine laboratory tests reveal the presence of this kidney disease only after about two-thirds of kidney function is lost. When overt symptoms of urinary dysfunction arise, it is often too late to correct or prevent worsening conditions, and progression to kidney dialysis or death is possible.

Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility in men. Lead can alter the structure of sperm cells raising the risk of birth defects. There is evidence of miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves. Lead exposure also may result in decreased fertility, and abnormal menstrual cycles in women. The course of pregnancy may be adversely affected by exposure to lead since lead crosses the placental barrier and poses risks to developing fetuses. Children born of parents either one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or die during the first year of childhood.

Overexposure to lead also disrupts the blood-forming system resulting in decreased hemoglobin (the substance in the blood that carries oxygen to the cells) and ultimately anemia. Anemia is characterized by weakness, pallor and fatigability as a result of decreased oxygen carrying capacity in the blood.

**(3) Health protection goals of the standard.**

In order to reduce the risk of adverse health effects from exposure to lead for most workers throughout a working lifetime, studies suggest that worker blood lead (PbB) levels should be maintained as low as possible. The number of years a blood lead level is elevated is an important factor, which determines the increased risk of an adverse health effect. The blood lead levels of female workers who are pregnant should be maintained below 5 µg/dL at all times to prevent adverse health effects to the developing fetus.

The measurement of your blood lead level is the most useful indicator of the amount of lead being absorbed by your body. Blood lead levels (PbB) are most often reported in units of milligrams (mg) or micrograms (µg) of lead (1 mg=1000 µg) per 100 grams (100 g), 100 milliliters (100 mL) or deciliter (dL) of blood. These three units are essentially the same. Sometime PbB's are expressed in the form of mg percent or µg percent. This is a shorthand notation for 100 g, 100 mL, or dL.

PbB measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. PbB measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead-related diseases, however, has focused heavily on associations between PbBs and various diseases. As a result, your PbB is an important indicator of the likelihood that you will gradually acquire a lead-related health impairment or disease.

If your blood lead level increases, your risk of adverse health effects increases. There is a wide variability of individual's response to lead, thus it is difficult to say that a particular PbB in a given person will cause a particular effect. Your PbB is a crucial indicator of the risks to your health, but one other factor is also extremely important. This factor is the length of time you have had elevated PbBs. The longer you have an elevated PbB, the greater the risk that large quantities of lead are being gradually stored in your organs and tissues (body burden). The greater your overall body burden, the greater the chances of substantial permanent damage.

The provisions of this standard are designed to reduce your exposure to lead. Your employer has prime responsibility to assure compliance with the provisions of this standard both by the company and by individual workers. You as a worker, however, also have a responsibility to assist your employer in complying with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, learning what the standard requires, following the standard where it governs your own actions, and seeing that your employer complies with provisions governing his actions.

**(4) Reporting signs and symptoms of health problems.**

You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning or if you desire medical advice concerning the effects of current or past exposure to lead or your ability to have a healthy child. You should also notify your employer if you have difficulty breathing during a respirator fit test or while wearing a respirator. In each of these cases, your employer must make available to you appropriate medical examinations or consultations. These must be provided at no cost to you and at a reasonable time and place.

The standard contains a procedure whereby you can obtain a second opinion by a physician of your choice if your employer selected the initial physician.

# APPENDIX B – NON-MANDATORY
# EMPLOYEE STANDARD SUMMARY

The information contained in this appendix is not intended to create any additional obligations or requirements not otherwise imposed by this standard nor detract from any existing obligations or requirements.

In accordance with the Administrative Procedures Act, PA 306 of 1969, these appendices "do not have the force of law." They are not mandatory and are intended for information only.

This appendix summarizes key provisions of the interim final standard for lead in construction that you as a worker should become familiar with.

## I. PERMISSIBLE EXPOSURE LIMIT (PEL)

The standard sets a permissible exposure limit (PEL) of 50 micrograms of lead per cubic meter of air (50 µg/$m^3$), averaged over an 8-hour workday which is referred to as a time-weighted average (TWA). This is the highest level of lead in air to which you may be permissibly exposed over an 8-hour workday. However, since this is an 8-hour average, short exposures above the PEL are permitted so long as for each 8-hour work day your average exposure does not exceed this level.

This interim final standard, however, takes into account the fact that your daily exposure to lead can extend beyond a typical 8-hour workday as the result of overtime or other alterations in your work schedule. To deal with this situation, the standard contains a formula which reduces your permissible exposure when you are exposed more than 8 hours. For example, if you are exposed to lead for 10 hours a day, the maximum permitted average exposure would be 40 µg/$m^3$.

## II. EXPOSURE ASSESSMENT

If lead is present in your workplace in any quantity, your employer is required to make an initial determination of whether any employee's exposure to lead exceeds the action level (30 µg/$m^3$ averaged over an 8-hour day).

Employee exposure is that exposure which would occur if the employee were not using a respirator. This initial determination requires your employer to monitor workers' exposures unless he or she has objective data which can demonstrate conclusively that no employee will be exposed to lead in excess of the action level. Where objective data is used in lieu of actual monitoring the employer must establish and maintain an accurate record, documenting its relevancy in assessing exposure levels for current job conditions. If such objective data is available, the employer need proceed no further on employee exposure assessment until such time that conditions have changed, and the determination is no longer valid.

Objective date may be compiled from various sources, e.g., insurance companies and trade associations and information from suppliers or exposure data collected from similar operations. Objective data may also comprise previously-collected sampling data including area monitoring. If it cannot be determined through using objective data that worker exposure is less than the action level, your employer must conduct monitoring or must rely on relevant previous personal sampling, if available. Where monitoring is required for the initial determination, it may be limited to a representative number of employees who are reasonably expected to have the highest exposure levels. If your employer has conducted appropriate air sampling for lead in the past 12 months, he or she may use these results, provided they are applicable to the same employee tasks and exposure conditions and meet the requirements for accuracy as specified in the standard. As with objective data, if such results are relied upon for the initial determination, your employer must establish and maintain a record as to the relevancy of such data to current job conditions.

If there have been any employee complaints of symptoms which may be attributable to exposure to lead or if there is any other information or observations which would indicate employee exposure to lead, this must also be considered as part of the initial determination.

If this initial determination shows that a reasonable possibility exists that any employee may be exposed, without regard to respirators, over the action level, your employer must set up an air monitoring program to determine the exposure level representative of each employee exposed to lead at your workplace. In carrying out this air monitoring program, your employer is not required to monitor the exposure of every employee, but he or she must monitor a representative number of employees and job types. Enough sampling must be done to enable each employee's exposure level to be reasonably represent full shift exposure. In addition, these air samples must be taken under conditions which represent each employee's regular, daily exposure to lead. Sampling performed in the past 12 months may be used to determine exposures above the action level if such sampling was conducted during work activities essentially similar to present work conditions.

The standard lists certain tasks which may likely result in exposures to lead in excess of the PEL and, in some cases, exposures in excess of 50 times the PEL. If you are performing any of these tasks, your employer must provide you with appropriate respiratory protection, protective clothing and equipment, change areas, hand washing facilities, biological monitoring, and training until such time that an exposure assessment is conducted which demonstrates that your exposure level is below the PEL.

If you are exposed to lead and air sampling is performed, your employer is required to notify you in writing within 5 working days of the air monitoring results which represent your exposure. If the results indicate that your exposure exceeds the PEL (without regard to your use of a respirator), then your employer must also notify you of this in writing, and provide you with a description of the corrective action that has been taken or will be taken to reduce your exposure.

Your exposure must be rechecked by monitoring, at least every six months if your exposure is at or over the action level but below the PEL. Your employer may discontinue monitoring for you if 2 consecutive measurements, taken at least 7 days apart, are at or below the action level. Air monitoring must be repeated every 3 months if you are exposed over the PEL. Your employer must continue monitoring for you at this frequency until 2 consecutive measurements, taken at least 7 days apart, are below the PEL but above the action level, at which time your employer must repeat monitoring of your exposure every six months and may discontinue monitoring only after your exposure drops to or below the action level. However, whenever there is a change of equipment, process, control, or personnel or a new type of job is added at your workplace which may result in new or additional exposure to lead, your employer must perform additional monitoring.

## III. METHODS OF COMPLIANCE

Your employer is required to assure that no employee is exposed to lead in excess of the PEL as an 8-hour TWA. The interim final standard for lead in construction requires employers to institute engineering and work practice controls including administrative controls to the extent feasible to reduce employee exposure to lead. Where such controls are feasible but not adequate to reduce exposures below the PEL they must be used nonetheless to reduce exposures to the lowest level that can be accomplished by these means and then supplemented with appropriate respiratory protection.

Your employer is required to develop and implement a written compliance program prior to the commencement of any job where employee exposures may reach the PEL as an 8-hour TWA. The interim final standard identifies the various elements that must be included in the plan. For example, employers are required to include a description of operations in which lead is emitted, detailing other relevant information about the operation such as the type of equipment used, the type of material involved, employee job responsibilities, operating procedures and maintenance practices. In addition, your employer's compliance plan must specify the means that will be used to achieve compliance and, where engineering controls are required, include any engineering plans or studies that have been used to select the control methods. If administrative controls involving job rotation are used to reduce employee exposure to lead, the job rotation schedule must be included in the compliance plan. The plan must also detail the type of protective clothing and equipment, including respirators, housekeeping and hygiene practices that will be used to protect you from the adverse effects of exposure to lead.

The written compliance program must be made available, upon request, to affected employees and their designated representatives, the Assistant Secretary and the Director.

Finally, the plan must be reviewed and updated at least every 6 months to assure it reflects the current status in exposure control.

## IV. RESPIRATORY PROTECTION

Your employer is required to provide and assure your use of respirators when your exposure to lead is not controlled below the PEL by other means. The employer must pay the cost of the respirator. Whenever you request one, your employer is also required to provide you a respirator even if your air exposure level is not above the PEL. You might desire a respirator when, for example, you have received medical advice that your lead absorption should be decreased. Or, you may intend to have children in the near future, and want to reduce the level of lead in your body to minimize adverse reproductive effects. While respirators are the least satisfactory means of controlling your exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned, maintained, and replaced when they stop providing adequate protection.

Your employer is required to select respirators from the types listed in Table I of the Respiratory Protection section of the standard. Any respirator chosen must be approved by the Mine Safety and Health Administration (MSHA) or the National Institute for Occupational Safety and Health (NIOSH). This respirator selection table will enable your employer to choose a type of respirator which will give you a proper amount of protection based on your airborne lead exposure. Your employer may select a type of respirator that provides greater protection than that required by the standard; that is, one recommended for a higher concentration of lead than is present in your workplace. For example, a powered air purifying respirator (PAPR) is much more protective than a typical negative pressure respirator, and may also be more comfortable to wear.

A PAPR has a filter, cartridge or canister to clean the air, and a power source which continuously blows filtered air into your breathing zone. Your employer might make a PAPR available to you to ease the burden of having to wear a respirator for long periods of time. The standard provides that you can obtain a PAPR upon request.

Your employer must also start a Respiratory Protection Program. This program must include written procedures for the proper selection, use, cleaning, storage, and maintenance of respirators.

Any respirator chosen must be approved by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 42 CFR part 84. This respirator selection table will enable your employer to choose a type of respirator that will give you a proper amount of protection based on your airborne lead exposure. Your employer may select a type of respirator that provides greater protection than that required by the standard; that is, one recommended for a higher concentration of lead than is present in your workplace. For example, a powered air-purifying respirator (PAPR) is much more protective than a typical negative pressure respirator, and may also be more comfortable to wear. A PAPR has a filter, cartridge, or canister to clean the air, and a power source that continuously blows filtered air into your breathing zone. Your employer might make a PAPR available to you to ease the burden of having to wear a respirator for long periods of time. The standard provides that you can obtain a PAPR upon request.

You must also receive from your employer proper training in the use of respirators. Your employer is required to teach you how to wear a respirator, to know why it is needed, and to understand its limitations.

Your employer must ensure that your respirator facepiece fits properly. Proper fit of a respirator facepiece is critical to your protection from airborne lead. Obtaining a proper fit on each employee may require your employer to make available several different types of respirator masks. To ensure that your respirator fits properly, and that facepiece leakage is minimal, your employer must give you either a qualitative or quantitative fit test as specified in Appendix A of the Respiratory Protection standard located at 29 CFR 1910.134.

The standard provides that if your respirator uses filter elements, you must be given an opportunity to change the filter elements whenever an increase in breathing resistance is detected. You also must be permitted to periodically leave your work area to wash your face and respirator facepiece whenever necessary to prevent skin irritation. If you ever have difficulty in breathing during a fit test or while using a respirator, your employer must make a medical examination available to you to determine whether you can safely wear a respirator. The result of this examination may be to give you a positive pressure respirator (which reduces breathing resistance) or to provide alternative means of protection.

## V. PROTECTIVE WORK CLOTHING AND EQUIPMENT

If you are exposed to lead above the PEL as an 8-hour TWA, without regard to your use of a respirator, or if you are exposed to lead compounds such as lead arsenate or lead azide which can cause skin and eye irritation, your employer must provide you with protective work clothing and equipment appropriate for the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your airborne exposure to lead is greater than 200 $\mu g/m^3$. Appropriate protective work clothing and equipment can include coveralls or similar full-body work clothing, gloves, hats, shoes or disposable shoe coverlets, and face shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. In addition, your employer is responsible for providing repairs and replacement as necessary, and also is responsible for the cleaning, laundering or disposal of protective clothing and equipment.

The interim final standard requires that your employer assure that you follow good work practices when you are working in areas where your exposure to lead may exceed the PEL.

With respect to protective clothing and equipment, where appropriate, the following procedures should be observed prior to beginning work:

1. Change into work clothing and shoe covers in the clean section of the designated changing areas;
2. Use work garments of appropriate protective gear, including respirators before entering the work area; and
3. Store any clothing not worn under protective clothing in the designated changing area.

Workers should follow these procedures upon leaving the work area:

1. HEPA vacuum heavily contaminated protective work clothing while it is still being worn. At no time may lead be removed from protective clothing by any means which result in uncontrolled dispersal of lead into the air;
2. Remove shoe covers and leave them in the work area;
3. Remove protective clothing and gear in the dirty area of the designated changing area. Remove protective coveralls by carefully rolling down the garment to reduce exposure to dust.
4. Remove respirators last; and
5. Wash hands and face.

Workers should follow these procedures upon finishing work for the day (in addition to procedures described above):

1. Where applicable, place disposal coveralls and shoe covers with the abatement waste;
2. Contaminated clothing which is to be cleaned, laundered or disposed of must be placed in closed containers in the change room.
3. Clean protective gear, including respirators, according to standard procedures;
4. Wash hands and face again. If showers are available, take a shower and wash hair. If shower facilities are not available at the work site, shower immediately at home and wash hair.

## VI. HOUSEKEEPING

Your employer must establish a housekeeping program sufficient to maintain all surfaces as free as practicable of accumulations of lead dust. Vacuuming is the preferred method of meeting this requirement, and the use of compressed air to clean floors and other surfaces is generally prohibited unless removal with compressed air is done in conjunction with ventilation systems designed to contain dispersal of the lead dust. Dry or wet sweeping, shoveling, or brushing may not be used except where vacuuming or other equally effective methods have been tried and do not work. Vacuums must be used equipped with a special filter called a high-efficiency particulate air (HEPA) filter and emptied in a manner which minimizes the reentry of lead into the workplace.

## VII. HYGIENE FACILITIES AND PRACTICES

The standard requires that hand washing facilities be provided where occupational exposure to lead occurs. In addition, change areas, showers (where feasible), and lunchrooms or eating areas are to be made available to workers exposed to lead above the PEL. Your employer must assure that except in these facilities, food and beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, where airborne exposures are above the PEL. Change rooms provided by your employer must be equipped with separate storage facilities for your protective clothing and equipment and street clothes to avoid cross-contamination. After showering, no required protective clothing or equipment worn during the shift may be worn home. It is important that contaminated clothing or equipment be removed in change areas and not be worn home, or you will extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc.

Lunchrooms or eating areas may not be entered with protective clothing or equipment unless surface dust has been removed by vacuuming, downdraft booth, or other cleaning method. Finally, workers exposed above the PEL must wash both their hands and faces prior to eating, drinking, smoking or applying cosmetics.

All of the facilities and hygiene practices just discussed are essential to minimize additional sources of lead absorption from inhalation or ingestion of lead that may accumulate on you, your clothes, or your possessions. Strict compliance with these provisions can virtually eliminate several sources of lead exposure which significantly contribute to excessive lead absorption.

## VIII. MEDICAL SURVEILLANCE

The medical surveillance program is part of the standard's comprehensive approach to the prevention of lead-related disease. Its purpose is to supplement the main thrust of the standard which is aimed at minimizing airborne concentrations of lead and sources of ingestion. Only medical surveillance can determine if the other provisions of the standard have effectively protected you as an individual.

Compliance with the standard's provision will protect most workers from the adverse effects of lead exposure, but may not be satisfactory to protect individual workers

(1) who have high body burdens of lead acquired over past years,
(2) who have additional uncontrolled sources of non-occupational lead exposure,
(3) who exhibit unusual variations in lead absorption rates, or
(4) who have specific non-work related medical conditions which could be aggravated by lead exposure (e.g., renal disease, anemia).

In addition, control systems may fail, or hygiene and respirator programs may be inadequate. Periodic medical surveillance of individual workers will help detect those failures. Medical surveillance will also be important to protect your reproductive ability-regardless of whether you are a man or woman.

All medical surveillance required by the interim final standard must be performed by or under the supervision of a licensed physician. The employer must provide required medical surveillance without cost to employees and at a reasonable time and place. The standard's medical surveillance program has two parts-periodic biological monitoring and medical examinations.

Your employer's obligation to offer you medical surveillance is triggered by the results of the air monitoring program. Full medical surveillance must be made available to all employees who are or may be exposed to lead in excess of the action level for more than 30 days a year and whose blood lead level exceeds 15 µg/dL. Initial medical surveillance consisting of blood sampling and analysis for lead must be provided to all employees exposed at any time (1 day) above the action level.

Biological monitoring under the standard must be provided at least every 2 months for the first 6 months and every 6 months thereafter until your blood lead level is below 15 µg/dL.

If your PbB exceeds 15 µg/dL the monitoring frequency must be increased from every 6 months to at least every 2 months and not reduced until 2 consecutive PbB's indicate a blood lead level below 15 µg/dL. Each time your PbB is determined to be over 15 µg/dL, your employer must notify you of this in writing within 5 working days of his or her receipt of the test results. The employer must also inform you that the standard requires temporary medical removal with economic protection when your PbB exceeds 30 µg/dL. (See Discussion of Medical Removal Protection).

Medical examinations beyond the initial one must be made available on an annual basis if your blood lead level exceeds 15 µg/dL at any time during the preceding year and you are being exposed above the airborne action level of 30 $\mu g/m^3$ for 30 or more days per year. The initial examination will provide information to establish a baseline to which subsequent data can be compared.

An initial medical examination to consist of blood sampling and analysis for lead must also be made available (prior to assignment) for each employee being assigned for the first time to an area where the airborne concentration of lead equals or exceeds the action level at any time. In addition, a medical examination or consultation must be made available as soon as possible if you notify your employer that you are experiencing signs or symptoms commonly associated with lead poisoning or that you have difficulty breathing while wearing a respirator or during a respirator fit test. You must also be provided a medical examination or consultation if you notify your employer that you desire medical advice concerning the effects of current or past exposure to lead on your ability to procreate a healthy child.

Finally, appropriate follow-up medical examinations or consultations may also be provided for employees who have been temporarily removed from exposure under the medical removal protection provisions of the standard. (See Part IX, below.)

The standard specifies the minimum content of pre-assignment and annual medical examinations. The content of other types of medical examinations and consultations is left up to the sound discretion of the examining physician.

Pre-assignment and annual medical examinations must include

(1) a detailed work history and medical history;
(2) a thorough physical examination, including an evaluation of your pulmonary status if you will be required to use a respirator;
(3) a blood pressure measurement; and
(4) a series of laboratory tests designed to check your blood chemistry and your kidney function.

In addition, at any time upon your request, a laboratory evaluation of male fertility will be made (microscopic examination of a sperm sample), or a pregnancy test will be given.

The standard does not require that you participate in any of the medical procedures, tests, etc. which your employer is required to make available to you. Medical surveillance can, however, play a very important role in protecting your health. You are strongly encouraged, therefore, to participate in a meaningful fashion. The standard contains a multiple physician review mechanism which will give you a chance to have a physician of your choice directly participate in the medical surveillance program. If you are dissatisfied with an examination by a physician chosen by your employer, you can select a second physician to conduct an independent analysis. The two doctors would attempt to resolve any differences of opinion, and select a third physician to resolve any firm dispute. Generally, your employer will choose the physician who conducts medical surveillance under the lead standard-unless you and your employer can agree on the choice of a physician or physicians. Some companies and unions have agreed in advance, for example, to use certain independent medical laboratories or panels of physicians. Any of these arrangements are acceptable so long as required medical surveillance is made available to workers.

The standard requires your employer to provide certain information to a physician to aid in his or her examination of you. This information includes

(1) the standard and its appendices,
(2) a description of your duties as they relate to occupational lead exposure,
(3) your exposure level or anticipated exposure level,
(4) a description of any personal protective equipment you wear,
(5) prior blood lead level results, and
(6) prior written medical opinions concerning you that the employer has.

After a medical examination or consultation, the physician must prepare a written report which must contain

(1) the physician's opinion as to whether you have any medical condition which places you at increased risk of material impairment to health from exposure to lead,
(2) any recommended special protective measures to be provided to you,
(3) any blood lead level determinations, and
(4) any recommended limitation on your use of respirators.

This last element must include a determination of whether you can wear a powered air purifying respirator (PAPR) if you are found unable to wear a negative pressure respirator.

The medical surveillance program of the interim lead standard may at some point in time serve to notify certain workers that they have acquired a disease or other adverse medical condition as a result of occupational lead exposure. If this is true, these workers might have legal rights to compensation from public agencies, their employers, firms that supply hazardous products to their employers, or other persons. Some states have laws, including worker compensation laws, that disallow a worker who learns of a job-related health impairment to sue, unless the worker sues within a short period of time after learning of the impairment. (This period of time may be a matter of months or years.) An attorney can be consulted about these possibilities. It should be stressed that OSHA is in no way trying to either encourage or discourage claims or lawsuits. However, since results of the standard's medical surveillance program can significantly affect the legal remedies of a worker who has acquired a job-related disease or impairment, it is proper for OSHA to make you aware of this.

The medical surveillance section of the standard also contains provisions dealing with chelation. Chelation is the use of certain drugs (administered in pill form or injected into the body) to reduce the amount of lead absorbed in body tissues. Experience accumulated by the medical and scientific communities has largely confirmed the effectiveness of this type of therapy for the treatment of very severe lead poisoning. On the other hand, it has also been established that there can be a long list of extremely harmful side effects associated with the use of chelating agents. The medical community has balanced the advantages and disadvantages resulting from the use of chelating agents in various circumstances and has established when the use of these agents is acceptable. The standard includes these accepted limitations due to a history of abuse of chelation therapy by some lead companies. The most widely used chelating agents Succimer, meso 2, 3-dimercaptosuccinic acid (DMSA).

The standard prohibits "prophylactic chelation" of any employee by any person the employer retains, supervises or controls. *Prophylactic chelation* is the routine use of chelating or similarly acting drugs to prevent elevated blood levels in workers who are occupationally exposed to lead, or the use of these drugs to routinely lower blood lead levels to predesignated concentrations believed to be "safe". It should be emphasized that where an employer takes a worker who has no symptoms of lead poisoning and has chelation carried out by a physician (either inside or outside of a hospital) solely to reduce the worker's blood lead level, that will generally be considered prophylactic chelation. The use of a hospital and a physician does not mean that prophylactic chelation is not being performed. Routine chelation to prevent increased or reduce current blood lead levels is unacceptable whatever the setting.

The standard allows the use of "therapeutic" or "diagnostic" chelation if administered under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring. Therapeutic chelation responds to severe lead poisoning where there are marked symptoms. Diagnostic chelation involved giving a patient a dose of the drug then collecting all urine excreted for some period of time as an aid to the diagnosis of lead poisoning.

In cases where the examining physician determines that chelation is appropriate, you must be notified in writing of this fact before such treatment. This will inform you of a potentially harmful treatment, and allow you to obtain a second opinion.

## IX. MEDICAL REMOVAL PROTECTION

Excessive lead absorption subjects you to increased risk of disease. Medical removal protection (MRP) is a means of protecting you when, for whatever reasons, other methods, such as engineering controls, work practices, and respirators, have failed to provide the protection you need. MRP involves the temporary removal of a worker from his or her regular job to a place of significantly lower exposure without any loss of earnings, seniority, or other employment rights or benefits. The purpose of this program is to cease further lead absorption and allow your body to naturally excrete lead which has previously been absorbed. Temporary medical removal can result from an elevated blood lead level, or a medical opinion. For up to 18 months, or for as long as the job the employee was removed from lasts, protection is provided as a result of either form of removal. The vast majority of removed workers, however, will return to their former jobs long before this 18-month period expires.

You may also be removed from exposure even if your blood lead level is below 30 µg/dL if a final medical determination indicates that you temporarily need reduced lead exposure for medical reasons. If the physician who is implementing your employers medical program makes a final written opinion recommending your removal or other special protective measures, your employer must implement the physician's recommendation. If you are removed in this manner, you may only be returned when the doctor indicates that it is safe for you to do so.

The standard does not give specific instructions dealing with what an employer must do with a removed worker. Your job assignment upon removal is a matter for you, your employer and your union (if any) to work out consistent with existing procedures for job assignments. Each removal must be accomplished in a manner consistent with existing collective bargaining relationships. Your employer is given broad discretion to implement temporary removals so long as no attempt is made to override existing agreements. Similarly, a removed worker is provided no right to veto an employer's choice which satisfies the standard.

In most cases, employers will likely transfer removed employees to other jobs with sufficiently low lead exposure. Alternatively, a worker's hours may be reduced so that the time weighted average exposure is reduced, or he or she may be temporarily laid off if no other alternative is feasible.

In all of these situation, MRP benefits must be provided during the period of removal - i.e., you continue to receive the same earnings, seniority, and other rights and benefits you would have had if you had not been removed. Earnings includes more than just your base wage; it includes overtime, shift differentials, incentives, and other compensation you would have earned if you had not been removed. During the period of removal, you must also be provided with appropriate follow-up medical surveillance. If you were removed because your blood lead level was too high, you must be provided with a monthly blood test. If a medical opinion caused your removal, you must be provided medical tests or examinations that the doctor believes to be appropriate. If you do not participate in this follow up medical surveillance, you may lose your eligibility for MRP benefits.

When you are medically eligible to return to your former job, your employer must return you to your "former job status." This means that you are entitled to the position, wages, benefits, etc., you would have had if you had not been removed. If you would still be in your old job if no removal had occurred that is where you go back. If not, you are returned consistent with whatever job assignment discretion your employer would have had if no removal had occurred. MRP only seeks to maintain your rights, not expand them or diminish them.

If you are removed under MRP and you are also eligible for worker compensation or other compensation for lost wages, your employer's MRP benefits obligation is reduced by the amount that you actually receive from these other sources. This is also true if you obtain other employment during the time you are laid off with MRP benefits.

The standard also covers situations where an employer voluntarily removes a worker from exposure to lead due to the effects of lead on the employee's medical condition, even though the standard does not require removal. In these situations, MRP benefits must still be provided as though the standard required removal. Finally, it is important to note that in all cases where removal is required, respirators cannot be used as a substitute. Respirators may be used before removal becomes necessary, but not as an alternative to a transfer to a low exposure job, or to a lay-off with MRP benefits.

## X. EMPLOYEE INFORMATION AND TRAINING

Your employer is required to provide an information and training program for all employees exposed to lead above the action level or who may suffer skin or eye irritation from lead compounds such as lead arsenate or lead azide.

The program must train these employees regarding the specific hazards associated with their work environment, protective measures which can be taken, including the contents of any compliance plan in effect, the danger of lead to their bodies (including their reproductive systems), and their rights under the standard. All employees must be trained prior to initial assignment to areas where there is a possibility of exposure over the action level.

This training program must also be provided at least annually thereafter unless further exposure above the action level will not occur.

## XI. SIGNS

The standard requires that the following warning sign be posted in work areas when the exposure to lead is above the PEL:

DANGER
LEAD WORK AREA
MAY DAMAGE FERTILITY OR THE UNBORN CHILD
CAUSES DAMAGE TO THE CENTRAL NERVOUS SYSTEM
DO NOT EAT, DRINK OR SMOKE IN THIS AREA

Prior to June 1, 2016, employers may use the following legend in lieu of that specified above:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

## XII. RECORDKEEPING

Your employer is required to keep all records of exposure monitoring for airborne lead. These records must include the name and job classification of employees measured, details of the sampling and analytical techniques, the results of this sampling, and the type of respiratory protection being worn by the person sampled. Such records are to be retained for at least 30 years. Your employer is also required to keep all records of biological monitoring and medical examination results. These records must include the names of the employees, the physician's written opinion, and a copy of the results of the examination. Medical records must be preserved and maintained for the duration of employment plus 30 years. However, if the employee's duration of employment is less than one year, the employer need not retain that employee's medical records beyond the period of employment if they are provided to the employee upon termination of employment.

Recordkeeping is also required if you are temporarily removed from your job under the medical removal protection program. This record must include your name, the date of your removal and return, how the removal was or is being accomplished, and whether or not the reason for the removal was an elevated blood lead level. Your employer is required to keep each medical removal record only for as long as the duration of an employee's employment.

The standard requires that if you request to see or copy environmental monitoring, blood lead level monitoring, or medical removal records, they must be made available to you or to a representative that you authorize. Your union also has access to these records. Medical records other than PbB's must also be provided upon request to you, to your physician or to any other person whom you may specifically designate. Your union does not have access to your personal medical records unless you authorize their access.

## XIII. OBSERVATION OF MONITORING

When air monitoring for lead is performed at your workplace as required by this standard, your employer must allow you or someone you designate to act as an observer of the monitoring. Observers are entitled to an explanation of the measurement procedure, and to record the results obtained. Since results will not normally be available at the time of the monitoring, observers are entitled to record or receive the results of the monitoring when returned by the laboratory. Your employer is required to provide the observer with any personal protective devices required to be worn by employees working in the area that is being monitored. The employer must require the observer to wear all such equipment and to comply with all other applicable safety and health procedures.

# APPENDIX C – NON-MANDATORY
# MEDICAL SURVEILLANCE INFORMATION

The information contained in this appendix is not intended to create any additional obligations or requirements not otherwise imposed by this standard nor detract from any existing obligations or requirements.

In accordance with the Administrative Procedures Act, PA 306 of 1969, these appendices "do not have the force of law." They are not mandatory and are intended for information only.

## INTRODUCTION

The primary purpose of the Occupational Safety and Health Act of 1970 is to assure, so far as possible, safe and healthful working conditions for every working man and woman. The interim final occupational health standard for lead in construction is designed to protect workers exposed to inorganic lead including metallic lead, all inorganic lead compounds and organic lead soaps.

It is hoped that this review and discussion will give the physician a better understanding of the MIOSHA standard with the ultimate goal of protecting the health and well-being of the worker exposed to lead under his or her care.

Under this interim final standard occupational exposure to inorganic lead is to be limited to 50 µg/m$^{(3)}$ (micrograms per cubic meter) based on an 8-hour time-weighted average (TWA). This permissible exposure limit (PEL) must be achieved through a combination of engineering, work practice and administrative controls to the extent feasible. Where these controls are in place but are found not to reduce employee exposures to or below the PEL, they must be used nonetheless, and supplemented with respirators to meet the 50 µg/m$^{(3)}$ exposure limit.

In addition to the requirements of this standard, a program of biological monitoring for employees exposed to lead above the action level at any time, and additional medical surveillance for all employees exposed to levels of inorganic lead above 30 µg/m$^{(3)}$ (TWA) for more than 10 days per year, or whose work could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, regardless of airborne lead concentrations or surface contamination levels.

The purpose of this document is to outline the medical surveillance provisions of the interim standard for inorganic lead in construction, and to provide further information to the physician regarding the examination and evaluation of workers exposed to inorganic lead.

Section 1 provides a detailed description of the monitoring procedure including the required frequency of blood testing for exposed workers, provisions for medical removal protection (MRP), the recommended right of the employee to a second medical opinion, and notification and recordkeeping requirements of the employer. A discussion of the requirements for respirator use and respirator monitoring and OSHA's position on prophylactic chelation therapy are also included in this appendix.

Section 2 discusses the toxic effects and clinical manifestations of lead poisoning and effects of lead intoxication on enzymatic pathways in heme synthesis. The adverse effects on both male and female reproductive capacity and on the fetus are also discussed.

Section 3 outlines the recommended medical evaluation of the worker exposed to inorganic lead, including details of the medical history, physical examination, and recommended laboratory tests, which are based on the toxic effects of lead as discussed in Section 2.

Section 4 provides detailed information concerning the laboratory tests available for the monitoring of exposed workers. Included also is a discussion of the relative value of each test and the limitations and precautions which are necessary in the interpretation of the laboratory results.

## I. MEDICAL SURVEILLANCE AND MONITORING REQUIREMENTS FOR WORKERS EXPOSED TO INORGANIC LEAD

In addition to the requirements of this standard, a program of biological monitoring and medical surveillance should be considered for all employees exposed to lead above the action level of 30 µg/m$^{(3)}$ TWA for more than 10 days each year, or whose job duties could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, regardless of airborne lead concentrations or surface contamination levels. Periodic blood sampling and medical evaluation should be considered and performed on a schedule which is defined by previous laboratory results, worker complaints or concerns, and the clinical assessment of the examining physician.

The blood lead level of all employees who are exposed to lead above the action level of 30 µg/$m^{(3)}$, or whose job duties could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, should be determined at time of assignment to work at this exposure level (or when exposure at this level is initially determined), at least every 2 months for the first 6 months, and then at least every 6 months thereafter. The frequency is increased to every 2 months for employees whose last blood lead level was at or above 15 µg/dL and less than 30 µg/dL. For employees returned to work after removal from exposure to lead due to an elevated blood testing should be considered at least monthly until 2 consecutive blood lead levels, are below 10 µg/dL whole blood.

An annual medical examination and consultation performed under the guidelines discussed in Section 3 should be considered for each employee for whom a blood test conducted at any time during the preceding 12 months indicated a blood lead level at or above 15 µg/dL. Also, an examination should be considered for all employees prior to their assignment to an area in which airborne lead concentrations reach or exceed the action level or whose job duties could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, regardless of airborne lead concentrations or surface contamination levels.

Results of biological monitoring or the recommendations of an examining physician may necessitate removal of an employee from further lead exposure pursuant to the standard's medical removal protection (MRP) program. The object of the MRP program is to provide temporary medical removal to workers either with substantially elevated blood lead levels or otherwise at risk of sustaining material health impairment from continued substantial exposure to lead.

The best practices are summarized in Table 1.

**TABLE 1**
**HEALTH BASED MEDICAL SURVEILLANCE TO BE CONSIDERED FOR LEAD-EXPOSED WORKERS**

| BLOOD LEAD LEVELS | EMPLOYER SHOULD CONSIDER |
|---|---|
| All lead-exposed workers* | • Baseline or preplacement medical history and physical examination, baseline PbB, serum creatinine |
| < 10 µg/dL | • PbB every month for first 3 months of placement, or upon change in task to higher exposure, then PbB every 6 months<br>• If PbB increases ≥ 5 µg/dL, evaluate exposure and protective measures.<br>• Increase monitoring if indicated |
| 10-19 µg/dL | As above for PbB < 10 µg/dL, plus:<br>• PbB every 3 months<br>• Evaluate exposure, engineering controls, and work practices<br>• Revert to testing PbB every 6 months after 2 PbBs < 10 µg/dL |
| ≥ 20 µg/dL | • Refer to the standard |

*A lead-exposed worker is one whose job duties could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, regardless of airborne lead concentrations or surface contamination levels.

Recommendations from the examining physician may be more stringent than the specific provisions of the standard. The examining physician, therefore, has broad flexibility to tailor special protective procedures to the needs of individual employees. This flexibility extends to the evaluation and management of pregnant workers and male and female workers who are planning to raise children. Based on the history, physical examination, and laboratory studies, the physician might recommend special protective measures or medical removal for an employee who is pregnant or who is planning to conceive a child when, in the physician's judgment, continued exposure to lead at the current job would pose a significant risk.

The return of the employee to his or her former job status, or the removal of special protections or limitations, depends upon the examining physician determining that the employee is no longer at increased risk of material impairment or that special measures are no longer needed.

During the period of any form of special protection or removal, the employer must maintain the worker's earnings, seniority, and other employment rights and benefits (as though the worker had not been removed) for a period of up to 18 months or for as long as the job the employee was removed from lasts if less than 18 months. This economic protection will maximize meaningful worker participation in the medical surveillance program, and is appropriate as part of the employer's overall obligation to provide a safe and healthful workplace. The provisions of MRP benefits during the employee's removal period may, however, be conditioned upon participation in medical surveillance.

On rare occasions, an employee's blood lead level may not acceptably decline within 18 months of removal. This situation will arise only in unusual circumstances; thus, the standard relies on an individual medical examination to determine how to protect such an employee. In this situation the physician should consider non-occupational sources of lead. This medical determination is to be based on both laboratory values, including lead levels, blood counts, and other tests felt to be warranted, as well as the physician's judgment that any symptoms or findings on physical examination are a result of lead toxicity. The medical determination may be that the employee is incapable of ever safely returning to his or her former job status. The medical determination may provide additional removal time past 18 months for some employees or specify special protective measures to be implemented.

The lead standard provides for a multiple physician review in cases where the employee wishes a second opinion concerning potential lead poisoning or toxicity. If an employee wishes a second opinion, he or she can make an appointment with a physician of his or her choice. This second physician will review the findings, recommendations or determinations of the first physician and conduct any examinations, consultations or tests deemed necessary in an attempt to make a final medical determination. If the first and second physicians do not agree in their assessment they must try to resolve their differences. If they cannot reach an agreement, then they must designate a third physician to resolve the dispute.

The employer must provide examining and consulting physicians with the following specific information: a copy of the lead regulations and all appendices, a description of the employee's duties as related to exposure, the exposure level or anticipated level to lead and any other toxic substances (if applicable), a description of personal protective equipment used, blood lead levels, and all prior written medical opinions regarding the employee in the employer's possession or control. The employer must also obtain from the physician and provide the employee with a written medical opinion containing blood lead levels, the physician's opinion as to whether the employee is at risk of material impairment to health, any recommended protective measures for the employee if further exposure is permitted, as well as any recommended limitations upon an employee's use of respirators.

Employers must instruct each physician not to reveal to the employer in writing or in any other way his or her findings, laboratory results, or diagnoses which are felt to be unrelated to occupational lead exposure. They must also instruct each physician to advise the employee of any occupationally or non-occupationally related medical condition requiring further treatment or evaluation.

The standard provides for the use of respirators where engineering and other primary controls are not effective. However, the use of respirator protection shall not be used in lieu of temporary medical removal due to elevated blood lead levels or findings that an employee is at risk of material health impairment. This is based on the numerous inadequacies of respirators including skin rash where the face-piece makes contact with the skin, unacceptable stress to breathing in some workers with underlying cardiopulmonary impairment, difficulty in providing adequate fit, the tendency for respirators to create additional hazards by interfering with vision, hearing, and mobility, and the difficulties of assuring the maximum effectiveness of a complicated work practice program involving respirators. Respirators do, however, serve a useful function where engineering and work practice controls are inadequate by providing supplementary, interim, or short-term protection, provided they are properly selected for the environment in which the employee will be working, properly fitted to the employee, maintained and cleaned periodically, and worn by the employee when required.

In its interim final standard on occupational exposure to inorganic lead in the construction industry, OSHA has prohibited prophylactic chelation. Diagnostic and therapeutic chelation are permitted only under the supervision of a licensed physician with appropriate medical monitoring in an acceptable clinical setting. The decision to initiate chelation therapy must be made on an individual basis and take into account the severity of symptoms felt to be a result of lead toxicity along with blood lead levels, and other laboratory tests as appropriate. Succimer, meso 2, 3-dimercaptosuccinic acid (DMSA), which is the primary chelating agents used in the therapy of occupational lead poisoning has potential side effects and its use must be justified on the basis of expected benefits to the worker. Unless frank and severe symptoms are present, therapeutic chelation is not recommended, given the opportunity to remove a worker from exposure and allow the body to naturally excrete accumulated lead. As a diagnostic aid, the chelation mobilization test using CA-EDTA is not part of standard medical practice.

In accordance with this standard, employers are required to assure that accurate records are maintained on exposure assessment, including environmental monitoring, medical surveillance, and medical removal for each employee. Exposure assessment records must be kept for at least 30 years. Medical surveillance records must be kept for the duration of employment plus 30 years except in cases where the employment was less than one year. If duration of employment is less than one year, the employer need not retain this record beyond the term of employment if the record is provided to the employee upon termination of employment. Medical removal records also must be maintained for the duration of employment. All records required under this standard must be made available upon request to the Director of the Department of Licensing and Regulatory Affairs. Employers must also make environmental and biological monitoring and medical removal records available to affected employees and to former employees or their authorized employee representatives. Employees or their specifically designated representatives have access to their entire medical surveillance records.

In addition, the standard requires that the employer inform all workers exposed to lead at or above the action level, or performing work involving the handling of materials with a significant lead content in a manner which could reasonably be expected to result in potentially harmful exposure through inhalation or ingestion, of the provisions of the standard and all its appendices, the purpose and description of medical surveillance and provisions for medical removal protection if temporary removal is required. An understanding of the potential health effects of lead exposure by all exposed employees along with full understanding of their rights under the lead standard is essential for an effective monitoring program.

## II. ADVERSE HEALTH EFFECTS OF INORGANIC LEAD

Although the toxicity of lead has been known for 2,000 years, the knowledge of the complex relationship between lead exposure and human response is still being refined. Significant research into the toxic properties of lead continues throughout the world, and it should be anticipated that our understanding of thresholds of effects and margins of safety will be improved in future years. In order to reduce the risk of adverse health effects from exposure to lead for most workers throughout a working lifetime, studies suggest that worker blood lead (PbB) levels should be maintained as low as possible. The number of years a blood lead level is elevated is an important factor, which determines the increased risk of an adverse health effect. The blood lead levels of female workers who are pregnant should be maintained below 5 µg/dL at all times to prevent adverse health effects to the developing fetus.

The spectrum of health effects caused by lead exposure are summarized in the following sections.

### 1. Neurological Effects.

Inorganic lead has been found to have toxic effects on both the central and peripheral nervous systems. The National Toxicology Program (NTP) of the US Department of Health and Human Services has concluded that there is sufficient evidence that blood lead levels below 10 µg/dL are associated with essential tremor in adults.

The earliest stages of lead-induced central nervous system effects first manifest themselves in the form of behavioral disturbances and central nervous system symptoms including irritability, restlessness, insomnia and other sleep disturbances, fatigue, vertigo, headache, poor memory, tremor, depression, and apathy. With more severe exposure, symptoms can progress to drowsiness, stupor, hallucinations, delirium, convulsions and coma. Studies have suggested exposure to lead may be linked to psychiatric disorders including anxiety and depression, reduced auditory function, ALS and cognitive deficits in older adults.

The most severe and acute form of lead poisoning which usually follows ingestion or inhalation of large amounts of lead is acute encephalopathy which may arise precipitously with the onset of intractable seizures, coma, cardiorespiratory arrest, and death within 48 hours.

Cumulative lead exposure as measured in bone x-ray fluorescence has been associated with declining performance on neurocognitive tests. The central nervous system effects frequently are not reversible following discontinued exposure or chelation therapy and when improvement does occur, it is almost always only partial.

The peripheral neuropathy resulting from lead exposure characteristically involves only motor function with minimal sensory damage and has a marked predilection for the extensor muscles of the most active extremity. The peripheral neuropathy can occur with varying degrees of severity.

At 40 µg/dL this may be manifested by slowing of motor nerve conduction velocity often without clinical symptoms, other than essential tremor. With progression of the neuropathy there is development of painless extensor muscle weakness usually involving the extensor muscles of the fingers and hand in the most active upper extremity, followed in severe cases by wrist drop or, much less commonly, foot drop.

While the peripheral neuropathies can occasionally be reversed with therapy, again such recovery is not assured particularly in the more severe neuropathies and often improvement is only partial. The lack of reversibility is felt to be due in part to segmental demyelination.

**2. Cardiovascular effects.**

Hypertension, an important risk factor for cardiovascular and cerebrovascular morbidity and mortality, has frequently been noted in occupationally exposed individuals. There is now sufficient evidence that hypertension is associated with levels of lead exposure < 10 µg/dL. Several studies based upon the National Health and Nutrition Evaluation Surveys (NHANES) suggest a 20% increase in relative risk of cardiovascular mortality at blood lead levels between 5 and 9 µg/dL, and a 55% increase at levels above 10 µg/dL.

**3. Renal.**

Renal toxicity represents one of the most serious health effects of lead poisoning. Even under 10 µg/dL, there is sufficient evidence of decreased glomerular filtration rates in adults. In the early stages of disease nuclear inclusion bodies can frequently be identified in proximal renal tubular cells. Renal function remains normal and the changes in this stage are probably reversible. Long-term, higher level exposure can result in chronic lead nephropathy. With more advanced disease there is progressive interstitial fibrosis and impaired renal function. Eventually extensive interstitial fibrosis ensues with sclerotic glomeruli and dilated and atrophied proximal tubules; all represent end stage kidney disease. Azotemia can be progressive, eventually resulting in frank uremia necessitating dialysis. There is occasionally associated hypertension and hyperuricemia with or without gout.

Individuals with other renal risk factors, such as diabetes or underlying hypertension, may be at greater risk for the renal toxicity of lead.

Early kidney disease is difficult to detect. The urinalysis is normal in early lead nephropathy and the blood urea nitrogen and serum creatinine increase only when two-thirds of kidney function is lost. Measurement of creatinine clearance can often detect earlier disease as can other methods of measurement of glomerular filtration rate.

**4. Gastrointestinal.**

Lead may also affect the gastrointestinal system producing abdominal colic or diffuse abdominal pain. Constipation, obstipation, diarrhea, anorexia, nausea and vomiting may occur at blood lead levels of 30 µg/dL. Lead colic may develop at blood lead levels above 40 µg/dL, but it tends to be uncommon below 80 µg/dL.

**5. Heme Synthesis Inhibition.**

Lead has the ability to inhibit enzymes of the heme synthesis pathway at moderate blood levels. Inhibition of delta aminolevulinic acid dehydrase (ALA-D) which catalyzes the conversion of delta-aminolevulinic acid (ALA) to protoporphyrin is observed at a blood lead level below 20 µg/dL. At a blood lead level of 40 µg/dL, more than 20% of the population will have 70 percent inhibition of ALA-D. There is an exponential increase in ALA excretion at blood lead levels greater than 40 µg/dL.

Another enzyme, ferrochelatase, is also inhibited at low blood lead levels. Inhibition of ferrochelatase leads to increased free erythrocyte protoporphyrin (FEP) in the blood which can then bind to zinc to yield zinc protoporphyrin (ZPP). At a blood lead level of 50 µg/dL or greater, nearly 100% of the population will have an increase in FEP. There is also an exponential relationship between blood lead levels greater than 40 µg/dL and the associated ZPP level, which has led to the development of the ZPP screening test for lead exposure.

One of the eventual results of lead-induced inhibition of enzymes in the heme synthesis pathway is anemia which can be asymptomatic if mild but associated with a wide array of symptoms including dizziness, fatigue, and tachycardia when more severe. Studies have indicated that lead levels as low as 50 µg/dL can be associated with a definite decreased hemoglobin, although most cases of lead-induced anemia, as well as shortened red-cell survival times, occur at lead levels exceeding 80 µg/dL. Inhibited hemoglobin synthesis is more common in chronic cases whereas shortened erythrocyte life span is more common in acute cases.

In lead-induced anemias, there is usually a reticulocytosis along with the presence of basophilic stippling, and ringed sideroblasts, although none of the above are pathognomonic for lead-induced anemia.

**6. Cancer.**

The International Agency on Research on Cancer (IARC) has categorized lead as a "probable human carcinogen," category 2A. The US National Toxicology Program (NTP) has classified lead and lead compounds as "*reasonably anticipated to be human carcinogens".*

**7. Reproductive and childhood effects.**

Exposure to lead can have serious effects on reproductive function in both males and females. In male workers exposed to lead there can be a decrease in sexual drive, impotence, decreased ability to produce healthy sperm, and sterility. Malformed sperm (teratospermia), decreased number of sperm (hypospermia), and sperm with decreased motility (asthenospermia) can all occur. Above 15 µg/dL, there is sufficient evidence of adverse modifications in sperm parameters, as well as delays in time to pregnancy.

Women exposed to lead may experience menstrual disturbances including dysmenorrhea, menorrhagia and amenorrhea. Following exposure to lead, women have a higher frequency of sterility, premature births, spontaneous miscarriages, and stillbirths.

Germ cells can be affected by lead and cause genetic damage in the egg or sperm cells before conception and result in failure to implant, miscarriage, stillbirth, or birth defects.

Infants of mothers with lead poisoning have a higher mortality during the first year and suffer from lowered birth weights, slower growth, and nervous system disorders.

Lead can pass through the placental barrier and lead levels in the mother's blood are comparable to concentrations of lead in the umbilical cord at birth. Transplacental passage becomes detectable at 12-14 weeks of gestation and increases until birth.

There is sufficient evidence that women exposed with blood lead levels under 5 µg/dL may experience reduced fetal growth.

Lead exposure to children due to “take home lead” (carried to the home on worker clothing) can cause significant neurobehavioral impairments, including hyperactivity. Given the overall body of literature concerning the adverse health effects of lead in children, the blood lead level in children, and women who are pregnant or attempting to become pregnant, should be maintained below 5 µg/dL.

Blood lead levels in the fetus and newborn likewise should not exceed 5 µg/dL.

Because of lead's ability to pass through the placental barrier and also because of the demonstrated adverse effects of lead on reproductive function in both the male and female as well as the risk of genetic damage of lead on both the ovum and sperm, it is recommended that the maximum permissible blood lead level in both males and females who wish to bear children is 5 µg/dL.

**8. Other toxic effects.**

Some data have suggested that lead impairs thyroid function and interferes with the pituitary-adrenal axis, but again these effects have not been well defined.

## III. MEDICAL EVALUATION

The most important principle in evaluating a worker for any occupational disease including lead poisoning is a high index of suspicion on the part of the examining physician. As discussed in Section 2, lead can affect numerous organ systems and produce a wide array of signs and symptoms, most of which are non-specific and subtle in nature at least in the early stages of disease. Unless serious concern for lead toxicity is present, many of the early clues to diagnosis may easily be overlooked.

The crucial initial step in the medical evaluation is recognizing that a worker's employment can result in exposure to lead. The worker will frequently be able to define exposures to lead and lead containing materials but often will not volunteer this information unless specifically asked. In other situations, the worker may not know of any exposures to lead but the suspicion might be raised on the part of the physician because of the industry or occupation of the worker.

Potential occupational exposure to lead and its compounds occur in many occupations in the construction industry, including demolition and salvaging operations, removal or encapsulation of materials containing lead, construction, alteration, repair or renovation of structures containing lead, transportation, disposal, storage or containment of lead or lead-containing materials on construction sites, and maintenance operations associated with construction activities. Specific examples include, but are not limited to, firing ranges, removal of lead containing paint in renovation of homes built before 1978, or from renovation, repair, demolition, and clean-up of industrial facilities and equipment, as well as structures such as bridges and water towers with lead containing paint or materials.

The most important part of a medical evaluation is a blood lead test. The half-life of lead in blood is approximately five weeks. The focus can then be directed toward eliciting information from the medical history, physical exam, and from laboratory data to evaluate the worker for potential lead toxicity.

A complete and detailed work and hobby history is important in the initial evaluation. A listing of all previous employment with information on job description, exposure to fumes or dust, known exposures to lead or other toxic substances, a description of any personal protective equipment used, and previous medical surveillance should all be included in the worker's record. Where exposure to lead is suspected, information concerning on-the-job personal hygiene, smoking or eating habits in work areas, laundry procedures, and use of any protective clothing or respiratory protection equipment should be noted. A complete work history is essential in the medical evaluation of a worker with suspected lead toxicity, especially when long term effects such as neurotoxicity, hypertensive effects, and nephrotoxicity are considered.

The medical history is of fundamental importance and should include a listing of all past and current medical conditions, current medications including proprietary drug intake, previous surgeries and hospitalizations, allergies, smoking history, alcohol consumption, history of gunshot wounds and presence and location of any retained bullets or shrapnel, and also non-occupational lead exposures particularly the frequency of use of indoor firing ranges and casting and reloading of bullets. Also known childhood exposures should be elicited. Any previous history of hematological, neurological, cardiovascular, gastrointestinal, renal, psychological, gynecological, genetic, or reproductive problems should be specifically noted.

A careful and complete review of systems must be performed to assess both recognized complaints and subtle or slowly acquired symptoms which the worker might not appreciate as being significant. The review of systems should include the following:

| | |
|---|---|
| General | Weight loss, fatigue, decreased appetite. |
| Head, Eyes, Ears, Nose, Throat (HEENT) | Headaches, visual disturbances or decreased visual acuity, hearing deficits or tinnitus, pigmentation of the oral mucosa, or metallic taste in mouth |
| Cardio-pulmonary | Shortness of breath, cough, chest pains, palpitations, or orthopnea |
| Gastrointestinal | Nausea, vomiting, heartburn, abdominal pain, constipation or diarrhea |
| Neurologic | Irritability, insomnia, weakness (fatigue), dizziness, loss of memory, confusion, hallucinations, incoordination, ataxia, decreased strength in hands or feet, disturbances in gait, difficulty in climbing stairs, or seizures |
| Hematologic | Pallor, easy fatigability, abnormal blood loss melena |
| Cardiovascular | Hypertension, dysrhythmias, stigmata of heart failure |
| Reproductive (male and female and spouse where relevant) | History of infertility, impotence, loss of libido, abnormal menstrual periods, history of miscarriages, stillbirths, or children with birth defects |
| Musculoskeletal | Muscle and joint pains. |

The physical examination should emphasize the neurological, gastrointestinal, and cardiovascular systems. The worker's weight and blood pressure should be recorded, and the oral mucosa checked for a lead line on the gingiva. It should be noted, however, that the occurrence of a lead line is very rare even in severe lead poisoning if good oral hygiene is practiced.

The presence of pallor on skin examination may indicate an anemia which, if severe, might also be associated with a tachycardia. If an anemia is suspected, an active search for blood loss should be undertaken including potential blood loss through the gastrointestinal tract.

A complete neurological examination should include an adequate mental status evaluation including a search for behavioral and psychological disturbances, memory testing, evaluation for irritability, insomnia, hallucinations, and mental clouding. Gait and coordination should be examined along with close observation for tremor. A detailed evaluation of peripheral nerve function including careful sensory and motor function testing is warranted. Strength testing particularly of extensor muscle groups of all extremities is of fundamental importance.

Cranial nerve evaluation should also be included in the routine examination.

The abdominal examination should include auscultation for bowel sounds and abdominal bruits and palpation for organomegaly, masses, and diffuse abdominal tenderness.

Cardiovascular examination should evaluate possible early signs of congestive heart failure. Pulmonary status should be addressed particularly if respirator protection is contemplated.

As part of the medical evaluation, the interim lead standard requires the following laboratory studies:

| | |
|---|---|
| 1. | Blood lead level |
| 2. | Hemoglobin and hematocrit determinations, red cell indices, and examination of the peripheral blood smear to evaluate red blood cell morphology |
| 3. | Blood urea nitrogen |
| 4. | Serum creatinine |
| 5. | Routine urinalysis with microscopic examination |

In addition to the above, the physician is authorized to order any further laboratory or other tests which he or she deems necessary in accordance with sound medical practice. The evaluation must also include pregnancy testing or laboratory evaluation of male fertility if requested by the employee.

If an anemia is detected further studies including a careful examination of the peripheral smear, reticulocyte count, stool for occult blood, serum iron, total iron binding capacity, bilirubin, and, if appropriate, vitamin B12 and folate may be of value in attempting to identify the cause of the anemia.

If a peripheral neuropathy is suspected, nerve conduction studies are warranted both for diagnosis and as a basis to monitor any therapy.

If renal disease is questioned, a 24-hour urine collection for creatinine clearance, protein, and electrolytes may be indicated. Elevated uric acid levels may result from lead-induced renal disease and a serum uric acid level might be performed.

An electrocardiogram and chest x-ray may be obtained as deemed appropriate.

Sophisticated and highly specialized testing should not be done routinely and where indicated should be under the direction of a specialist.

## IV. LABORATORY EVALUATION

The blood lead level at present remains the single most important test to monitor lead exposure and is the test used in the medical surveillance program under the lead standard to guide employee medical removal.

This section will discuss the blood lead level in detail. Other blood tests currently available to evaluate lead exposure will also be reviewed. The blood lead level is a good index of current or recent lead absorption. The half-life of lead in blood is approximately five weeks.

However, blood lead levels do not indicate the total body burden of lead and are not adequate measures of past exposure. Lead has a high affinity for bone and up to 90% of the body's total lead is deposited there. Also, lead is deposited in soft tissue (liver, kidney, and brain). The blood lead levels is a function of the dynamics of lead absorption, distribution, deposition in bone and excretion. Following discontinuation of exposure to lead, the excess body burden is slowly mobilized from bone and other relatively stable body stores, enters the blood and is excreted. Consequently, an elevated blood lead level may represent recent exposure to lead without a significant total body excess, slow release from bone from a past exposure, or a combination of recent exposure and slow release.

Due to its correlation with recent exposures, the blood lead level may vary considerably over short time intervals.

To minimize laboratory error and erroneous results due to contamination, blood specimens must be carefully collected after thorough cleaning of the skin with appropriate methods using lead-free blood containers and analyzed by a reliable laboratory. Under the standard, samples must be analyzed in laboratories which are approved by OSHA.

The determination of lead in urine is generally considered a less reliable monitoring technique than analysis of whole blood primarily due to individual variability in urinary excretion capacity as well as the technical difficulty of obtaining accurate 24-hour urine collections. In addition, workers with renal insufficiency, whether due to lead or some other cause, may have decreased lead clearance and consequently urine lead levels may underestimate the true lead burden. Therefore, urine lead levels are not recommended.

The zinc protoporphyrin test, unlike the blood lead determination, measures an adverse metabolic effect of lead. The level of ZPP reflects lead absorption over the preceding 3 to 4 months, and therefore can sometimes be an indicator of lead body burden. The ZPP requires more time than the blood lead to read significantly elevated levels; the return to normal after discontinuing lead exposure is also slower. A limitation of the ZPP test is that it can also be elevated in patients with anemia and certain forms of porphyria.

Zinc protoporphyrin results from the inhibition of the enzyme ferrochelatase which catalyzes the insertion of an iron molecule into the protoporphyrin molecule, which then becomes heme. If iron is not inserted into the molecule then zinc, having a greater affinity for protoporphyrin, takes the place of the iron, forming ZPP.

An elevation in the level of circulating ZPP may occur at blood lead levels as low as 20-30 µg/dL in some workers. Once the blood lead level has reached 40 µg/dL there can be a more marked rise in the ZPP value from its normal range of less than 100 µg/100 dL. Increases in blood lead levels beyond 40 µg/dL can be associated with exponential increases in ZPP.

ZPP is measured directly in red blood cells and is present for the cell's entire 120-day life-span. Therefore, the ZPP level in blood reflects the average ZPP production over the previous 3-4 months and consequently the average lead exposure during that time interval.

It is recommended that a hematocrit be determined whenever a confirmed ZPP of 50 µg/100 dL whole blood is obtained to rule out a significant underlying anemia. If the ZPP is in excess of 100 µg/100 dL and not associated with abnormal elevations in blood lead levels, the laboratory should be checked to be sure that blood leads were determined using atomic absorption spectrophotometry anodic stripping voltammetry, or any method which meets the accuracy requirements set forth by the standard by an OSHA approved laboratory which is experienced in lead level determinations. and other causes of an elevated ZPP should be considered. Repeat periodic blood lead studies should be obtained in all individuals with elevated ZPP levels to be certain that an associated elevated blood lead level has not been missed due to transient fluctuations in blood leads.

ZPP has a characteristic fluorescence spectrum with a peak at 594 nm which is detectable with a hematofluorimeter. The hematofluorimeter is accurate and portable and can provide on-site, instantaneous results for workers who can be frequently tested via a finger prick.

However, careful attention must be given to calibration and quality control procedures. Limited data on blood lead-ZPP correlations and the ZPP levels which are associated with the adverse health effects discussed in Section 2 are the major limitations of the test. Also, it is difficult to correlate ZPP levels with environmental exposure and there is some variation of response with age and sex.

Increasing concentrations of ALA result from the inhibition of the enzyme delta-aminolevulinic acid dehydrase (ALA-D). Although the test is relatively easy to perform, inexpensive, and rapid, the disadvantages include variability in results, the necessity to collect a complete 24-hour urine sample which has a specific gravity greater than 1.010, and also the fact that ALA decomposes in the presence of light.

With lead poisoning, the urine concentrations of coproporphyrins I and II, porphobilinogen and uroporphyrin I rise. The most important increase, however, is that of coproporphyrin III; levels may exceed 5,000 µg/1 in the urine in lead poisoned individuals, but its correlation with blood lead levels and ZPP are not as good as those of ALA. Increases in urinary porphyrins are not diagnostic of lead toxicity and may be seen in porphyria, some liver diseases, and in patients with high reticulocyte counts.

**SUMMARY.**

The Michigan Occupational Safety and Health Administration's interim standard for inorganic lead in the construction industry places significant emphasis on the medical surveillance of all workers exposed to levels of inorganic lead above 30 µg/$m^{(3)}$ TWA or whose work could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, regardless of airborne lead concentrations or surface contamination levels. The physician has a fundamental role in this surveillance program, and in the operation of the medical removal protection program.

Even with adequate worker education on the adverse health effects of lead and appropriate training in work practices, personal hygiene and other control measures, the physician has a primary responsibility for evaluating potential lead toxicity in the worker. It is only through a careful and detailed medical and work history, a complete physical examination and appropriate laboratory testing that an accurate assessment can be made. Many of the adverse health effects of lead toxicity are either irreversible or only partially reversible and therefore early detection of disease is very important.

This document outlines the medical monitoring program as defined by the occupational safety and health standard for inorganic lead. It reviews the adverse health effects of lead poisoning and describes the important elements of the history and physical examinations as they relate to these adverse effects. Finally, the appropriate laboratory testing for evaluating lead exposure and toxicity is presented.

It is hoped that this review and discussion will give the physician a better understanding of the MIOSHA standard with the ultimate goal of protecting the health and well-being of the worker exposed to lead under his or her care.


Michigan Occupational Safety and Health Administration
PO Box 30643
Lansing, Michigan 48909-8143
For technical questions of this standard – Ph: 517-284-7680 (CSHD) or 517-284-7720 (CETD)
To order copies of this standard – Ph: 517-284-7740

# APPENDIX D

Michigan’s General Industry Safety and Health Standard

MIOSHA-STD-1207 (4/21)
40 Pages

For further information
Ph: 517-284-7740
www.michigan.gov/mioshastandards

**DEPARTMENT OF LABOR AND ECONOMIC OPPORTUNITY**

**GENERAL INDUSTRY STANDARD**

Filed with the secretary of state on February 17, 1998 (as amended October 4, 2000) (as amended February 24, 2015) (as amended December 11, 2018) (as amended December 12, 2018) **(as amended April 13, 2021)**

These rules take effect immediately upon filing with the secretary of state unless adopted under section 33, 44, or 45a(6) of the administrative procedures act of 1969, 1969 PA 306, MCL 24.233, 24.244, or 24.245a.

Rules adopted under these sections become effective 7 days after filing with the secretary of state.

(By authority conferred on the director of the department of labor and economic opportunity by sections 14, 16, 19, 21, and 24 of the Michigan occupational safety and health act, 1974 PA 154, MCL 408.1014, 408.1016, 408.1019, 408.1021, and 408.1024, and Executive Reorganization Order Nos. 1996 1, 1996 2, 2003 1, 2008 4, 2011 4, and 2019-3, MCL 330.3101, 445.2001, 445.2011, 445.2025, 445.2030, and 125.1998)

R 325.51901 and R325.51937 of the Michigan Administrative Code are amended, as follows:

# PART 310, LEAD IN GENERAL INDUSTRY

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**R 325.51901 Scope, application, adoption, and availability of standards.**

**Rule 1.** (1) These rules apply to all occupational exposures to lead, except that they do not apply to construction work or to agricultural operations.

(2) The federal Occupational Safety and Health Administration (OSHA) regulations 29 CFR 1910.1025 "Lead," as amended February 18, 2020, are adopted by reference in these rules, except for the following:

(a) Section 1910.1025(j)(2)(i)(A) to (C) has been replaced with R 325.51933.

(b) Section 1910.1025(j)(2)(iv)(A) to (B) has been replaced with R 325.51936.

(c) Section 1910.1025(j)(3)(i)(A) to (D) has been replaced with R 325.51937.

(d) Section 1910.1025(j)(3)(ii)(A) to (F) has been replaced with R 325.51938.

(e) Section 1910.1025(k)(1)(i)(A) to (B) has been replaced with R 325.51943.

(f) Section 1910.1025(k)(1)(iii)(A) to (B) has been replaced with R 325.51945.

(3) A reference to 29 CFR 1910.133 means both of the following:

(a) General Industry Safety and Health Standard Part 33. "Personal Protective Equipment."

(b) General Industry Safety and Health Standard Part 433. "Personal Protective Equipment."

(4) A reference to 29 CFR 1910.1200 means General Industry Safety Standard Part 92. "Hazard Communication."

(5) A reference to 29 CFR 1910.141 means General Industry Safety and Health Standard Part 474. "Sanitation."

(6) A reference to 29 CFR 1910.1020 means General Industry and Construction Safety and Health Standard Part 470. "Employee Medical Records and Trade Secrets."

(7) A reference to 29 CFR 1910.134 means General Industry and Construction Safety and Health Standard Part 451. "Respiratory Protection."

(8) The adopted federal regulations have the same force and effect as a rule promulgated under the Michigan occupational safety and health act, 1974 PA 154, MCL 408.1001 to 408.1094.

(9) The OSHA regulations adopted in these rules are available from the United States Department of Labor, Occupational Safety and Health Administration website, www.osha.gov, at no charge, as of the time of adoption of these rules.

(10) The regulations adopted in these rules are available for inspection at the Department of Labor and Economic Opportunity, MIOSHA, Standards and FOIA Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909-8143.

(11) The regulations adopted in these rules may be obtained from the publisher or may be obtained from the Department of Labor and Economic Opportunity, MIOSHA, Standards and FOIA Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909-8143, at the cost charged in this rule, plus $20.00 for shipping and handling.

(12) The following Michigan occupational safety and health administration (MIOSHA) standards are referenced in these rules. Up to 5 copies of these standards may be obtained at no charge from the Michigan Department of Labor and Economic Opportunity, MIOSHA, Standards and FOIA Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909-8143 or via the internet at the following website: www.michigan.gov/mioshastandards. For quantities greater than 5, the cost, as of the time of adoption of these rules, is 4 cents per page.

(a) General Industry Safety and Health Standard Part 33. "Personal Protective Equipment," R 408.13301 to R 408.13398.

(b) General Industry Safety and Health Standard Part 433. "Personal Protective Equipment," R 325.60001 to R 325.60013.

(c) General Industry Safety Standard Part 92. "Hazard Communication," R 408.19201 to R 408.19204.

(d) General Industry Safety and Health Standard Part 474. "Sanitation," R 325.47401 to R 325.47425.

(e) General Industry and Construction Safety and Health Standard Part 470. "Employee Medical Records and Trade Secrets," R 325.3451 to R 325.3476.

(f) General Industry and Construction Safety and Health Standard Part 451. "Respiratory Protection," R 325.60051 to R 325.60052.

# 1910.1025 LEAD

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# 1910.1025 LEAD

## 1910.1025(a) SCOPE AND APPLICATION.

1910.1025(a)(1) This section applies to all occupational exposure to lead, except as provided in paragraph (a)(2).

1910.1025(a)(2) This section does not apply to the construction industry or to agricultural operations covered by 29 CFR Part 1928.

## 1910.1025(b) DEFINITIONS.

Action level means employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air (30 µg/$m^3$) averaged over an 8-hour period.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Director means the Director, National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health, Education, and Welfare, or designee.

Lead means metallic lead, all inorganic lead compounds, and organic lead soaps. Excluded from this definition are all other organic lead compounds.

## 1910.1025(c) PERMISSIBLE EXPOSURE LIMIT (PEL).

1910.1025(c)(1) The employer shall assure that no employee is exposed to lead at concentrations greater than fifty micrograms per cubic meter of air (50 µg/$m^3$) averaged over an 8-hour period.

1910.1025(c)(2) If an employee is exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a time weighted average (TWA) for that day, shall be reduced according to the following formula:

| Maximum permissible limit (in µg/$m^3$) = 400 divided by hours worked in the day. |
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1910.1025(c)(3) When respirators are used to supplement engineering and work practice controls to comply with the PEL and all the requirements of paragraph (f) have been met, employee exposure, for the purpose of determining whether the employer has complied with the PEL, may be considered to be at the level provided by the protection factor of the respirator for those periods the respirator is worn. Those periods may be averaged with exposure levels during periods when respirators are not worn to determine the employee's daily TWA exposure.

## 1910.1025(d) EXPOSURE MONITORING.

### 1910.1025(d)(1) General.

1910.1025(d)(1)(i) For the purposes of paragraph (d), employee exposure is that exposure which would occur if the employee were not using a respirator.

1910.1025(d)(1)(ii) With the exception of monitoring under paragraph (d)(3), the employer shall collect full shift (for at least 7 continuous hours) personal samples including at least one sample for each shift for each job classification in each work area.

1910.1025(d)(1)(iii) Full shift personal samples shall be representative of the monitored employee's regular, daily exposure to lead.

### 1910.1025(d)(2) Initial determination.

Each employer who has a workplace or work operation covered by this standard shall determine if any employee may be exposed to lead at or above the action level.

**1910.1025(d)(3) Basis of initial determination.**

1910.1025(d)(3)(i) The employer shall monitor employee exposures and shall base initial determinations on the employee exposure monitoring results and any of the following, relevant considerations:

1910.1025(d)(3)(i)(A) Any information, observations, or calculations which would indicate employee exposure to lead;

1910.1025(d)(3)(i)(B) Any previous measurements of airborne lead; and

1910.1025(d)(3)(i)(C) Any employee complaints of symptoms which may be attributable to exposure to lead.

1910.1025(d)(3)(ii) Monitoring for the initial determination may be limited to a representative sample of the exposed employees who the employer reasonably believes are exposed to the greatest airborne concentrations of lead in the workplace.

1910.1025(d)(3)(iii) Measurements of airborne lead made in the preceding 12 months may be used to satisfy the requirement to monitor under paragraph (d)(3)(i) if the sampling and analytical methods used meet the accuracy and confidence levels of paragraph (d)(9) of this section.

**1910.1025(d)(4) Positive initial determination and initial monitoring.**

1910.1025(d)(4)(i) Where a determination conducted under paragraphs (d)(2) and (3) of this section shows the possibility of any employee exposure at or above the action level, the employer shall conduct monitoring which is representative of the exposure for each employee in the workplace who is exposed to lead.

1910.1025(d)(4)(ii) Measurements of airborne lead made in the preceding 12 months may be used to satisfy this requirement if the sampling and analytical methods used meet the accuracy and confidence levels of paragraph (d)(9) of this section.

**1910.1025(d)(5) Negative initial determination.**

Where a determination, conducted under paragraphs (d)(2) and (3) of this section is made that no employee is exposed to airborne concentrations of lead at or above the action level, the employer shall make a written record of such determination. The record shall include at least the information specified in paragraph (d)(3) of this section and shall also include the date of determination, location within the worksite, and the name of each employee monitored.

**1910.1025(d)(6) Frequency.**

1910.1025(d)(6)(i) If the initial monitoring reveals employee exposure to be below the action level the measurements need not be repeated except as otherwise provided in paragraph (d)(7) of this section.

1910.1025(d)(6)(ii) If the initial determination or subsequent monitoring reveals employee exposure to be at or above the action level but below the permissible exposure limit the employer shall repeat monitoring in accordance with this paragraph at least every 6 months. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the action level at which time the employer may discontinue monitoring for that employee except as otherwise provided in paragraph (d)(7) of this section.

1910.1025(d)(6)(iii) If the initial monitoring reveals that employee exposure is above the permissible exposure limit the employer shall repeat monitoring quarterly. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the PEL but at or above the action level at which time the employer shall repeat monitoring for that employee at the frequency specified in paragraph (d)(6)(ii), except as otherwise provided in paragraph (d)(7) of this section.

**1910.1025(d)(7) Additional monitoring.**

Whenever there has been a production, process, control or personnel change which may result in new or additional exposure to lead, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to lead, additional monitoring in accordance with this paragraph shall be conducted.

**1910.1025(d)(8) Employee notification.**

1910.1025(d)(8)(i) The employer must, within 15 working days after the receipt of the results of any monitoring performed under this section, notify each affected employee of these results either individually in writing or by posting the results in an appropriate location that is accessible to affected employees.

1910.1025(d)(8)(ii) Whenever the results indicate that the representative employee exposure, without regard to respirators, exceeds the permissible exposure limit, the employer shall include in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action taken or to be taken to reduce exposure to or below the permissible exposure limit.

**1910.1025(d)(9) Accuracy of measurement.**

The employer shall use a method of monitoring and analysis which has an accuracy (to a confidence level of 95%) of not less than plus or minus 20 percent for airborne concentrations of lead equal to or greater than 30 $\mu g/m^3$.

**1910.1025(e) METHODS OF COMPLIANCE.**

**1910.1025(e)(1) Engineering and work practice controls.**

1910.1025(e)(1)(i) Where any employee is exposed to lead above the permissible exposure limit for more than 30 days per year, the employer shall implement engineering and work practice controls (including administrative controls) to reduce and maintain employee exposure to lead in accordance with the implementation schedule in Table I below, except to the extent that the employer can demonstrate that such controls are not feasible. Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposure to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest feasible level and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (f) of this section.

1910.1025(e)(1)(ii) Where any employee is exposed to lead above the permissible exposure limit, but for 30 days or less per year, the employer shall implement engineering controls to reduce exposures to 200 µg/m$^3$, but thereafter may implement any combination of engineering, work practice (including administrative controls), and respiratory controls to reduce and maintain employee exposure to lead to or below 50 µg/m$^3$

| **TABLE 1** | |
|---|---|
| **Industry** | **Compliance dates(1): (50 µg/m$^3$)** |
| Lead chemicals, secondary copper smeting | July 19, 1996 |
| Nonferrous foundries | July 19, 1996(2) |
| Brass and bronze ingot manufacture | 6 years(3) |
| Footnote(1) Calculated by counting from the date the stay on implementation of paragraph (e)(1) was lifted by the U.S. Court of Appeals for the District of Columbia, the number of years specified in the 1978 lead standard and subsequent amendments for compliance with the PEL of 50 µg/m$^3$ for exposure to airborne concentrations of lead levels for the particular industry. | |
| Footnote(2) Large nonferrous foundries (20 or more employees) are required to achieve the PEL of 50 µg/m$^3$ by means of engineering and work practice controls. Small nonferrous foundries (fewer than 20 employees) are required to achieve an 8-hour TWA of 75 µg/m$^3$ by such controls. | |
| Footnote(3) Expressed as the number of years from the date on which the Court lifts the stay on the implementation of paragraph (e)(1) for this industry for employers to achieve a lead in air concentration of 75 µg/m$^3$. Compliance with paragraph (e) in this industry is determined by a compliance directive that incorporates elements from the settlement agreement between OSHA and representatives of the injury. are required to comply within five years. | |

**1910.1025(e)(2) Respiratory protection.**

Where engineering and work practice controls do not reduce employee exposure to or below the 50 µg/m$^3$ permissible exposure limit, the employer shall supplement these controls with respirators in accordance with paragraph (f).

**1910.1025(e)(3) Compliance program.**

1910.1025(e)(3)(i) Each employer shall establish and implement a written compliance program to reduce exposures to or below the permissible exposure limit, and interim levels if applicable, solely by means of engineering and work practice controls in accordance with the implementation schedule in paragraph (e)(1).

1910.1025(e)(3)(ii) Written plans for these compliance programs shall include at least the following:

1910.1025(e)(3)(ii)(A) A description of each operation in which lead is emitted; e.g. machinery used, material processed, controls in place, crew size, employee job responsibilities, operating procedures and maintenance practices;

1910.1025(e)(3)(ii)(B) A description of the specific means that will be employed to achieve compliance, including engineering plans and studies used to determine methods selected for controlling exposure to lead;

1910.1025(e)(3)(ii)(C) A report of the technology considered in meeting the permissible exposure limit;

1910.1025(e)(3)(ii)(D) Air monitoring data which documents the source of lead emissions;

1910.1025(e)(3)(ii)(E) A detailed schedule for implementation of the program, including documentation such as copies of purchase orders for equipment, construction contracts, etc.;

1910.1025(e)(3)(ii)(F) A work practice program which includes items required under paragraphs (g), (h) and (i) of this regulation;

1910.1025(e)(3)(ii)(G) An administrative control schedule required by paragraph (e)(6), if applicable;

1910.1025(e)(3)(ii)(H) Other relevant information.

1910.1025(e)(3)(iii) Written programs shall be submitted upon request to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, Director, any affected employee or authorized employee representatives.

1910.1025(e)(3)(iv) Written programs must be revised and updated at least annually to reflect the current status of the program.

**1910.1025(e)(4) Mechanical ventilation.**

1910.1025(e)(4)(i) When ventilation is used to control exposure, measurements which demonstrate the effectiveness of the system in controlling exposure, such as capture velocity, duct velocity, or static pressure shall be made at least every 3 months. Measurements of the system's effectiveness in controlling exposure shall be made within 5 days of any change in production, process, or control which might result in a change in employee exposure to lead.

1910.1025(e)(4)(ii) Recirculation of air. If air from exhaust ventilation is recirculated into the workplace, the employer shall assure that (A) the system has a high efficiency filter with reliable back-up filter; and (B) controls to monitor the concentration of lead in the return air and to bypass the recirculation system automatically if it fails are installed, operating, and maintained.

**1910.1025(e)(5) Administrative controls.**

If administrative controls are used as a means of reducing employees TWA exposure to lead, the employer shall establish and implement a job rotation schedule which includes:

1910.1025(e)(5)(i) Name or identification number of each affected employee;

1910.1025(e)(5)(ii) Duration and exposure levels at each job or work station where each affected employee is located; and

1910.1025(e)(5)(iii) Any other information which may be useful in assessing the reliability of administrative controls to reduce exposure to lead.

## 1910.1025(f) RESPIRATORY PROTECTION.

**1910.1025(f)(1) General.**

For employees who use respirators required by this section, the employer must provide each employee an appropriate respirator that complies with the requirements of this paragraph. Respirators must be used during:

1910.1025(f)(1)(i) Periods necessary to install or implement engineering or work-practice controls.

1910.1025(f)(1)(ii) Work operations for which engineering and work-practice controls are not sufficient to reduce employee exposures to or below the permissible exposure limit.

1910.1025(f)(1)(iii) Periods when an employee requests a respirator.

**1910.1025(f)(2) Respirator program.**

1910.1025(f)(2)(i) The employer must implement a respiratory protection program in accordance with § 1910.134(b) through (d) (except (d)(1)(iii)), and (f) through (m), which covers each employee required by this section to use a respirator.

1910.1025(f)(2)(ii) If an employee has breathing difficulty during fit testing or respirator use, the employer must provide the employee with a medical examination in accordance with paragraph (j)(3)(i)(C) of this section to determine whether or not the employee can use a respirator while performing the required duty.

**1910.1025(f)(3) Respirator selection.**

1910.1025(f)(3)(i) Employers must:

1910.1025(f)(3)(i)(A) Select, and provide to employees, the appropriate respirators specified in paragraph (d)(3)(i)(A) of 29 CFR 1910.134.

1910.1025(f)(3)(i)(B) Provide employees with full facepiece respirators instead of half mask respirators for protection against lead aerosols that cause eye or skin irritation at the use concentrations.

1910.1025(f)(3)(i)(C) Provide HEPA filters for powered and non-powered air-purifying respirators.

1910.1025(f)(3)(ii) Employers must provide employees with a powered air-purifying respirator (PAPR) instead of a negative pressure respirator selected according to paragraph (f)(3)(i) of this standard when an employee chooses to use a PAPR and it provides adequate protection to the employee as specified by paragraph (f)(3)(i) of this standard.

## 1910.1025(g) PROTECTIVE WORK CLOTHING AND EQUIPMENT

**1910.1025(g)(1) Provision and use.**

If an employee is exposed to lead above the PEL, without regard to the use of respirators or where the possibility of skin or eye irritation exists, the employer shall provide at no cost to the employee and assure that the employee uses appropriate protective work clothing and equipment such as, but not limited to:

1910.1025(g)(1)(i) Coveralls or similar full-body work clothing;

1910.1025(g)(1)(ii) Gloves, hats, and shoes or disposable shoe coverlets; and

1910.1025(g)(1)(iii) Face shields, vented goggles, or other appropriate protective equipment which complies with 1910.133 of this Part.

**1910.1025(g)(2) Cleaning and replacement.**

1910.1025(g)(2)(i) The employer shall provide the protective clothing required in paragraph (g)(1) of this section in a clean and dry condition at least weekly, and daily to employees whose exposure levels without regard to a respirator are over 200 µg/$m^3$ of lead as an 8-hour TWA.

1910.1025(g)(2)(ii) The employer shall provide for the cleaning, laundering, or disposal of protective clothing and equipment required by paragraph (g)(1) of this section.

1910.1025(g)(2)(iii) The employer shall repair or replace required protective clothing and equipment as needed to maintain their effectiveness.

1910.1025(g)(2)(iv) The employer shall assure that all protective clothing is removed at the completion of a work shift only in change rooms provided for that purpose as prescribed in paragraph (i)(2) of this section.

1910.1025(g)(2)(v) The employer shall assure that contaminated protective clothing which is to be cleaned, laundered, or disposed of, is placed in a closed container in the change-room which prevents dispersion of lead outside the container.

1910.1025(g)(2)(vi) The employer shall inform in writing any person who cleans or launders protective clothing or equipment of the potentially harmful effects of exposure to lead.

1910.1025(g)(2)(vii) Labeling of contaminated protective clothing and equipment.

1910.1025(g)(2)(vii)(A) The employer shall ensure that labels of bags or containers of contaminated protective clothing and equipment include the following information:

DANGER: CLOTHING AND EQUIPMENT CONTAMINATED WITH LEAD.
MAY DAMAGE FERTILITY OR THE UNBORN CHILD.
CAUSES DAMAGE TO THE CENTRAL NERVOUS SYSTEM.
DO NOT EAT, DRINK OR SMOKE WHEN HANDLING.
DO NOT REMOVE DUST BY BLOWING OR SHAKING.
DISPOSE OF LEAD CONTAMINATED WASH WATER IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, OR FEDERAL REGULATIONS.

1910.1025(g)(2)(vii)(B) Prior to June 1, 2015, employers may include the following information on bags or containers of contaminated protective clothing and equipment in lieu of the labeling requirements in paragraphs (g)(2)(vii)(A) of this section:

CAUTION: CLOTHING CONTAMINATED WITH LEAD.
DO NOT REMOVE DUST BY BLOWING OR SHAKING.
DISPOSE OF LEAD CONTAMINATED WASH WATER IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, OR FEDERAL REGULATIONS.

1910.1025(g)(2)(viii) The employer shall prohibit the removal of lead from protective clothing or equipment by blowing, shaking, or any other means which disperses lead into the air.

## 1910.1025(h) HOUSEKEEPING.

**1910.1025(h)(1) Surfaces.**

All surfaces shall be maintained as free as practicable of accumulations of lead.

**1910.1025(h)(2) Cleaning floors.**

1910.1025(h)(2)(i) Floors and other surfaces where lead accumulates may not be cleaned by the use of compressed air.

1910.1025(h)(2)(ii) Shoveling, dry or wet sweeping, and brushing may be used only where vacuuming or other equally effective methods have been tried and found not to be effective.

**1910.1025(h)(3) Vacuuming.**

Where vacuuming methods are selected, the vacuums shall be used and emptied in a manner which minimizes the reentry of lead into the workplace.

## 1910.1025(i) HYGIENE FACILITIES AND PRACTICES.

**1910.1025(i)(1)**

The employer shall assure that in areas where employees are exposed to lead above the PEL, without regard to the use of respirators, food or beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in change rooms, lunchrooms, and showers required under paragraphs (i)(2) - through (i)(4) of this section.

**1910.1025(i)(2) Change rooms.**

1910.1025(i)(2)(i) The employer shall provide clean change rooms for employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators.

1910.1025(i)(2)(ii) The employer shall assure that change rooms are equipped with separate storage facilities for protective work clothing and equipment and for street clothes which prevent cross-contamination.

**1910.1025(i)(3) Showers.**

1910.1025(i)(3)(i) The employer shall assure that employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators, shower at the end of the work shift.

1910.1025(i)(3)(ii) The employer shall provide shower facilities in accordance with 1910.141 (d)(3) of this part.

1910.1025(i)(3)(iii) The employer shall assure that employees who are required to shower pursuant to paragraph (i)(3)(i) do not leave the workplace wearing any clothing or equipment worn during the work shift.

**1910.1025(i)(4) Lunchrooms.**

1910.1025(i)(4)(i) The employer shall provide lunchroom facilities for employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators.

1910.1025(i)(4)(ii) The employer shall assure that lunchroom facilities have a temperature controlled, positive pressure, filtered air supply, and are readily accessible to employees.

1910.1025(i)(4)(iii) The employer shall assure that employees who work in areas where their airborne exposure to lead is above the PEL without regard to the use of a respirator wash their hands and face prior to eating, drinking, smoking or applying cosmetics.

1910.1025(i)(4)(iv) The employer shall assure that employees do not enter lunchroom facilities with protective work clothing or equipment unless surface lead dust has been removed by vacuuming, down draft booth, or other cleaning method.

**1910.1025(i)(5) Lavatories.**

The employer shall provide an adequate number of lavatory facilities which comply with 1910.141(d)(1) and (2) of this part.

## 1910.1025(j) MEDICAL SURVEILLANCE.

**1910.1025(j)(1) General.**

1910.1025(j)(1)(i) The employer shall institute a medical surveillance program for all employees who are or may be exposed at or above the action level for more than 30 days per year.

1910.1025(j)(1)(ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician.

1910.1025(j)(1)(iii) The employer shall provide the required medical surveillance including multiple physician review under paragraph (j)(3)(iii) without cost to employees and at a reasonable time and place.

**1910.1025(j)(2) Biological monitoring.**

**R 325.51933 Biological monitoring. This rule replaces OSHA Section 1910.1025(j)(2)(i)(A) to (C).**

**Rule 33.** An employer shall make available biological monitoring in the form of blood sampling and analysis for lead levels to each employee who or may be exposed to concentrations of lead greater than the action level for more than 30 days a year in accordance with the following schedule:

(a) At least once every 6 months for each employee.

(b) At least once every 2 months for each employee whose blood sample and analysis indicated a blood lead level at or above 15 micrograms (µg) per deciliter (dL). The 2-month frequency shall continue until 2 consecutive blood samples and analyses indicate a blood level below 15 µg/dL of whole blood.

(c) At least monthly during the period of time an employee is removed from exposure to lead due to an elevated blood lead level.

**1910.1025(j)(2)(ii) Follow-up blood sampling tests.**

Whenever the results of a blood lead level test indicate that an employee's blood lead level is at or above the numerical criterion for medical removal under paragraph (k)(1)(i)(A) of this section, the employer shall provide a second (follow-up) blood sampling test within two weeks after the employer receives the results of the first blood sampling test.

**1910.1025(j)(2)(iii) Accuracy of blood lead level sampling and analysis.**

Blood lead level sampling and analysis provided pursuant to this section shall have an accuracy (to a confidence level of 95 percent) within plus or minus 15 percent or 6 µg/100 ml, whichever is greater, and shall be conducted by a laboratory licensed by the Center for Disease Control, United States Department of Health, Education and Welfare (CDC) or which has received a satisfactory grade in blood lead proficiency testing from CDC in the prior twelve months.

**R 325.51936 Employee notifications. This rule replaces OSHA Section 1910.1025(j)(2)(iv)(A) to (B).**

**Rule 36.** Within 5 working days after the receipt of biological monitoring results, an employer shall notify each employee, in writing, whose blood lead level is at or above 15 µg/dL of whole blood of both of the following:

(a) The employee’s blood lead level.

(b) That these rules require temporary medical removal with Medical Removal Protection benefits when an employee’s blood lead level is at or above the numerical criterion for medical removal pursuant to R 325.51943.

**1910.1025(j)(3) Medical examinations and consultations**

**R 325.51937 Medical examinations and consultations. This rule replaces OSHA Section 1910.1025(j)(3)(i)(A) to (D).**

**Rule 37**. An employer shall make available medical examinations and consultations to each employee who is or may be exposed to concentrations of lead greater than the action level for more than 30 days a year according to the following schedule:

(a) At least annually for each employee for whom a blood sampling test conducted at any time during the previous 12 months indicated a blood lead level at or above 15 µg/dL of whole blood.

(b) Prior to an employee's being assigned for the first time to an area in which airborne concentrations of lead are at or above the action level.

(c) As soon as possible after notification by an employee that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice concerning the effects of current or past exposure to lead on the employee's ability to procreate a healthy child, or that the employee has demonstrated difficulty in breathing either during a respirator fitting test or during use of a respirator.

(d) As medically appropriate for an employee who is either removed from exposure to lead due to a risk of sustaining material impairment to health or who is otherwise limited pursuant to a final medical determination.

**R 325.51938 Content. This rule replaces OSHA Section 1910.1025(j)(3)(ii)(A) to (F).**

**Rule 38.** (1) A medical examination made available pursuant to R 325.51937(a) and (b) shall include all of the following elements:

(a) A detailed work history and a medical history, with particular attention to past occupational and non-occupational lead exposure in all of the following:

(i) Personal habits (smoking, hygiene).
(ii) Past gastrointestinal.
(iii) Personal hematological.
(iv) Renal.
(v) Cardiovascular.
(vi) Reproductive.
(vii) Neurological problems.

(b) A thorough physical examination, with particular attention to all of the following:

(i) Teeth.
(ii) Gums.
(iii) Hematological status.
(iv) Gastrointestinal status.
(v) Renal status.
(vi) Cardiovascular status.
(vii) Neurological status.
(viii) Pulmonary status shall be evaluated if respiratory protection is to be used.

(c) A blood pressure measurement.

(d) A blood sample and an analysis which determines all of the following:

(i) Blood lead level.
(ii) Hemoglobin and hematocrit determinations, red cell indices, and examination of peripheral and smear morphology.
(iii) Blood urea nitrogen.
(iv) Serum creatinine.

(e) A routine urinalysis with microscopic examination.

(f) A laboratory or other test which an examining physician deems necessary by sound medical practice.

(2) The contents of a medical examination made available pursuant to R 325.51937(c) and (d) shall be determined by an examining physician and, if requested by an employee, shall include pregnancy testing or laboratory evaluation of male fertility, as the case may be.

**1910.1025(j)(3)(iii) Multiple physician review mechanism.**

1910.1025(j)(3)(iii)(A) If the employer selects the initial physician who conducts any medical examination or consultation provided to an employee under this section, the employee may designate a second physician:

1910.1025(j)(3)(iii)(A)(1) To review any findings, determinations or recommendations of the initial physician; and

1910.1025(j)(3)(iii)(A)(2) To conduct such examinations, consultations, and laboratory tests as the second physician deems necessary to facilitate this review.

1910.1025(j)(3)(iii)(B) The employer shall promptly notify an employee of the right to seek a second medical opinion after each occasion that an initial physician conducts a medical examination or consultation pursuant to this section. The employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee doing the following within fifteen (15) days after receipt of the foregoing notification, or receipt of the initial physician's written opinion, whichever is later:

1910.1025(j)(3)(iii)(B)(1) The employee informing the employer that he or she intends to seek a second medical opinion, and

1910.1025(j)(3)(iii)(B)(2) The employee initiating steps to make an appointment with a second physician.

1910.1025(j)(3)(iii)(C) If the findings, determinations or recommendations of the second physician differ from those of the initial physician, then the employer and the employee shall assure that efforts are made for the two physicians to resolve any disagreement.

1910.1025(j)(3)(iii)(D) If the two physicians have been unable to quickly resolve their disagreement, then the employer and the employee through their respective physicians shall designate a third physician:

1910.1025(j)(3)(iii)(D)(1) To review any findings, determinations or recommendations of the prior physicians; and

1910.1025(j)(3)(iii)(D)(2) To conduct such examinations, consultations, laboratory tests and discussions with the prior physicians as the third physician deems necessary to resolve the disagreement of the prior physicians.

1910.1025(j)(3)(iii)(E) The employer shall act consistent with the findings, determinations and recommendations of the third physician, unless the employer and the employee reach an agreement which is otherwise consistent with the recommendations of at least one of the three physicians.

**1910.1025(j)(3)(iv) Information provided to examining and consulting physicians.**

1910.1025(j)(3)(iv)(A) The employer shall provide an initial physician conducting a medical examination or consultation under this section with the following information:

1910.1025(j)(3)(iv)(A)(1) A copy of this regulation for lead including all Appendices;

1910.1025(j)(3)(iv)(A)(2) A description of the affected employee's duties as they relate to the employee's exposure;

1910.1025(j)(3)(iv)(A)(3) The employee's exposure level or anticipated exposure level to lead and to any other toxic substance (if applicable);

1910.1025(j)(3)(iv)(A)(4) A description of any personal protective equipment used or to be used;

1910.1025(j)(3)(iv)(A)(5) Prior blood lead determinations; and

1910.1025(j)(3)(iv)(A)(6) All prior written medical opinions concerning the employee in the employer's possession or control.

1910.1025(j)(3)(iv)(B) The employer shall provide the foregoing information to a second or third physician conducting a medical examination or consultation under this section upon request either by the second or third physician, or by the employee.

**1910.1025(j)(3)(v) Written medical opinions.**

1910.1025(j)(3)(v)(A) The employer shall obtain and furnish the employee with a copy of a written medical opinion from each examining or consulting physician which contains the following information:

1910.1025(j)(3)(v)(A)(1) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at increased risk of material impairment of the employee's health from exposure to lead;

1910.1025(j)(3)(v)(A)(2) Any recommended special protective measures to be provided to the employee, or limitations to be placed upon the employee's exposure to lead;

1910.1025(j)(3)(v)(A)(3) Any recommended limitation upon the employee's use of respirators, including a determination of whether the employee can wear a powered air purifying respirator if a physician determines that the employee cannot wear a negative pressure respirator; and

1910.1025(j)(3)(v)(A)(4) The results of the blood lead determinations.

1910.1025(j)(3)(v)(B) The employer shall instruct each examining and consulting physician to:

1910.1025(j)(3)(v)(B)(1) Not reveal either in the written opinion, or in any other means of communication with the employer, findings, including laboratory results, or diagnoses unrelated to an employee's occupational exposure to lead; and

1910.1025(j)(3)(v)(B)(2) Advise the employee of any medical condition, occupational or nonoccupational, which dictates further medical examination or treatment.

**1910.1025(j)(3)(vi) Alternate Physician Determination Mechanisms.**

The employer and an employee or authorized employee representative may agree upon the use of any expeditious alternate physician determination mechanism in lieu of the multiple physician review mechanism provided by this paragraph so long as the alternate mechanism otherwise satisfies the requirements contained in this paragraph.

**1910.1025(j)(4) Chelation.**

1910.1025(j)(4)(i) The employer shall assure that any person whom he retains, employs, supervises or controls does not engage in prophylactic chelation of any employee at any time.

1910.1025(j)(4)(ii) If therapeutic or diagnostic chelation is to be performed by any person in paragraph (j)(4)(i), the employer shall assure that it be done under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring and that the employee is notified in writing prior to its occurrence.

## 1910.1025(k) MEDICAL REMOVAL PROTECTION

**1910.1025(k)(1)Temporary medical removal and return of an employee.**

**R 325.51943 Temporary medical removal due to elevated blood lead levels. This rule replaces OSHA Section 1910.1025(k)(1)(i)(A) to (B)**

**Rule 43.** (1) An employer shall remove an employee from work who has an exposure to lead at or above the action level on each occasion that a periodic blood sampling test and a follow-up blood sampling test conducted under these rules indicate that the employee's blood lead level is at or above 30 µg/dL of whole blood.

(2) An employer shall remove an employee from work if the employee has an exposure to lead at or above the action level on each occasion that the average of the last 3 blood sampling tests conducted under these rules, or the average of all blood sampling tests conducted over the previous 6 months, whichever is longer, indicates that the employee's blood lead level is at or above 20 µg/dL of whole blood. However, an employee shall not be removed if the last blood sampling test indicates a blood lead level below 15 µg/dL of whole blood.

**1910.1025(k)(1)(ii) Temporary removal due to a final medical determination.**

1910.1025(k)(1)(ii)(A) The employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that a final medical determination results in a medical finding, determination, or opinion that the employee has a detected medical condition which places the employee at increased risk of material impairment to health from exposure to lead.

1910.1025(k)(1)(ii)(B) For the purposes of this section, the phrase "final medical determination" shall mean the outcome of the multiple physician review mechanism or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section.

1910.1025(k)(1)(ii)(C) Where a final medical determination results in any recommended special protective measures for an employee, or limitations on an employee's exposure to lead, the employer shall implement and act consistent with the recommendation.

**R 325.51945 Return of employee to former job status. This rule replaces OSHA Section 1910.1025(k)(1)(iii)(A) to (B)**

**Rule 45**. (1) An employer shall return an employee to his or her former job status under any of the following circumstances:

(a) For an employee removed due to a blood lead level at or above 30 µg/dL of whole blood or due to an average blood lead level at or above 20 µg/dL of blood, when 2 consecutive blood sampling tests indicate that the employee's blood lead level is below 15 µg/dL of whole blood.

(b) For an employee removed due to a final medical determination, when a subsequent final medical determination results in a medical finding, determination or opinion that the employee no longer has a detected medical condition which places the employee at an increased risk of material impairment to health from exposure to lead.

(2) For purposes of this rule, the requirement that an employer return an employee to his or her former job status is not intended to expand upon or restrict any rights an employee has or would have had, absent temporary medical removal, to a specific job classification or position under the terms of a collective bargaining agreement.

**1910.1025(k)(1)(iv) Removal of other employee special protective measure or limitations.**

The employer shall remove any limitations placed on an employee or end any special protective measures provided to an employee pursuant to a final medical determination when a subsequent final medical determination indicates that the limitations or special protective measures are no longer necessary.

**1910.1025(k)(1)(v) Employer options pending a final medical determination.**

Where the multiple physician review mechanism, or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section, has not yet resulted in a final medical determination with respect to an employee, the employer shall act as follows:

**1910.1025(k)(1)(v)(A) Removal.**

The employer may remove the employee from exposure to lead, provide special protective measures to the employee, or place limitations upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status.

**1910.1025(k)(1)(v)(B) Return.**

The employer may return the employee to his or her former job status, end any special protective measures provided to the employee, and remove any limitations placed upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status, with two exceptions. If -

1910.1025(k)(1)(v)(B)(1) the initial removal, special protection, or limitation of the employee resulted from a final medical determination which differed from the findings, determinations, or recommendations of the initial physician or

1910.1025(k)(1)(v)(B)(2) The employee has been on removal status for the preceding eighteen months due to an elevated blood lead level, then the employer shall await a final medical determination.

**1910.1025(k)(2) Medical removal protection benefits.**

**1910.1025(k)(2)(i) Provision of medical removal protection benefits.**

The employer shall provide to an employee up to eighteen (18) months of medical removal protection benefits on each occasion that an employee is removed from exposure to lead or otherwise limited pursuant to this section.

**1910.1025(k)(2)(ii) Definition of medical removal protection benefits.**

For the purposes of this section, the requirement that an employer provide medical removal protection benefits means that the employer shall maintain the earnings, seniority and other employment rights and benefits of an employee as though the employee had not been removed from normal exposure to lead or otherwise limited.

**1910.1025(k)(2)(iii) Follow-up medical surveillance during the period of employee removal or limitation.**

During the period of time that an employee is removed from normal exposure to lead or otherwise limited, the employer may condition the provision of medical removal protection benefits upon the employee's participation in follow-up medical surveillance made available pursuant to this section.

**1910.1025(k)(2)(iv) Workers' compensation claims.**

If a removed employee files a claim for workers' compensation payments for a lead-related disability, then the employer shall continue to provide medical removal protection benefits pending disposition of the claim. To the extent that an award is made to the employee for earnings lost during the period of removal, the employer's medical removal protection obligation shall be reduced by such amount. The employer shall receive no credit for workers' compensation payments received by the employee for treatment related expenses.

**1910.1025(k)(2)(v) Other credits.**

The employer's obligation to provide medical removal protection benefits to a removed employee shall be reduced to the extent that the employee receives compensation for earnings lost during the period of removal either from a publicly or employer-funded compensation program, or receives income from employment with another employer made possible by virtue of the employee's removal.

**1910.1025(k)(2)(vi) Employees whose blood lead levels do not adequately decline within 18 months of removal.**

The employer shall take the following measures with respect to any employee removed from exposure to lead due to an elevated blood lead level whose blood lead level has not declined within the past eighteen (18) months of removal so that the employee has been returned to his or her former job status:

1910.1025(k)(2)(vi)(A) The employer shall make available to the employee a medical examination pursuant to this section to obtain a final medical determination with respect to the employee;

1910.1025(k)(2)(vi)(B) The employer shall assure that the final medical determination obtained indicates whether or not the employee may be returned to his or her former job status, and if not, what steps should be taken to protect the employee's health;

1910.1025(k)(2)(vi)(C) Where the final medical determination has not yet been obtained, or once obtained indicates that the employee may not yet be returned to his or her former job status, the employer shall continue to provide medical removal protection benefits to the employee until either the employee is returned to former job status, or a final medical determination is made that the employee is incapable of ever safely returning to his or her former job status.

1910.1025(k)(2)(vi)(D) Where the employer acts pursuant to a final medical determination which permits the return of the employee to his or her former job status despite what would otherwise be an unacceptable blood lead level, later questions concerning removing the employee again shall be decided by a final medical determination. The employer need not automatically remove such an employee pursuant to the blood lead level removal criteria provided by this section.

**1910.1025(k)(2)(vii) Voluntary removal or restriction of an employee.**

Where an employer, although not required by this section to do so, removes an employee from exposure to lead or otherwise places limitations on an employee due to the effects of lead exposure on the employee's medical condition, the employer shall provide medical removal protection benefits to the employee equal to that required by paragraph (k)(2)(i) of this section.

## 1910.1025(l) EMPLOYEE INFORMATION AND TRAINING

**1910.1025(l)(1) Training program.**

1910.1025(l)(1)(i) Each employer who has a workplace in which there is a potential exposure to airborne lead at any level shall inform employees of the content of Appendices A and B of this regulation.

1910.1025(l)(1)(ii) The employer shall train each employee who is subject to exposure to lead at or above the action level, or for whom the possibility of skin or eye irritation exists, in accordance with the requirements of this section. The employer shall institute a training program and ensure employee participation in the program.

1910.1025(l)(1)(iii) The employer shall provide initial training by 180 days from the effective date for those employees covered by paragraph (l)(1)(ii) on the standard's effective date and prior to the time of initial job assignment for those employees subsequently covered by this paragraph.

1910.1025(l)(1)(iv) The training program shall be repeated at least annually for each employee.

1910.1025(l)(1)(v) The employer shall assure that each employee is informed of the following:

1910.1025(l)(1)(v)(A) The content of this standard and its appendices;

1910.1025(l)(1)(v)(B) The specific nature of the operations which could result in exposure to lead above the action level;

1910.1025(l)(1)(v)(C) The purpose, proper selection, fitting, use, and limitations of respirators;

1910.1025(l)(1)(v)(D) The purpose and a description of the medical surveillance program, and the medical removal protection program including information concerning the adverse health effects associated with excessive exposure to lead (with particular attention to the adverse reproductive effects on both males and females);

1910.1025(l)(1)(v)(E) The engineering controls and work practices associated with the employee's job assignment;

1910.1025(l)(1)(v)(F) The contents of any compliance plan in effect; and

1910.1025(l)(1)(v)(G) Instructions to employees that chelating agents should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed physician;

**1910.1025(l)(2) Access to information and training materials.**

1910.1025(l)(2)(i) The employer shall make readily available to all affected employees a copy of this standard and its appendices.

1910.1025(l)(2)(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

1910.1025(l)(2)(iii) In addition to the information required by paragraph (l)(1)(v), the employer shall include as part of the training program, and shall distribute to employees, any materials pertaining to the Occupational Safety and Health Act, the regulations issued pursuant to that Act, and this lead standard, which are made available to the employer by the Assistant Secretary.

## 1910.1025(m) COMMUNICATION OF HAZARDS.

**1910.1025(m)(1) Hazard communication - general.**

1910.1025(m)(1)(i) Chemical manufacturers, importers, distributors and employers shall comply with all requirements of the Hazard Communication Standard (HCS) (§ 1910.1200) for lead.

1910.1025(m)(1)(ii) In classifying the hazards of lead at least the following hazards are to be addressed: Reproductive/developmental toxicity; central nervous system effects; kidney effects; blood effects; and acute toxicity effects.

1910.1025(m)(1)(iii) Employers shall include lead in the hazard communication program established to comply with the HCS (§ 1910.1200). Employers shall ensure that each employee has access to labels on containers of lead and to safety data sheets, and is trained in accordance with the requirements of HCS and paragraph (l) of this section.

**1910.1025(m)(2) Signs.**

1910.1025(m)(2)(i) The employer shall post the following warning signs in each work area where the PEL is exceeded:

DANGER
LEAD
MAY DAMAGE FERTILITY OR THE UNBORN CHILD
CAUSES DAMAGE TO THE CENTRAL NERVOUS SYSTEM
DO NOT EAT, DRINK OR SMOKE IN THIS AREA

1910.1025(m)(2)(ii) The employer shall ensure that no statement appears on or near any sign required by this paragraph (m)(2) which contradicts or detracts from the meaning of the required sign.

1910.1025(m)(2)(iii) The employer shall ensure that signs required by this paragraph (m)(2) are illuminated and cleaned as necessary so that the legend is readily visible.

1910.1025(m)(2)(iv) The employer may use signs required by other statutes, regulations, or ordinances in addition to, or in combination with, signs required by this paragraph (m)(2).

1910.1025(m)(2)(v) Prior to June 1, 2016, employers may use the following legend in lieu of that specified in paragraph (m)(2)(ii) of this section:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

## 1910.1025(n) RECORDKEEPING.

**1910.1025(n)(1) Exposure monitoring.**

1910.1025(n)(1)(i) The employer shall establish and maintain an accurate record of all monitoring required in paragraph (d) of this section.

1910.1025(n)(1)(ii) This record shall include:

1910.1025(n)(1)(ii)(A) The date(s), number, duration, location and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure where applicable;

1910.1025(n)(1)(ii)(B) A description of the sampling and analytical methods used and evidence of their accuracy;

1910.1025(n)(1)(ii)(C) The type of respiratory protective devices worn, if any;

1910.1025(n)(1)(ii)(D) Name, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent; and

1910.1025(n)(1)(ii)(E) The environmental variables that could affect the measurement of employee exposure.

1910.1025(n)(1)(iii) The employer shall maintain these monitoring records for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

**1910.1025(n)(2) Medical surveillance.**

1910.1025(n)(2)(i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (j) of this section.

1910.1025(n)(2)(ii) This record shall include:

1910.1025(n)(2)(ii)(A) The name, and description of the duties of the employee;

1910.1025(n)(2)(ii)(B) A copy of the physician's written opinions;

1910.1025(n)(2)(ii)(C) Results of any airborne exposure monitoring done for that employee and the representative exposure levels supplied to the physician; and

1910.1025(n)(2)(ii)(D) Any employee medical complaints related to exposure to lead.

1910.1025(n)(2)(iii) The employer shall keep, or assure that the examining physician keeps, the following medical records:

1910.1025(n)(2)(iii)(A) A copy of the medical examination results including medical and work history required under paragraph (j) of this section;

1910.1025(n)(2)(iii)(B) A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results or references to that information;

1910.1025(n)(2)(iii)(C) A copy of the results of biological monitoring.

1910.1025(n)(2)(iv) The employer shall maintain or assure that the physician maintains those medical records for at least 40 years, or for the duration of employment plus 20 years, whichever is longer.

**1910.1025(n)(3) Medical removals.**

1910.1025(n)(3)(i) The employer shall establish and maintain an accurate record for each employee removed from current exposure to lead pursuant to paragraph (k) of this section.

1910.1025(n)(3)(ii) Each record shall include:

1910.1025(n)(3)(ii)(A) The name and number of the employee;

1910.1025(n)(3)(ii)(B) The date on each occasion that the employee was removed from current exposure to lead as well as the corresponding date on which the employee was returned to his or her former job status;

1910.1025(n)(3)(ii)(C) A brief explanation of how each removal was or is being accomplished; and

1910.1025(n)(3)(ii)(D) A statement with respect to each removal indicating whether or not the reason for the removal was an elevated blood lead level.

1910.1025(n)(3)(iii) The employer shall maintain each medical removal record for at least the duration of an employee's employment.

**1910.1025(n)(4) Availability.**

1910.1025(n)(4)(i) The employer shall make available upon request all records required to be maintained by paragraph (n) of this section to the Assistant Secretary and the Director for examination and copying.

1910.1025(n)(4)(ii) Environmental monitoring, medical removal, and medical records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.1020 (a)-(e) and (2)-(i). Medical removal records shall be provided in the same manner as environmental monitoring records.

**1910.1025(n)(5) Transfer of records.**

1910.1025(n)(5)(i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (n) of this section.

1910.1025(n)(5)(ii) The employer shall also comply with any additional requirements involving transfer of records set forth in 29 CFR 1910.1020(h).

## 1910.1025(o) OBSERVATION OF MONITORING.

**1910.1025(o)(1) Employee observation.**

The employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to lead conducted pursuant to paragraph (d) of this section.

**1910.1025(o)(2) Observation procedures.**

1910.1025(o)(2)(i) Whenever observation of the monitoring of employee exposure to lead requires entry into an area where the use of respirators, protective clothing or equipment is required, the employer shall provide the observer with and assure the use of such respirators, clothing and such equipment, and shall require the observer to comply with all other applicable safety and health procedures.

1910.1025(o)(2)(ii) Without interfering with the monitoring, observers shall be entitled to:

1910.1025(o)(2)(ii)(A) Receive an explanation of the measurement procedures;

1910.1025(o)(2)(ii)(B) Observe all steps related to the monitoring of lead performed at the place of exposure; and

1910.1025(o)(2)(ii)(C) Record the results obtained or receive copies of the results when returned by the laboratory.

## 1910.1025(p) APPENDICES.

The information contained in the appendices to this section is not intended by itself, to create any additional obligations not otherwise imposed by this standard nor detract from any existing obligation.

[60 FR 52856, Oct. 11, 1995; 61 FR 5507, Feb. 13, 1996; 63 FR 1152, Jan. 8, 1998; 63 FR 20098, April 23, 1998; 70 FR 1142, Jan. 5, 2005; 71 FR 16672 and 16673, April 3, 2006; 71 FR 50189, August 24, 2006; 73 FR 75585, Dec. 12, 2008; 76 FR 33608, June 8, 2011; 76 FR 80740, Dec. 27, 2011; 77 FR 17780, March 26, 2012; 85 FR 8732, Feb. 18. 2020]

# APPENDIX A – NON-MANDATORY
# SUBSTANCE DATA SHEET FOR OCCUPATIONAL EXPOSURE TO LEAD

The information contained in this appendix is not intended to create any additional obligations or requirements not otherwise imposed by this standard nor detract from any existing obligations or requirements.

In accordance with the Administrative Procedures Act, PA 306 of 1969, these appendices "do not have the force of law." They are not mandatory and are intended for information only.

## I. SUBSTANCE IDENTIFICATION

### A. Substance:

Pure lead (Pb) is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.

### B. Compounds

Covered by the Standard: The word "lead" when used in this standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.

### C. Uses:

Exposure to lead occurs in at least 120 different occupations, including primary and secondary lead smelting, lead storage battery manufacturing, lead pigment manufacturing and use, solder manufacturing and use, shipbuilding and ship repairing, auto manufacturing, and printing.

### D. Permissible Exposure:

The Permissible Exposure Limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air (50 $\mu g/m^{(3)}$), averaged over an 8-hour workday.

### E. Action Level:

The standard establishes an action level of 30 micrograms per cubic meter of air (30 $\mu g/m^{(3)}$), time weighted average, based on an 8-hour work-day. The action level initiates several requirements of the standard, such as exposure monitoring, medical surveillance, and training and education.

## II. HEALTH HAZARD DATA

### A. Ways in which lead enters your body.

When absorbed into your body in certain doses lead is a toxic substance. The object of the lead standard is to prevent absorption of harmful quantities of lead. The standard is intended to protect you not only from the immediate toxic effects of lead, but also from the serious toxic effects that may not become apparent until years of exposure have passed.

Lead can be absorbed into your body by inhalation (breathing) and ingestion (eating). Lead (except for certain organic lead compounds not covered by the standard, such as tetraethyl lead) is not absorbed through your skin. When lead is scattered in the air as a dust, fume or mist it can be inhaled and absorbed through your lungs and upper respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. You can also absorb lead through your digestive system if lead gets into your mouth and is swallowed. If you handle food, cigarettes, chewing tobacco, or make-up which have lead on them or handle them with hands contaminated with lead, this will contribute to ingestion.

A significant portion of the lead that you inhale or ingest gets into your blood stream. Once in your blood stream, lead is circulated throughout your body and stored in various organs and body tissues. Some of this lead is quickly filtered out of your body and excreted, but some remains in the blood and other tissues. As exposure to lead continues, the amount stored in your body will increase if you are absorbing more lead than your body is excreting. Even though you may not be aware of any immediate symptoms of disease, this lead stored in your tissues can be slowly causing irreversible damage, first to individual cells, then to your organs and whole body systems.

**B. Effects of overexposure to lead.**

**(1) Short term (acute) overexposure.**

Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy may arise which develops quickly to seizures, coma, and death from cardiorespiratory arrest. A short term large dose of lead can lead to acute encephalopathy. Fortunately, short term occupational exposures of this magnitude are highly unusual. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead, and chronic effects which take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease which arise after periods of exposure as short as days or as long as several years. Depending on the levels of exposure and lead absorption, other short-term effects may include other effects on the nervous system, cardiovascular effects such as hypertension (high blood pressure), anemia, and adverse reproductive outcomes such as miscarriage and sperm abnormalities.

**(2) Long-term (chronic) overexposure.**

Chronic overexposure to lead may result in severe damage to your blood-forming, cardiovascular, nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, high blood pressure, weakness, insomnia, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic there may be severe abdominal pain.

Damage to the central nervous system in general and the brain (encephalopathy) in particular is one of the most severe forms of lead poisoning. The most severe, often fatal, form of encephalopathy may be preceded by vomiting, a feeling of dullness progressing to drowsiness and stupor, poor memory, restlessness, irritability, tremor, and convulsions. It may arise suddenly with the onset of seizures, followed by coma, and death. There is a tendency for muscular weakness to develop at the same time. This weakness may progress to paralysis often observed as a characteristic "wrist drop" or "foot drop" and is a manifestation of a disease to the nervous system called peripheral neuropathy.

Chronic overexposure to lead also results in kidney disease with few, if any, symptoms appearing until extensive and most likely permanent kidney damage has occurred. Routine laboratory tests reveal the presence of this kidney disease only after about two-thirds of kidney function is lost. When overt symptoms of urinary dysfunction arise, it is often too late to correct or prevent worsening conditions, and progression to kidney dialysis or death is possible.

Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility in men. Lead can alter the structure of sperm cells raising the risk of birth defects. There is evidence of miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves. Lead exposure also may result in decreased fertility, and abnormal menstrual cycles in women. The course of pregnancy may be adversely affected by exposure to lead since lead crosses the placental barrier and poses risks to developing fetuses. Children born of parents either one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or die during the first year of childhood.

Overexposure to lead also disrupts the blood-forming system resulting in decreased hemoglobin (the substance in the blood that carries oxygen to the cells) and ultimately anemia. Anemia is characterized by weakness, pallor and fatigability as a result of decreased oxygen carrying capacity in the blood.

**(3) Health protection goals of the standard.**

In order to reduce the risk of adverse health effects from exposure to lead for most workers throughout a working lifetime, studies suggest that worker blood lead (PbB) levels should be maintained as low as possible. The number of years a blood lead level is elevated is an important factor, which determines the increased risk of an adverse health effect. The blood lead levels of female workers who are pregnant should be maintained below 5 µg/dL at all times to prevent adverse health effects to the developing fetus.

The measurement of your blood lead level is the most useful indicator of the amount of lead being absorbed by your body. The blood lead (PbB) level is most often reported in units of milligrams (mg) or micrograms (µg) of lead (1 mg=1000 µg) per 100 grams (100 g), 100 milliliters (100 mL) or deciliter (dL) of blood. These three units are essentially the same. Sometime PbBs are expressed in the form of mg percent or µg percent. This is a shorthand notation for 100 g, 100 mL, or dL.

PbB measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. PbB measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead-related diseases, however, has focused heavily on associations between PbBs and various diseases. As a result, your PbB is an important indicator of the likelihood that you will gradually acquire a lead-related health impairment or disease.

If your blood lead level increases, your risk of adverse health effects increases. There is a wide variability of an individual's response to lead, thus it is difficult to say that a particular PbB in a given person will cause a particular effect. Your PbB is a crucial indicator of the risks to your health, but one other factor is also extremely important. This factor is the length of time you have had elevated PbBs. The longer you have an elevated PbB, the greater the risk that large quantities of lead are being gradually stored in your organs and tissues (body burden). The greater your overall body burden, the greater the chances of substantial permanent damage.

The provisions of this standard are designed to reduce your exposure to lead. Your employer has prime responsibility to assure compliance with the provisions of this standard both by the company and by individual workers. You as a worker, however, also have a responsibility to assist your employer in complying with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, learning what the standard requires, following the standard where it governs your own actions, and seeing that your employer complies with provisions governing his actions.

**(4) Reporting signs and symptoms of health problems.**

You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning or if you desire medical advice concerning the effects of current or past exposure to lead on your ability to have a healthy child. You should also notify your employer if you have difficulty breathing during a respirator fit test or while wearing a respirator. In each of these cases your employer must make available to your appropriate medical examinations or consultations. These must be provided at no cost to you and at a reasonable time and place.

The standard contains a procedure whereby you can obtain a second opinion by a physician of your choice if the employer selected the initial physician.

# APPENDIX B – NON-MANDATORY
# EMPLOYEE STANDARD SUMMARY

The information contained in this appendix is not intended to create any additional obligations or requirements not otherwise imposed by this standard nor detract from any existing obligations or requirements.

In accordance with the Administrative Procedures Act, PA 306 of 1969, these appendices "do not have the force of law." They are not mandatory and are intended for information only.

This appendix summarizes key provisions of the standard that you as a worker should become familiar with.

## I. PERMISSIBLE EXPOSURE LIMIT (PEL)

The standards sets a permissible exposure limit (PEL) of fifty micrograms of lead per cubic meter of air (50 μg/$m^{(3)}$), averaged over an 8-hour work-day. This is the highest level of lead in air to which you may be permissibly exposed over an 8-hour workday. Since it is an 8-hour average it permits short exposures above the PEL so long as for each 8-hour work day your average exposure does not exceed the PEL.

This standard recognizes that your daily exposure to lead can extend beyond a typical 8-hour workday as the result of overtime or other alterations in your work schedule. To deal with this, the standard contains a formula which reduces your permissible exposure when you are exposed more than 8 hours. For example, if you are exposed to lead for 10 hours a day, the maximum permitted average exposure would be 40 μg/$m^{(3)}$.

## II. EXPOSURE MONITORING

If lead is present in the workplace where you work in any quantity, your employer is required to make an initial determination of whether the action level is exceeded for any employee. This initial determination must include instrument monitoring of the air for the presence of lead and must cover the exposure of a representative number of employees who are reasonably believed to have the highest exposure levels. If your employer has conducted appropriate air sampling for lead in the past year he may use these results. If there have been any employee complaints of symptoms which may be attributable to exposure to lead or if there is any other information or observations which would indicate employee exposure to lead, this must also be considered as part of the initial determination. This initial determination must have been completed by March 31, 1979. If this initial determination shows that a reasonable possibility exists that any employee may be exposed, without regard to respirators, over the action level (30 μg/$m^{(3)}$) your employer must set up an air monitoring program to determine the exposure level of every employee exposed to lead at your workplace.

In carrying out this air monitoring program, your employer is not required to monitor the exposure of every employee, but he must monitor a representative number of employees and job types. Enough sampling must be done to enable each employee's exposure level to be reasonably represented by at least one full shift (at least 7 hours) air sample. In addition, these air samples must be taken under conditions which represent each employee's regular, daily exposure to lead. All initial exposure monitoring must have been completed by May 30, 1979.

If you are exposed to lead and air sampling is performed, your employer is required to quickly notify you in writing of air monitoring results which represent your exposure. If the results indicate your exposure exceeds the PEL (without regard to your use of respirators), then your employer must also notify you of this in writing, and provide you with a description of the corrective action that will be taken to reduce your exposure.

Your exposure must be rechecked by monitoring every six months if your exposure is over the action level but below the PEL. Air monitoring must be repeated every 3 months if you are exposed over the PEL. Your employer may discontinue monitoring for you if 2 consecutive measurements, taken at least two weeks apart, are below the action level. However, whenever there is a production, process, control, or personnel change at your workplace which may result in new or additional exposure to lead, or whenever there is any other reason to suspect a change which may result in new or additional exposure to lead, your employer must perform additional monitoring.

## III. METHODS OF COMPLIANCE

Your employer is required to assure that no employee is exposed to lead in excess of the PEL. The standard establishes a priority of methods to be used to meet the PEL.

## IV. RESPIRATORY PROTECTION

Your employer is required to provide and assure your use of respirators when your exposure to lead is not controlled below the PEL by other means. The employer must pay the cost of the respirator. Whenever you request one, your employer is also required to provide you a respirator even if your air exposure level does not exceed the PEL. You might desire a respirator when, for example, you have received medical advice that your lead absorption should be decreased. Or, you may intend to have children in the near future, and want to reduce the level of lead in your body to minimize adverse reproductive effects. While respirators are the least satisfactory means of controlling your exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned, maintained, and replaced when they stop providing adequate protection.

Your employer is required to select respirators from the seven types listed in Table II of the Respiratory Protection section of the standard (Sec. 1910.1025(f)). Any respirator chosen must be approved by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 42 CFR part 84. This respirator selection table will enable your employer to choose a type of respirator that will give you a proper amount of protection based on your airborne lead exposure. Your employer may select a type of respirator that provides greater protection than that required by the standard; that is, one recommended for a higher concentration of lead than is present in your workplace. For example, a powered air-purifying respirator (PAPR) is much more protective than a typical negative pressure respirator, and may also be more comfortable to wear.

A PAPR has a filter, cartridge, or canister to clean the air, and a power source that continuously blows filtered air into your breathing zone. Your employer might make a PAPR available to you to ease the burden of having to wear a respirator for long periods of time. The standard provides that you can obtain a PAPR upon request.

Your employer must also start a Respiratory Protection Program. This program must include written procedures for the proper selection, use, cleaning, storage, and maintenance of respirators.

Your employer must ensure that your respirator facepiece fits properly. Proper fit of a respirator facepiece is critical to your protection from airborne lead. Obtaining a proper fit on each employee may require your employer to make available several different types of respirator masks. To ensure that your respirator fits properly and that facepiece leakage is minimal, your employer must give you either a qualitative or quantitative fit test as specified in Appendix A of the Respiratory Protection standard located at 29 CFR 1910.134.

You must also receive from your employer proper training in the use of respirators. Your employer is required to teach you how to wear a respirator, to know why it is needed, and to understand its limitations.

The standard provides that if your respirator uses filter elements, you must be given an opportunity to change the filter elements whenever an increase in breathing resistance is detected. You also must be permitted to periodically leave your work area to wash your face and respirator facepiece whenever necessary to prevent skin irritation. If you ever have difficulty in breathing during a fit test or while using a respirator, your employer must make a medical examination available to you to determine whether you can safely wear a respirator. The result of this examination may be to give you a positive pressure respirator (which reduces breathing resistance) or to provide alternative means of protection.

## V. PROTECTIVE WORK CLOTHING AND EQUIPMENT

If you are exposed to lead above the PEL, or if you are exposed to lead compounds such as lead arsenate or lead azide which can cause skin and eye irritation, your employer must provide you with protective work clothing and equipment appropriate for the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your airborne exposure to lead is greater than 200 $\mu g/m^{(3)}$. Appropriate protective work clothing and equipment can include coveralls or similar full-body work clothing, gloves, hats, shoes or disposable shoe coverlets, and face shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. He is responsible for providing repairs and replacement as necessary, and also is responsible for the cleaning, laundering or disposal of protective clothing and equipment. Contaminated work clothing or equipment must be removed in change rooms and not worn home or you will extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc. Contaminated clothing which is to be cleaned, laundered or disposed of must be placed in closed containers in the change room. At no time may lead be removed from protective clothing or equipment by any means which disperses lead into the workroom air.

## VI. HOUSEKEEPING

Your employer must establish a housekeeping program sufficient to maintain all surfaces as free as practicable of accumulations of lead dust. Vacuuming is the preferred method of meeting this requirement, and the use of compressed air to clean floors and other surfaces is absolutely prohibited. Dry or wet sweeping, shoveling, or brushing may not be used except where vacuuming or other equally effective methods have been tried and do not work. Vacuums must be used and emptied in a manner which minimizes the reentry of lead into the workplace.

## VII. HYGIENE FACILITIES AND PRACTICES

The standard requires that change rooms, showers, and filtered air lunchrooms be constructed and made available to workers exposed to lead above the PEL. When the PEL is exceeded the employer must assure that food and beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in these facilities. Change rooms, showers, and lunchrooms, must be used by workers exposed in excess of the PEL. After showering, no clothing or equipment worn during the shift may be worn home, and this includes shoes and underwear. Your own clothing worn during the shift should be carried home and cleaned carefully so that it does not contaminate your home.

Lunchrooms may not be entered with protective clothing or equipment unless surface dust has been removed by vacuuming, downdraft booth, or other cleaning method. Finally, workers exposed above the PEL must wash both their hands and faces prior to eating, drinking, smoking or applying cosmetics.

All of the facilities and hygiene practices just discussed are essential to minimize additional sources of lead absorption from inhalation or ingestion of lead that may accumulate on you, your clothes, or your possessions. Strict compliance with these provisions can virtually eliminate several sources of lead exposure which significantly contribute to excessive lead absorption.

## VIII. MEDICAL SURVEILLANCE

The medical surveillance program is part of the standard's comprehensive approach to the prevention of lead-related disease. Its purpose is to supplement the main thrust of the standard which is aimed at minimizing airborne concentrations of lead and sources of ingestion. Only medical surveillance can determine if the other provisions of the standard have affectively protected you as an individual.

Compliance with the standard's provision will protect most workers from the adverse effects of lead exposure, but may not be satisfactory to protect individual workers

(1) who have high body burdens of lead acquired over past years,
(2) who have additional uncontrolled sources of non-occupational lead exposure,
(3) who exhibit unusual variations in lead absorption rates, or
(4) who have specific non-work related medical conditions which could be aggravated by lead exposure (e.g., renal disease, anemia).

In addition, control systems may fail, or hygiene and respirator programs may be inadequate. Periodic medical surveillance of individual workers will help detect those failures. Medical surveillance will also be important to protect your reproductive ability-regardless of whether you are a man or woman.

All medical surveillance required by the standard must be performed by or under the supervision of a licensed physician. The employer must provide required medical surveillance without cost to employees and at a reasonable time and place. The standard's medical surveillance program has two parts-periodic biological monitoring and medical examinations.

Your employer's obligation to offer you medical surveillance is triggered by the results of the air monitoring program. Medical surveillance must be made available to all employees who are exposed in excess of the action level for more than 30 days a year. The initial phase of the medical surveillance program, which includes blood lead level tests and medical examinations, must be completed for all covered employees no later than August 28, 1979. Priority within this first round of medical surveillance must be given to employees whom the employer believes to be at greatest risk from continued exposure (for example, those with the longest prior exposure to lead, or those with the highest current exposure). Thereafter, the employer must periodically make medical surveillance-both biological monitoring and medical examinations-available to all covered employees.

Biological monitoring under the standard consists of blood lead level (PbB) tests at least every 6 months after the initial PbB test.

If a worker's PbB exceeds 15 µg/dL the monitoring frequency must be increased from every 6 months to at least every 2 months and not reduced until 2 consecutive PbBs indicate a blood lead level below 15 µg/dL. Each time your PbB is determined to be over 15 µg/dL, your employer must notify you of this in writing within 5 working days of his receipt of the test results. The employer must also inform you that the standard requires temporary medical removal with economic protection when your PbB exceeds certain criteria. (See Discussion of Medical Removal Protection).

Medical examinations beyond the initial one must be made available on an annual basis if your blood lead level exceeds 15 µg/dL at any time during the preceding year. The initial examination will provide information to establish a baseline to which subsequent data can be compared.

An initial medical examination must also be made available (prior to assignment) for each employee being assigned for the first time to an area where the airborne concentration of lead equals or exceeds the action level. In addition, a medical examination or consultation must be made available as soon as possible if you notify your employer that you are experiencing signs or symptoms commonly associated with lead poisoning or that you have difficulty breathing while wearing a respirator or during a respirator fit test. You must also be provided a medical examination or consultation if you notify your employer that you desire medical advice concerning the effects of current or past exposure to lead on your ability to procreate a healthy child.

Finally, appropriate follow-up medical examinations or consultations may also be provided for employees who have been temporarily removed from exposure under the medical removal protection provisions of the standard. (See Part IX, below.)

The standard specifies the minimum content of pre-assignment and annual medical examinations. The content of other types of medical examinations and consultations is left up to the sound discretion of the examining physician.

Pre-assignment and annual medical examinations must include

(1) a detailed work history and medical history,
(2) a thorough physical examination, and
(3) a series of laboratory tests designed to check your blood chemistry and your kidney function.

In addition, at any time upon your request, a laboratory evaluation of male fertility will be made (microscopic examination of a sperm sample), or a pregnancy test will be given.

The standard does not require that you participate in any of the medical procedures, tests, etc. which your employer is required to make available to you. Medical surveillance can, however, play a very important role in protecting your health. You are strongly encouraged, therefore, to participate in a meaningful fashion. The standard contains a multiple physician review mechanism which would give you a chance to have a physician of your choice directly participate in the medical surveillance program. If you were dissatisfied with an examination by a physician chosen by your employer, you could select a second physician to conduct an independent analysis. The two doctors would attempt to resolve any differences of opinion, and select a third physician to resolve any firm dispute. Generally your employer will choose the physician who conducts medical surveillance under the lead standard-unless you and your employer can agree on the choice of a physician or physicians. Some companies and unions have agreed in advance, for example, to use certain independent medical laboratories or panels of physicians. Any of these arrangements are acceptable so long as required medical surveillance is made available to workers.

The standard requires your employer to provide certain information to a physician to aid in his or her examination of you. This information includes

(1) the standard and its appendices,
(2) a description of your duties as they relate to lead exposure,
(3) your exposure level,
(4) a description of personal protective equipment you wear,
(5) prior blood lead level results, and
(6) prior written medical opinions concerning you that the employer has.

After a medical examination or consultation the physician must prepare a written report which must contain

(1) the physician's opinion as to whether you have any medical condition which places you at increased risk of material impairment to health from exposure to lead,
(2) any recommended special protective measures to be provided to you,
(3) any blood lead level determinations, and
(4) any recommended limitation on your use of respirators.

This last element must include a determination of whether you can wear a powered air purifying respirator (PAPR) if you are found unable to wear a negative pressure respirator.

The medical surveillance program of the lead standard may at some point in time serve to notify certain workers that they have acquired a disease or other adverse medical condition as a result of occupational lead exposure. If this is true, these workers might have legal rights to compensation from public agencies, their employers, firms that supply hazardous products to their employers, or other persons. Some states have laws, including worker compensation laws, that disallow a worker who learns of a job-related health impairment to sue, unless the worker sues within a short period of time after learning of the impairment. (This period of time may be a matter of months or years.) An attorney can be consulted about these possibilities. It should be stressed that OSHA is in no way trying to either encourage or discourage claims or lawsuits. However, since results of the standard's medical surveillance program can significantly affect the legal remedies of a worker who has acquired a job-related disease or impairment, it is proper for OSHA to make you aware of this.

The medical surveillance section of the standard also contains provisions dealing with chelation. Chelation is the use of certain drugs (administered in pill form or injected into the body) to reduce the amount of lead absorbed in body tissues. Experience accumulated by the medical and scientific communities has largely confirmed the effectiveness of this type of therapy for the treatment of very severe lead poisoning. On the other hand, it has also been established that there can be a long list of extremely harmful side effects associated with the use of chelating agents. The medical community has balanced the advantages and disadvantages resulting from the use of chelating agents in various circumstances and has established when the use of these agents is acceptable. The standard includes these accepted limitations due to a history of abuse of chelation therapy by some lead companies. The most widely used chelating agents are Succimer, meso 2, and 3-dimercaptosuccinic acid (DMSA).

The standard prohibits "prophylactic chelation" of any employee by any person the employer retains, supervises or controls. "Prophylactic chelation" is the routine use of chelating or similarly acting drugs to prevent elevated blood levels in workers who are occupationally exposed to lead, or the use of these drugs to routinely lower blood lead levels to predesignated concentrations believed to be `safe'. It should be emphasized that where an employer takes a worker who has no symptoms of lead poisoning and has chelation carried out by a physician (either inside or outside of a hospital) solely to reduce the worker's blood lead level, that will generally be considered prophylactic chelation. The use of a hospital and a physician does not mean that prophylactic chelation is not being performed. Routine chelation to prevent increased or reduce current blood lead levels is unacceptable whatever the setting.

The standard allows the use of "therapeutic" or "diagnostic" chelation if administered under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring. Therapeutic chelation responds to severe lead poisoning where there are marked symptoms. Diagnostic chelation involved giving a patient a dose of the drug then collecting all urine excreted for some period of time as an aid to the diagnosis of lead poisoning.

In cases where the examining physician determines that chelation is appropriate, you must be notified in writing of this fact before such treatment. This will inform you of a potentially harmful treatment, and allow you to obtain a second opinion.

## IX. MEDICAL REMOVAL PROTECTION

Excessive lead absorption subjects you to increased risk of disease. Medical removal protection (MRP) is a means of protecting you when, for whatever reasons, other methods, such as engineering controls, work practices, and respirators, have failed to provide the protection you need. MRP involves the temporary removal of a worker from his or her regular job to a place of significantly lower exposure without any loss of earnings, seniority, or other employment rights or benefits. The purpose of this program is to cease further lead absorption and allow your body to naturally excrete lead which has previously been absorbed. Temporary medical removal can result from an elevated blood lead level, or a medical opinion. Up to 18 months of protection is provided as a result of either form of removal. The vast majority of removed workers, however, will return to their former jobs long before this eighteen month period expires. The standard contains special provisions to deal with the extraordinary but possible case where a long-term worker's blood lead level does not adequately decline during eighteen months of removal.

You may also be removed from exposure even if your blood lead levels are below current criteria if a final medical determination indicates that you temporarily need reduced lead exposure for medical reasons. If the physician who is implementing your employers medical program makes a final written opinion recommending your removal or other special protective measures, your employer must implement the physician's recommendation. If you are removed in this manner, you may only be returned when the doctor indicates that it is safe for you to do so.

The standard does not give specific instructions dealing with what an employer must do with a removed worker. Your job assignment upon removal is a matter for you, your employer and your union (if any) to work out consistent with existing procedures for job assignments. Each removal must be accomplished in a manner consistent with existing collective bargaining relationships. Your employer is given broad discretion to implement temporary removals so long as no attempt is made to override existing agreements. Similarly, a removed worker is provided no right to veto an employer's choice which satisfies the standard.

In most cases, employers will likely transfer removed employees to other jobs with sufficiently low lead exposure. Alternatively, a worker's hours may be reduced so that the time weighted average exposure is reduced, or he or she may be temporarily laid off if no other alternative is feasible.

In all of these situation, MRP benefits must be provided during the period of removal - i.e., you continue to receive the same earnings, seniority, and other rights and benefits you would have had if you had not been removed. Earnings includes more than just your base wage; it includes overtime, shift differentials, incentives, and other compensation you would have earned if you had not been removed. During the period of removal you must also be provided with appropriate follow-up medical surveillance. If you were removed because your blood lead level was too high, you must be provided with a monthly blood test. If a medical opinion caused your removal, you must be provided medical tests or examinations that the doctor believes to be appropriate. If you do not participate in this follow up medical surveillance, you may lose your eligibility for MRP benefits.

When you are medically eligible to return to your former job, your employer must return you to your "former job status." This means that you are entitled to the position, wages, benefits, etc., you would have had if you had not been removed. If you would still be in your old job if no removal had occurred that is where you go back. If not, you are returned consistent with whatever job assignment discretion your employer would have had if no removal had occurred. MRP only seeks to maintain your rights, not expand them or diminish them.

If you are removed under MRP and you are also eligible for worker compensation or other compensation for lost wages, your employer's MRP benefits obligation is reduced by the amount that you actually receive from these other sources. This is also true if you obtain other employment during the time you are laid off with MRP benefits.

The standard also covers situations where an employer voluntarily removes a worker from exposure to lead due to the effects of lead on the employee's medical condition, even though the standard does not require removal. In these situations MRP benefits must still be provided as though the standard required removal. Finally, it is important to note that in all cases where removal is required, respirators cannot be used as a substitute. Respirators may be used before removal becomes necessary, but not as an alternative to a transfer to a low exposure job, or to a lay-off with MRP benefits.

## X. EMPLOYEE INFORMATION AND TRAINING

Your employer is required to provide an information and training program for all employees exposed to lead above the action level or who may suffer skin or eye irritation from lead.

This program must inform these employees of the specific hazards associated with their work environment, protective measures which can be taken, the danger of lead to their bodies (including their reproductive systems), and their rights under the standard. In addition your employer must make readily available to all employees, including those exposed below the action level, a copy of the standard and its appendices and must distribute to all employees any materials provided to the employer by the Occupational Safety and Health Administration (OSHA).

Your employer is required to complete this training program for all employees by August 28, 1979. After this date, all new employees must be trained prior to initial assignment to areas where there is a possibility of exposure over the action level.

This training program must also be provided at least annually thereafter.

## XI. SIGNS

The standard requires that the following warning sign be posted in the work areas when the exposure to lead exceeds the PEL:

DANGER
LEAD
MAY DAMAGE FERTILITY OR THE UNBORN CHILD
CAUSES DAMAGE TO THE CENTRAL NERVOUS SYSTEM
DO NOT EAT, DRINK OR SMOKE IN THIS AREA

However, prior to June 1, 2016, employers may use the following legend in lieu of that specified above:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

## XII. RECORDKEEPING

Your employer is required to keep all records of exposure monitoring for airborne lead. These records must include the name and job classification of employees measured, details of the sampling and analytic techniques, the results of this sampling, and the type of respiratory protection being worn by the person sampled. Your employer is also required to keep all records of biological monitoring and medical examination results. These must include the names of the employees, the physician's written opinion, and a copy of the results of the examination. All of the above kinds of records must be kept for 40 years, or for at least 20 years after your termination of employment, whichever is longer.

Recordkeeping is also required if you are temporarily removed from your job under the medical removal protection program. This record must include your name and number, the date of your removal and return, how the removal was or is being accomplished, and whether or not the reason for the removal was an elevated blood lead level. Your employer is required to keep each medical removal record only for as long as the duration of an employee's employment.

The standard requires that if you request to see or copy environmental monitoring, blood lead level monitoring, or medical removal records, they must be made available to you or to a representative that you authorize. Your union also has access to these records. Medical records other than PbB's must also be provided upon request to you, to your physician or to any other person whom you may specifically designate. Your union does not have access to your personal medical records unless you authorize their access.

## XIII.OBSERVATIONS OF MONITORING

When air monitoring for lead is performed at your workplace as required by this standard, your employer must allow you or someone you designate to act as an observer of the monitoring. Observers are entitled to an explanation of the measurement procedure, and to record the results obtained. Since results will not normally be available at the time of the monitoring, observers are entitled to record or receive the results of the monitoring when returned by the laboratory. Your employer is required to provide the observer with any personal protective devices required to be worn by employees working in the area that is being monitored. The employer must require the observer to wear all such equipment and to comply with all other applicable safety and health procedures.

# APPENDIX C – NON-MANDATORY
# MEDICAL SURVEILLANCE INFORMATION

The information contained in this appendix is not intended to create any additional obligations or requirements not otherwise imposed by this standard nor detract from any existing obligations or requirements.

In accordance with the Administrative Procedures Act, PA 306 of 1969, these appendices "do not have the force of law." They are not mandatory and are intended for information only.

## INTRODUCTION

The primary purpose of the Occupational Safety and Health Act of 1970 is to assure, so far as possible, The primary purpose of the Occupational Safety and Health Act of 1970 is to assure, so far as possible, safe and healthful working conditions for every working man and woman. The occupational health standard for inorganic lead[(1)] was promulgated to protect workers exposed to inorganic lead including metallic lead, all inorganic lead compounds and organic lead soaps.

It is hoped that this review and discussion will give the physician a better understanding of the MIOSHA standard with the ultimate goal of protecting the health and well-being of the worker exposed to lead under his or her care.

Under this final standard in effect as of March 1, 1979, occupational exposure to inorganic lead is to be limited to 50 µg/m[(3)] (micrograms per cubic meter) based on an 8-hour time-weighted average (TWA). This level of exposure must be achieved through a combination of engineering, work practice and other administrative controls.

In addition to the requirements of this standard, a program of biological monitoring and medical surveillance should be considered for all employees exposed to levels of inorganic lead above the action level of 30 µg/m[(3)] (TWA) for more than 10 days per year, or whose work could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, regardless of airborne lead concentrations or surface contamination levels.

The purpose of this document is to outline the medical surveillance provisions of the standard for inorganic lead, and to provide further information to the physician regarding the examination and evaluation of workers exposed to inorganic lead.

Section 1 provides a detailed description of the monitoring procedure including the required frequency of blood testing for exposed workers, provisions for medical removal protection (MRP), the recommended right of the employee to a second medical opinion, and notification and recordkeeping requirements of the employer. A discussion of the requirements for respirator use and respirator monitoring and OSHA's position on prophylactic chelation therapy are also included in this appendix.

Section 2 discusses the toxic effects and clinical manifestations of lead poisoning and effects of lead intoxication on enzymatic pathways in heme synthesis. The adverse effects on both male and female reproductive capacity and on the fetus are also discussed.

Section 3 outlines the recommended medical evaluation of the worker exposed to inorganic lead including details of the medical history, physical examination, and recommended laboratory tests, which are based on the toxic effects of lead as discussed in Section 2.

Section 4 provides detailed information concerning the laboratory tests available for the monitoring of exposed workers. Included also is a discussion of the relative value of each test and the limitations and precautions which are necessary in the interpretation of the laboratory results.

Footnote[(1)] The term inorganic lead used throughout the medical surveillance appendices is meant to be synonymous with the definition of lead set forth in the standard.

## I. MEDICAL SURVEILLANCE AND MONITORING REQUIREMENTS FOR WORKERS EXPOSED TO INORGANIC LEAD

In addition to the requirements of this standard, a program of biological monitoring and medical surveillance should be considered for all employees exposed to lead above the action level of 30 µg/m$^{(3)}$ TWA for more than 10 days each year, or whose job duties could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, regardless of airborne lead concentrations or surface contamination levels. Periodic blood sampling and medical evaluation should be considered and performed on a schedule which is defined by previous laboratory results, worker complaints or concerns, and the clinical assessment of the examining physician.

The blood lead level of all employees who are exposed to lead above the action level of 30 µg/m$^{(3)}$, or whose job duties could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, should be determined at time of assignment to work at this exposure level (or when exposure at this level is initially determined), at least every 2 months for the first 6 months, and then at least every 6 months thereafter. The frequency is increased to every 2 months for employees whose last blood lead level was at or above 15 µg/dL and less than 30 µg/dL. For employees returned to work after removal from exposure to lead due to an elevated blood testing should be considered at least monthly until 2 consecutive blood lead levels, are below 10 µg/dL whole blood.

An annual medical examination and consultation performed under the guidelines discussed in Section 3 should be considered for each employee for whom a blood test conducted at any time during the preceding 12 months indicated a blood lead level at or above 15 µg/dL. Also, an examination should be considered for all employees prior to their assignment to an area in which airborne lead concentrations reach or exceed the action level or whose job duties could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, regardless of airborne lead concentrations or surface contamination levels.

Results of biological monitoring or the recommendations of an examining physician may necessitate removal of an employee from further lead exposure pursuant to the standard's medical removal protection (MRP) program. The object of the MRP program is to provide temporary medical removal to workers either with substantially elevated blood lead levels or otherwise at risk of sustaining material health impairment from continued substantial exposure to lead.

The best practices are summarized in Table 1.

**TABLE 1**
**HEALTH BASED MEDICAL SURVEILLANCE TO BE CONSIDERED FOR LEAD-EXPOSED WORKERS**

| BLOOD LEAD LEVELS | EMPLOYER SHOULD CONSIDER |
|---|---|
| All lead-exposed workers* | • Baseline or preplacement medical history and physical examination, baseline PbB, serum creatinine |
| < 10 µg/dL | • PbB every month for first 3 months of placement, or upon change in task to higher exposure, then PbB every 6 months<br>• If PbB increases ≥ 5 µg/dL, evaluate exposure and protective measures.<br>• Increase monitoring if indicated |
| 10-19 µg/dL | As above for PbB < 10 µg/dL, plus:<br>• PbB every 3 months<br>• Evaluate exposure, engineering controls, and work practices<br>• Revert to testing PbB every 6 months after 2 PbBs < 10 µg/dL |
| ≥ 20 µg/dL | • Refer to the standard |

*A lead-exposed worker is one whose job duties could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, regardless of airborne lead concentrations or surface contamination levels.

Recommendations from the examining physician may be more stringent than the specific provisions of the standard. The examining physician, therefore, has broad flexibility to tailor special protective procedures to the needs of individual employees. This flexibility extends to the evaluation and management of pregnant workers and male and female workers who are planning to raise children. Based on the history, physical examination, and laboratory studies, the physician might recommend special protective measures or medical removal for an employee who is pregnant or who is planning to conceive a child when, in the physician's judgment, continued exposure to lead at the current job would pose a significant risk. The return of the employee to his or her former job status, or the removal of special protections or limitations, depends upon the examining physician determining that the employee is no longer at increased risk of material impairment or that special measures are no longer needed.

During the period of any form of special protection or removal, the employer must maintain the worker's earnings, seniority, and other employment rights and benefits (as though the worker had not been removed) for a period of up to 18 months. This economic protection will maximize meaningful worker participation in the medical surveillance program, and is appropriate as part of the employer's overall obligation to provide a safe and healthful workplace. The provisions of MRP benefits during the employee's removal period may, however, be conditioned upon participation in medical surveillance.

On rare occasions, an employee's blood lead level may not acceptably decline within 18 months of removal. This situation will arise only in unusual circumstances; thus, the standard relies on an individual medical examination to determine how to protect such an employee. In this situation the physician should consider non-occupational sources of lead. This medical determination is to be based on both laboratory values, including lead levels, blood counts, and other tests felt to be warranted, as well as the physician's judgment that any symptoms or findings on physical examination are a result of lead toxicity. The medical determination may be that the employee is incapable of ever safely returning to his or her former job status. The medical determination may provide additional removal time past 18 months for some employees or specify special protective measures to be implemented.

The lead standard provides for a multiple physician review in cases where the employee wishes a second opinion concerning potential lead poisoning or toxicity. If an employee wishes a second opinion, he or she can make an appointment with a physician of his or her choice. This second physician will review the findings, recommendations or determinations of the first physician and conduct any examinations, consultations or tests deemed necessary in an attempt to make a final medical determination. If the first and second physicians do not agree in their assessment they must try to resolve their differences. If they cannot reach an agreement, then they must designate a third physician to resolve the dispute.

The employer must provide examining and consulting physicians with the following specific information: a copy of the lead regulations and all appendices, a description of the employee's duties as related to exposure, the exposure level to lead and any other toxic substances (if applicable), a description of personal protective equipment used, blood lead levels, and all prior written medical opinions regarding the employee in the employer's possession or control. The employer must also obtain from the physician and provide the employee with a written medical opinion containing blood lead levels, the physician's opinion as to whether the employee is at risk of material impairment to health, any recommended protective measures for the employee if further exposure is permitted, as well as any recommended limitations upon an employee's use of respirators.

Employers must instruct each physician not to reveal to the employer in writing or in any other way his or her findings, laboratory results, or diagnoses which are felt to be unrelated to occupational lead exposure. They must also instruct each physician to advise the employee of any occupationally or non-occupationally related medical condition requiring further treatment or evaluation.

The standard provides for the use of respirators where engineering and other primary controls have not been fully implemented. However, the use of respirator protection shall not be used in lieu of temporary medical removal due to elevated blood lead levels or findings that an employee is at risk of material health impairment. This is based on the numerous inadequacies of respirators including skin rash where the face-piece makes contact with the skin, unacceptable stress to breathing in some workers with underlying cardiopulmonary impairment, difficulty in providing adequate fit, the tendency for respirators to create additional hazards by interfering with vision, hearing, and mobility, and the difficulties of assuring the maximum effectiveness of a complicated work practice program involving respirators. Respirators do, however, serve a useful function where engineering and work practice controls are inadequate by providing supplementary, interim, or short-term protection, provided they are properly selected for the environment in which the employee will be working, properly fitted to the employee, maintained and cleaned periodically, and worn by the employee when required.

In its final standard on occupational exposure to inorganic lead, OSHA has prohibited prophylactic chelation. Diagnostic and therapeutic chelation are permitted only under the supervision of a licensed physician with appropriate medical monitoring in an acceptable clinical setting. The decision to initiate chelation therapy must be made on an individual basis and take into account the severity of symptoms felt to be a result of lead toxicity along with blood lead levels, and other laboratory tests as appropriate. Succimer, meso 2, 3-dimercaptosuccinic acid (DMSA), which is the primary chelating agent used in the therapy of occupational lead poisoning has potential side effects and its use must be justified on the basis of expected benefits to the worker. Unless frank and severe symptoms are present, therapeutic chelation is not recommended, given the opportunity to remove a worker from exposure and allow the body to naturally excrete accumulated lead. As a diagnostic aid, the chelation mobilization test using CA-EDTA is not part of standard medical practice.

In accordance with this standard, employers are required to assure that accurate records are maintained on exposure monitoring, medical surveillance, and medical removal for each employee. Exposure monitoring and medical surveillance records must be kept for 40 years or the duration of employment plus 20 years, whichever is longer, while medical removal records must be maintained for the duration of employment. All records required under this standard must be made available upon request to the Director of the Department of Licensing and Regulatory Affairs. Employers must also make environmental and biological monitoring and medical removal records available to affected employees and to former employees or their authorized employee representatives. Employees or their specifically designated representatives have access to their entire medical surveillance records.

In addition, the standard requires that the employer inform all workers exposed to lead at or above the action level, or performing work involving the handling of materials with a significant lead content in a manner which could reasonably be expected to result in potentially harmful exposure through inhalation or ingestion, of the provisions of the standard and all its appendices, the purpose and description of medical surveillance and provisions for medical removal protection if temporary removal is required. An understanding of the potential health effects of lead exposure by all exposed employees along with full understanding of their rights under the lead standard is essential for an effective monitoring program.

## II. ADVERSE HEALTH EFFECTS OF INORGANIC LEAD

Although the toxicity of lead has been known for 2,000 years, the knowledge of the complex relationship between lead exposure and human response is still being refined. Significant research into the toxic properties of lead continues throughout the world, and it should be anticipated that our understanding of thresholds of effects and margins of safety will be improved in future years. In order to reduce the risk of adverse health effects from exposure to lead for most workers throughout a working lifetime, studies suggest that worker blood lead (PbB) levels should be maintained as low as possible. The number of years a blood lead level is elevated is an important factor, which determines the increased risk of an adverse health effect. The blood lead levels of female workers who are pregnant should be maintained below 5 µg/dL at all times to prevent adverse health effects to the developing fetus.

The spectrum of health effects caused by lead exposure are summarized in the following sections.

### 1. Neurological Effects.

Inorganic lead has been found to have toxic effects on both the central and peripheral nervous systems. The National Toxicology Program (NTP) of the US Department of Health and Human Services has concluded that there is sufficient evidence that blood lead levels below 10 µg/dL are associated with essential tremor in adults.

The earliest stages of lead-induced central nervous system effects first manifest themselves in the form of behavioral disturbances and central nervous system symptoms including irritability, restlessness, insomnia and other sleep disturbances, fatigue, vertigo, headache, poor memory, tremor, depression, and apathy. With more severe exposure, symptoms can progress to drowsiness, stupor, hallucinations, delirium, convulsions and coma. Studies have suggested exposure to lead may be linked to psychiatric disorders including anxiety and depression, reduced auditory function, ALS and cognitive deficits in older adults.

The most severe and acute form of lead poisoning which usually follows ingestion or inhalation of large amounts of lead is acute encephalopathy which may arise precipitously with the onset of intractable seizures, coma, cardiorespiratory arrest, and death within 48 hours.

Cumulative lead exposure as measured in bone x-ray fluorescence has been associated with declining performance on neurocognitive tests. The central nervous system effects frequently are not reversible following discontinued exposure or chelation therapy and when improvement does occur, it is almost always only partial.

The peripheral neuropathy resulting from lead exposure characteristically involves only motor function with minimal sensory damage and has a marked predilection for the extensor muscles of the most active extremity. The peripheral neuropathy can occur with varying degrees of severity.

At 40 µg/dL this may be manifested by slowing of motor nerve conduction velocity often without clinical symptoms, other than essential tremor. With progression of the neuropathy there is development of painless extensor muscle weakness usually involving the extensor muscles of the fingers and hand in the most active upper extremity, followed in severe cases by wrist drop or, much less commonly, foot drop.

While the peripheral neuropathies can occasionally be reversed with therapy, again such recovery is not assured particularly in the more severe neuropathies and often improvement is only partial. The lack of reversibility is felt to be due in part to segmental demyelination.

**2. Cardiovascular effects.**

Hypertension, an important risk factor for cardiovascular and cerebrovascular morbidity and mortality, has frequently been noted in occupationally exposed individuals. There is now sufficient evidence that hypertension is associated with levels of lead exposure < 10 µg/dL. Several studies based upon the National Health and Nutrition Evaluation Surveys (NHANES) suggest a 20% increase in relative risk of cardiovascular mortality at blood lead levels between 5 and 9 µg/dL, and a 55% increase at levels above 10 µg/dL.

**3. Renal.**

Renal toxicity represents one of the most serious health effects of lead poisoning. Even under 10 µg/dL, there is sufficient evidence of decreased glomerular filtration rates in adults. In the early stages of disease nuclear inclusion bodies can frequently be identified in proximal renal tubular cells. Renal function remains normal and the changes in this stage are probably reversible. Long-term, higher level exposure can result in chronic lead nephropathy. With more advanced disease there is progressive interstitial fibrosis and impaired renal function. Eventually extensive interstitial fibrosis ensues with sclerotic glomeruli and dilated and atrophied proximal tubules; all represent end stage kidney disease. Azotemia can be progressive, eventually resulting in frank uremia necessitating dialysis. There is occasionally associated hypertension and hyperuricemia with or without gout.

Individuals with other renal risk factors, such as diabetes or underlying hypertension, may be at greater risk for the renal toxicity of lead.

Early kidney disease is difficult to detect. The urinalysis is normal in early lead nephropathy and the blood urea nitrogen and serum creatinine increase only when two-thirds of kidney function is lost. Measurement of creatinine clearance can often detect earlier disease as can other methods of measurement of glomerular filtration rate.

**4. Gastrointestinal.**

Lead may also affect the gastrointestinal system producing abdominal colic or diffuse abdominal pain. Constipation, obstipation, diarrhea, anorexia, nausea and vomiting may occur at blood lead levels of 30 µg/dL. Lead colic may develop at blood lead levels above 40 µg/dL, but it tends to be uncommon below 80 µg/dL.

**5. Heme Synthesis Inhibition.**

Lead has the ability to inhibit enzymes of the heme synthesis pathway at moderate blood levels. Inhibition of delta aminolevulinic acid dehydrase (ALA-D) which catalyzes the conversion of delta-aminolevulinic acid (ALA) to protoporphyrin is observed at a blood lead level below 20 µg/dL whole blood. At a blood lead level of 40 µg/dL, more than 20% of the population will have 70% inhibition of ALA-D. There is an exponential increase in ALA excretion at blood lead levels greater than 40 µg/dL.

Another enzyme, ferrochelatase, is also inhibited at low blood lead levels. Inhibition of ferrochelatase leads to increased free erythrocyte protoporphyrin (FEP) in the blood which can then bind to zinc to yield zinc protoporphyrin (ZPP). At a blood lead level of 50 µg/dL or greater, nearly 100% of the population will have an increase in FEP. There is also an exponential relationship between blood lead levels greater than 40 µg/dL and the associated ZPP level, which has led to the development of the ZPP screening test for lead exposure.

One of the eventual results of lead-induced inhibition of enzymes in the heme synthesis pathway is anemia which can be asymptomatic if mild but associated with a wide array of symptoms including dizziness, fatigue, and tachycardia when more severe. Studies have indicated that lead levels as low as 50 µg/dL can be associated with a definite decreased hemoglobin, although most cases of lead-induced anemia, as well as shortened red-cell survival times, occur at lead levels exceeding 80 µg/dL. Inhibited hemoglobin synthesis is more common in chronic cases whereas shortened erythrocyte life span is more common in acute cases.

In lead-induced anemias, there is usually a reticulocytosis along with the presence of basophilic stippling, and ringed sideroblasts, although none of the above are pathognomonic for lead-induced anemia.

**6. Cancer.**

The International Agency on Research on Cancer (IARC) has categorized lead as a “probable human carcinogen,” category 2A. The US National Toxicology Program (NTP) has classified lead and lead compounds as “*reasonably anticipated to be human carcinogens”.*

**7. Reproductive and childhood effects.**

Exposure to lead can have serious effects on reproductive function in both males and females. In male workers exposed to lead there can be a decrease in sexual drive, impotence, decreased ability to produce healthy sperm, and sterility. Malformed sperm (teratospermia), decreased number of sperm (hypospermia), and sperm with decreased motility (asthenospermia) can all occur. Above 15 µg/dL, there is sufficient evidence of adverse modifications in sperm parameters, as well as delays in time to pregnancy.

Women exposed to lead may experience menstrual disturbances including dysmenorrhea, menorrhagia, and amenorrhea. Following exposure to lead, women have a higher frequency of sterility, premature births, spontaneous miscarriages, and stillbirths.

Germ cells can be affected by lead and cause genetic damage in the egg or sperm cells before conception and result in failure to implant, miscarriage, stillbirth, or birth defects.

Infants of mothers with lead poisoning have a higher mortality during the first year and suffer from lowered birth weights, slower growth, and nervous system disorders.

Lead can pass through the placental barrier and lead levels in the mother's blood are comparable to concentrations of lead in the umbilical cord at birth. Transplacental passage becomes detectable at 12-14 weeks of gestation and increases until birth.

There is sufficient evidence that women exposed with blood lead levels under 5 µg/dL may experience reduced fetal growth.

Lead exposure to children due to “take home lead” (carried to the home on worker clothing) can cause significant neurobehavioral impairments, including hyperactivity. Given the overall body of literature concerning the adverse health effects of lead in children, the blood lead level in children, and women who are pregnant or attempting to become pregnant, should be maintained below 5 µg/dL.

Blood lead levels in the fetus and newborn likewise should not exceed 5 µg/dL.

Because of lead's ability to pass through the placental barrier and also because of the demonstrated adverse effects of lead on reproductive function in both the male and female as well as the risk of genetic damage of lead on both the ovum and sperm, it is recommended that the maximum permissible blood lead level in both males and females who wish to bear children is 5 µg/dL.

**8. Other toxic effects.**

Some data have suggested that lead impairs thyroid function and interferes with the pituitary-adrenal axis, but again these effects have not been well defined.

## III. MEDICAL EVALUATION

The most important principle in evaluating a worker for any occupational disease including lead poisoning is a high index of suspicion on the part of the examining physician. As discussed in Section 2, lead can affect numerous organ systems and produce a wide array of signs and symptoms, most of which are non-specific and subtle in nature at least in the early stages of disease. Unless serious concern for lead toxicity is present, many of the early clues to diagnosis may easily be overlooked.

The crucial initial step in the medical evaluation is recognizing that a worker's employment can result in exposure to lead. The worker will frequently be able to define exposures to lead and lead containing materials but often will not volunteer this information unless specifically asked. In other situations, the worker may not know of any exposures to lead but the suspicion might be raised on the part of the physician because of the industry or occupation of the worker.

Potential occupational exposure to lead and its compounds occur in at least 120 occupations, including lead smelting, the manufacture or recycling of lead storage batteries, the manufacture of lead pigments and products containing pigments, solder, brass or bronze manufacture, shipbuilding and ship repair, firing ranges, removal of lead containing paint in renovation of homes built before 1978, or from renovation, repair, demolition, and clean-up of industrial facilities and equipment, as well as structures such as bridges and water towers with lead containing paint or materials.

The most important part of a medical evaluation is a blood lead test. The half-life of lead in blood is approximately five weeks. The focus can then be directed toward eliciting information from the medical history, physical exam, and from laboratory data to evaluate the worker for potential lead toxicity.

A complete and detailed work and hobby history is important in the initial evaluation. A listing of all previous employment with information on work processes, exposure to fumes or dust, known exposures to lead or other toxic substances, respiratory protection used, and previous medical surveillance should all be included in the worker's record. Where exposure to lead is suspected, information concerning on-the-job personal hygiene, smoking or eating habits in work areas, laundry procedures, and use of any protective clothing or respiratory protection equipment should be noted. A complete work history is essential in the medical evaluation of a worker with suspected lead toxicity, especially when long term effects such as neurotoxicity, hypertensive effects, and nephrotoxicity are considered.

The medical history is of fundamental importance and should include a listing of all past and current medical conditions, current medications including proprietary drug intake, previous surgeries and hospitalizations, allergies, smoking history, alcohol consumption, history of gunshot wounds and presence and location of any retained bullets or shrapnel, and also non-occupational lead exposures particularly the frequency of use of indoor firing ranges and casting and reloading of bullets. Also known childhood exposures should be elicited. Any previous history of hematological, neurological, cardiovascular, gastrointestinal, renal, psychological, gynecological, genetic, or reproductive problems should be specifically noted.

A careful and complete review of systems must be performed to assess both recognized complaints and subtle or slowly acquired symptoms which the worker might not appreciate as being significant. The review of systems should include the following:

| | |
|---|---|
| General | Weight loss, fatigue, decreased appetite. |
| Head, Eyes, Ears, Nose, Throat (HEENT) | Headaches, visual disturbances or decreased visual acuity, hearing deficits or tinnitus, pigmentation of the oral mucosa, or metallic taste in mouth |
| Cardio-pulmonary | Shortness of breath, cough, chest pains, palpitations, or orthopnea |
| Gastrointestinal | Nausea, vomiting, heartburn, abdominal pain, constipation or diarrhea |
| Neurologic | Irritability, insomnia, weakness (fatigue), dizziness, loss of memory, confusion, hallucinations, incoordination, ataxia, decreased strength in hands or feet, disturbances in gait, difficulty in climbing stairs, or seizures |
| Hematologic | Pallor, easy fatigability, abnormal blood loss melena |
| Cardiovascular | Hypertension, dysrhythmias, stigmata of heart failure |
| Reproductive (male and female and spouse where relevant) | History of infertility, impotence, loss of libido, abnormal menstrual periods, history of miscarriages, stillbirths, or children with birth defects |
| Musculoskeletal | Muscle and joint pains. |

The physical examination should emphasize the neurological, gastrointestinal, and cardiovascular systems. The worker's weight and blood pressure should be recorded, and the oral mucosa checked for a lead line on the gingiva. It should be noted, however, that the occurrence of a lead line is very rare even in severe lead poisoning if good oral hygiene is practiced.

The presence of pallor on skin examination may indicate an anemia, which if severe might also be associated with a tachycardia. If an anemia is suspected, an active search for blood loss should be undertaken including potential blood loss through the gastrointestinal tract.

A complete neurological examination should include an adequate mental status evaluation including a search for behavioral and psychological disturbances, memory testing, evaluation for irritability, insomnia, hallucinations, and mental clouding. Gait and coordination should be examined along with close observation for tremor. A detailed evaluation of peripheral nerve function including careful sensory and motor function testing is warranted. Strength testing particularly of extensor muscle groups of all extremities is of fundamental importance.

Cranial nerve evaluation should also be included in the routine examination.

The abdominal examination should include auscultation for bowel sounds and abdominal bruits and palpation for organomegaly, masses, and diffuse abdominal tenderness.

Cardiovascular examination should evaluate possible early signs of congestive heart failure. Pulmonary status should be addressed particularly if respirator protection is contemplated.

As part of the medical evaluation, the lead standard requires the following laboratory studies:

| | |
|---|---|
| 1. | Blood lead level |
| 2. | Hemoglobin and hematocrit determinations, red cell indices, and examination of the peripheral blood smear to evaluate red blood cell morphology |
| 3. | Blood urea nitrogen |
| 4. | Serum creatinine |
| 5. | Routine urinalysis with microscopic examination |

In addition to the above, the physician is authorized to order any further laboratory or other tests which he or she deems necessary in accordance with sound medical practice. The evaluation must also include pregnancy testing or laboratory evaluation of male fertility if requested by the employee.

If an anemia is detected further studies including a careful examination of the peripheral smear, reticulocyte count, stool for occult blood, serum iron, total iron binding capacity, bilirubin, and, if appropriate, vitamin B12 and folate may be of value in attempting to identify the cause of the anemia.

If a peripheral neuropathy is suspected, nerve conduction studies are warranted both for diagnosis and as a basis to monitor any therapy.

If renal disease is questioned, a 24-hour urine collection for creatinine clearance, protein, and electrolytes may be indicated. Elevated uric acid levels may result from lead-induced renal disease and a serum uric acid level might be performed.

An electrocardiogram and chest x-ray may be obtained as deemed appropriate.

Sophisticated and highly specialized testing should not be done routinely and where indicated should be under the direction of a specialist.

## IV. LABORATORY EVALUATION

The blood lead level at present remains the single most important test to monitor lead exposure and is the test used in the medical surveillance program under the lead standard to guide employee medical removal.

This section will discuss the blood lead level in detail. Other blood tests currently available to evaluate lead exposure will also be reviewed. The blood lead level is a good index of current of recent lead absorption. The half-life of lead in blood is approximately five weeks.

However, blood lead levels do not indicate the total body burden of lead and are not adequate measures of past exposure. Lead has a high affinity for bone and up to 90% of the body's total lead is deposited there. Also, lead is deposited in soft tissue (liver, kidney, and brain). The blood lead level is a function of the dynamics of lead absorption, distribution, deposition in bone and excretion. Following discontinuation of exposure to lead, the excess body burden is slowly mobilized from bone and other relatively stable body stores, enters the blood and is excreted. Consequently, an elevated blood lead level may represent recent exposure to lead without a significant total body excess, slow release from bone from a past exposure, or a combination of recent exposure and slow release.

Due to its correlation with recent exposures, the blood lead level may vary considerably over short time intervals.

To minimize laboratory error and erroneous results due to contamination, blood specimens must be carefully collected after thorough cleaning of the skin with appropriate methods using lead-free blood containers and analyzed by a reliable laboratory. Under the standard, samples must be analyzed in laboratories which are approved by OSHA.

The determination of lead in urine is generally considered a less reliable monitoring technique than analysis of whole blood primarily due to individual variability in urinary excretion capacity as well as the technical difficulty of obtaining accurate 24-hour urine collections. In addition, workers with renal insufficiency, whether due to lead or some other cause, may have decreased lead clearance and consequently urine lead levels may underestimate the true lead burden. Therefore, urine lead levels are not recommended.

The zinc protoporphyrin test, unlike the blood lead determination, measures an adverse metabolic effect of lead. The level of ZPP reflects lead absorption over the preceding 3 to 4 months, and therefore can sometimes be an indicator of lead body burden. The ZPP requires more time than the blood lead to read significantly elevated levels; the return to normal after discontinuing lead exposure is also slower. A limitation of the ZPP test is that it can also be elevated in patients with anemia and certain forms of porphyria.

Zinc protoporphyrin results from the inhibition of the enzyme ferrochelatase which catalyzes the insertion of an iron molecule into the protoporphyrin molecule, which then becomes heme. If iron is not inserted into the molecule then zinc, having a greater affinity for protoporphyrin, takes the place of the iron, forming ZPP.

An elevation in the level of circulating ZPP may occur at blood lead levels as low as 20-30 µg/dL in some workers. Once the blood lead level has reached 40 µg/dL there can be a more marked rise in the ZPP value from its normal range of less than 100 µg/100 dL. Increases in blood lead levels beyond 40 µg/dL can be associated with exponential increases in ZPP.

ZPP is measured directly in red blood cells and is present for the cell's entire 120-day life-span. Therefore, the ZPP level in blood reflects the average ZPP production over the previous 3-4 months and consequently the average lead exposure during that time interval.

It is recommended that a hematocrit be determined whenever a confirmed ZPP of 50 µg/100 dL whole blood is obtained to rule out a significant underlying anemia. If the ZPP is in excess of 100 µg/100 dL and not associated with abnormal elevations in blood lead levels, the laboratory should be checked to be sure that blood leads were determined using atomic absorption spectrophotometry anodic stripping voltammetry, or any method which meets the accuracy requirements set forth by the standard by an OSHA approved laboratory which is experienced in lead level determinations, and other causes of an elevated ZPP should be considered. Repeat periodic blood lead studies should be obtained in all individuals with elevated ZPP levels to be certain that an associated elevated blood lead level has not been missed due to transient fluctuations in blood leads.

ZPP has a characteristic fluorescence spectrum with a peak at 594 nm which is detectable with a hematofluorimeter. The hematofluorimeter is accurate and portable and can provide on-site, instantaneous results for workers who can be frequently tested via a finger prick.

However, careful attention must be given to calibration and quality control procedures. Limited data on blood lead-ZPP correlations and the ZPP levels which are associated with the adverse health effects discussed in Section 2 are the major limitations of the test. Also, it is difficult to correlate ZPP levels with environmental exposure and there is some variation of response with age and sex.

Increasing concentrations of ALA result from the inhibition of the enzyme delta-aminolevulinic acid dehydrase (ALA-D). Although the test is relatively easy to perform, inexpensive, and rapid, the disadvantages include variability in results, the necessity to collect a complete 24-hour urine sample which has a specific gravity greater than 1.010, and also the fact that ALA decomposes in the presence of light.

With lead poisoning, the urine concentrations of coproporphyrins I and II, porphobilinogen and uroporphyrin I rise. The most important increase, however, is that of coproporphyrin III; levels may exceed 5,000 µg/1 in the urine in lead poisoned individuals, but its correlation with blood lead levels and ZPP are not as good as those of ALA. Increases in urinary porphyrins are not diagnostic of lead toxicity and may be seen in porphyria, some liver diseases, and in patients with high reticulocyte counts.

**SUMMARY.**

The Michigan Occupational Safety and Health Administration's standard for inorganic lead places significant emphasis on the medical surveillance of all workers exposed to levels of inorganic lead above the action level of 30 µg/$m^{(3)}$ TWA or whose work could reasonably be expected to result in potentially harmful exposure to lead, whether through inhalation or ingestion, regardless of airborne lead concentrations or surface contamination levels. The physician has a fundamental role in this surveillance program, and in the operation of the medical removal protection program.

Even with adequate worker education on the adverse health effects of lead and appropriate training in work practices, personal hygiene and other control measures, the physician has a primary responsibility for evaluating potential lead toxicity in the worker. It is only through a careful and detailed medical and work history, a complete physical examination and appropriate laboratory testing that an accurate assessment can be made. Many of the adverse health effects of lead toxicity are either irreversible or only partially reversible and therefore early detection of disease is very important.

This document outlines the medical monitoring program as defined by the occupational safety and health standard for inorganic lead. It reviews the adverse health effects of lead poisoning and describes the important elements of the history and physical examinations as they relate to these adverse effects. Finally, the appropriate laboratory testing for evaluating lead exposure and toxicity is presented.

It is hoped that this review and discussion will give the physician a better understanding of the MIOSHA standard with the ultimate goal of protecting the health and well-being of the worker exposed to lead under his or her care.


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