2017 - 2019 Report

Adult Blood Lead Epidemiology Surveillance (ABLES) Program

November 5, 2020

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Adult Blood Lead Epidemiology and Surveillance (ABLES) Program

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EXECUTIVE SUMMARY

This is the summary of the twentieth through twenty-second year of the results of blood lead levels (BLLs) ≥5 µg/dL in Michigan and covers individuals 16 years and older whose blood lead was tested in Michigan in 2017 through 2019.

- In 2017, Michigan received 20,995 blood lead tests for 19,137 individuals who were ≥16 years old. One thousand six hundred and sixty-nine blood lead tests were ≥5 µg/dL for 1,170 individuals. Four hundred and eighty-three (41.3%) of the 1,170 individuals had BLLs ≥10 micrograms per deciliter (µg/dL); 64 of those 483 had lead levels ≥25 µg/dL and three of the 64 had BLLs ≥50 µg/dL.

- In 2018, Michigan received 20,998 blood lead tests for 19,433 individuals who were ≥16 years old. Two thousand one hundred and forty-nine blood lead tests were ≥5 µg/dL for 1,164 individuals. Five hundred and eleven (43.9%) of the 1,164 individuals had BLLs ≥10 µg/dL; 85 of those 511 had lead levels ≥25 µg/dL and four of the 85 had BLLs ≥50 µg/dL.

- In 2019, Michigan received 19,390 blood lead tests for 18,328 individuals who were ≥16 years old. One thousand nine hundred and sixty-eight blood lead tests were ≥5 µg/dL for 1,284 individuals. Five hundred and forty-seven (42.6%) of the 1,284 individuals had BLLs ≥10 µg/dL; 67 of those 547 had lead levels ≥25 µg/dL and three of the 67 had BLLs ≥50 µg/dL.

- When individuals tested in 2017 through 2019 are only counted once, there were 2,623 individuals with BLLs ≥5 µg/dL of whom 1,126 (42.9%) individuals had BLLs ≥10 µg/dL, 169 (6.4%) had BLLs ≥25 µg/dL, and eight (0.3%) had BLLs ≥50 µg/dL.

- In 2015 and 2016, the number of adults with BLLs ≥5 µg/dL in Genesee county and the Flint-Area zip codes was 274 and 215, respectively. In 2017, 2018 and 2019, the number of blood lead tests ≥5 µg/dL in Genesee county and the Flint-Area zip codes decreased to 77 and 48, 49 and 25, and 47 and 17, respectively.

- The number of individuals with BLLs ≥10 µg/dL was 483 (41.3%) in 2017, 511 (43.9%) in 2018 and increased to 547 (42.6%) in 2019.

- The number of individuals with BLLs ≥25 µg/dL was 64 (5.5%) in 2017, 85 (7.3%) in 2018 and 67 (5.2%) in 2019.The number of individuals with BLLs ≥50 µg/dL was three (0.3%) in 2017, four (0.3%) in 2018 and three (0.2%) in 2019.

- For twelve consecutive years, from 1999 to 2010, there was a downward trend

for BLLs ≥25 µg/dL from the previous year. However, in 2011 and 2012 the number of BLLs ≥25 µg/dL increased from 102 in 2010 to 116 in 2011 and to 131 in 2012 and then dropped to 108 in 2013, to 70 in 2014 but then increased to 79 in 2015 and 96 in 2016. In 2017 the number of BLLs ≥25 µg/dL decreased to 64, and then increased to 85 in 2018 and then decreased to 67 2019. BLLs ≥ 10 µg/dL showed a similar trend as BLLs ≥25 µ/dL. The overall trend for work and non-work exposures was similar showing a downward trend until 2005 with no further decrease from 2006 through 2014. In 2015, there was a decrease in elevated BLLs from non-work exposures but not from the work exposure. In 2016, there was a decrease in elevated blood lead levels from work while there was an increase from non-work exposures. In 2017 through 2019, although there was a decrease in elevated BLLs from where source of exposure was known to be either work or non-work, there was no decrease when those with an unknown source were included.

- Among adults with BLLs ≥10 µg/dL, work-related exposure was the predominant source of lead exposure (84.1%); including work in abrasive blasting to remove lead paint on outdoor metal structures such as bridges, overpasses or water towers; cleaning 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 16% with non-work-related exposure, 63.1% of lead exposure was from recreational shooting at firing ranges, reloading or casting of bullets.

- In 2017 through 2019, outreach and intervention activities included providing educational material to 200 individuals, follow-up interviews with 109 lead-exposed individuals, and distribution of resources on diagnosis and management of lead exposure to 34 health care providers whose patients had an elevated BLL. 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.

- Since 1998, interviews of 556 adults with elevated BLL found that children in their household under the age of six who have been tested for lead were a high-risk group with 34.6% of the children having an elevated blood lead level of at least 10 µg/dL. The presumed source of exposure was lead brought home on the work clothes or shoes of the adult exposed at work.

- In 2017-2019, all eight companies inspected by MIOSHA because a worker had a BLL of ≥25 µg/dL received at least one lead-related citation. One other company, which was inspected in 2016 but was not included in the 2015-2016 report, also received a lead-related citation.

- On 12/11/2018, MIOSHA lowered the BLL that requires a worker be removed from lead exposure to 30 µg/dL and the level at which a worker can return to work after medical removal to 15 µg/dL.

BACKGROUND

This report contains data from the twentieth through twenty-second year of surveillance of BLLs in Michigan. It provides detailed data on individuals, who were ≥16 years old, whose blood lead was tested in Michigan in 2017 through 2019 and whose BLLs were ≥5 µg/dL. It provides annual trend data going back to 1998.

BLLs, including those of children, have been monitored by the State since 1992. From 1992 to 1995, laboratories performing analyses of blood lead levels, primarily of children, voluntarily submitted reports to the State. 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 require 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 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 the adults. Up to 41 states established lead registries through the ABLES program for surveillance of adult lead absorption, primarily based on reports of BLLs from clinical laboratories. Because of cutbacks in funding, 28 states currently participate. The most recent report of U.S. adult blood lead surveillance, published in the *Morbidity and Mortality Weekly Report*, October 14, 2016 / 63(55):59-65, is in Appendix A (1).

Surveillance for lead exposure in adults has focused on occupational exposure because 80% or more of adults with elevated lead levels have had their exposure at work. MIOSHA has updated two legal standards related to employer responsibilities for preventing lead exposure in employees – one for general industry and one for construction. The updated administrative standards lowered the blood lead level that triggers removal and the level at which a worker can return to a lead exposed area. The new rules became effective December 11, 2018 (2). All other requirements of the lead standard remain unchanged and are identical to the Federal OSHA standard. See Appendices B and C for a summary of the MIOSHA construction and general industry lead standards.

The new MIOSHA rules require that employees be removed from lead exposure when their BLL reaches 30 µg/dL and may not return to work involving lead exposure until their BLL is below 15 µg/dL (2). The new MIOSHA standard eliminated the requirement to perform blood testing for zinc protoporphyrin (ZPP), a hemoglobin precursor increased after exposure to lead. Michigan is the only state that has a lower acceptable blood levels for workers than Federal OSHA.

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's action limit) but below 50 µg/m^3 averaged over an 8-hour period (permissible exposure limit (PEL)), an employer must implement routine air monitoring; training; medical surveillance, including blood testing for lead, medical exams and consultation. See Appendix B and C for a more detailed description of the requirements.

It should be noted that in the absence of a specific exposure to lead, 95% of BLLs in the adult general population in the U.S. are below 3.8 µg/dL for men and below 2.8 µg/dL for women (3). In 2012, the CDC recommended public health actions be initiated for children at the reference level of ≥5 µg/dL but did not review this issue for adults (4). The CDC had previously considered blood leads of 10 µg/dL or greater as a level of concern. The Association for Occupational and Environmental Clinics (AOEC) (5), the Council for State and Territorial Epidemiologists (CSTE) (6), and the California Department of Public Health (7) have adopted medical guidelines that recommend a medical response for levels of ≥5 µg/dL in adults. In 2014, the CSTE recommended that a BLL of ≥5 µg/dL be considered elevated for adults, as well as children, and that surveillance for adults reflect this definition change (8).

A summary of reference blood lead values for adults is in Appendix D (although note the references do not reflect the MIOSHA removal BLL). Recommendations for medical management on lead exposed individuals are in APPENDIX E and F.

THE MICHIGAN ADULT BLOOD LEAD REGISTRY

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 blood lead levels among adults were received.

The 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 (9). Employers can now can 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” (10).

Data Management

The electronic record of all blood lead levels ≥5 µg/dL on individuals ≥16 years old are 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 are uploaded to an Access database. The database includes identifiers, demographics, information about source of exposure to lead, and name/address of employer for work-related exposures. Only venous blood leads are entered into the database. Urine, hair and capillary lead levels were excluded.

When BLL reports were received, they were reviewed for completeness. For blood lead reports ≥10 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 <10 µg/dL, with the exception of Flint residents where follow up was performed for BLLs of ≥5 µg/dL. Each record entered into the database had a visual quality control check on a monthly basis for any data entry errors, duplicate entries, missing data, and illogical data.

Case Follow-Up

An adult who has a BLL ≥25 µg/dL was contacted for an interview. Interviews were also conducted of individuals with BLLs ranging from 10 to 24 µg/dL if the source of their lead exposure could not be identified from the laboratory report. Since 2016, all Flint residents with a blood lead level ≥5 µg/dL were contacted for an interview. A letter was sent to these individuals 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 questionnaire collected patient demographic data, work exposure and history information, symptoms related to lead exposure, information on potential lead-using hobbies 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.

For those individuals with BLLs of ≥25 µg/dL whose exposure was work, MIOSHA decided on the utility of conducting a workplace follow-up.

Dissemination of Surveillance Data

In addition to Michigan's annual ABLES surveillance summaries, Michigan's ABLES data, without personal identifiers, were forwarded once a year to the program's funding agency, NIOSH at the CDC. NIOSH compiled surveillance summaries using data from all states that require reporting of BLLs and published them in the Morbidity and Mortality Weekly Report (MMWR) (1). See Appendix A for the most recent publication of ABLES surveillance results for the period 1994-2013.

This annual report provides a summary of data from reports of all adult BLLs ≥5 µg/dL received in 2017 through 2019 along with annual trends in numbers of adults reported with elevated BLLs going back to 1998. Also included is information about the MIOSHA inspections completed in 2017 through 2019 at the worksites where reported individuals were exposed to lead. Information is provided on households where adults with elevated BLLs reported children age younger than six living or spending time in the home.

There is strong medical evidence of health effects at levels as low as 5 µg/dL (5-7, 9), but with the exception of Flint residents, the program has insufficient resources to determine the source of exposure for the many individuals with BLLs <10 µg/dL (Table 1).

For Tables 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 and Figures 6, 7, 8, 9, 10 and 11 which show combined data for 2017-2019, individuals with blood leads testing in all three years are counted only once and only the highest blood lead of the three years was used; therefore the totals for the data in Figures 1, 2, 3, 4, 5, 12 and 13 for the individual years 2017, 2018 and 2019 differ from the totals for the data of the combined years.

RESULTS

This is the twentieth through twenty-second year with complete laboratory reporting in Michigan since the lead regulations became effective on October 11, 1997.

Number of Reports and Individuals

2017-2019: Between January 1, 2017 and December 31, 2019, the State of Michigan received 61,383 blood lead tests, including 5,793 blood lead test reports ≥5 µg/dL, for individuals ≥16 years old. Because an individual may be tested more than once each year, and/or during the three consecutive years, the 5,786 reports received were for 2,623 individuals. Between January 1 and December 31, 2017, the State of Michigan received 20,995 BLLs on 19,137 individuals (1,669 BLLs ≥5 µg/dL on 1,170 individuals), between January 1 and December 31, 2018, 20,998 BLLs on 19,433 individuals (2,149 BLLs ≥5 µg/dL on 1,164 individuals) and between January 1 and December 31, 2019, 19,390 BLLs on 18,328 individuals (1,968 BLLs ≥5 µg/dL on 1,284 individuals) (Figure 1 and Figure 2).

Two hundred and eighty-three individuals had blood lead test reports in all three calendar years (2017, 2018 and 2019), four hundred and thirty-one individuals had blood lead test reports in two calendar years, and two thousand nine hundred and nine individuals had blood lead test in one calendar year (either 2017, 2018 or 2019).

1998-2019 Trends: Up to 2007, the overall trend for the number of individuals tested each year and having a BLL ≥5 µg/dL showed a gradual increase (Figure 1 and Figure 2). The initial increase in 1999 and 2000 was most likely also due to better compliance by the laboratories with the 1997 reporting regulation. The increase after 2000 is assumed to be increased testing while the drop in numbers of tests noted in 2008 and 2009 was likely a reflection of the economic downturn. The reduction in 2013 and 2014 probably reflects a reduced number of companies conducting blood lead monitoring on their employees. The reason for the marked increase in the number of individuals tested in 2016 was due to increased testing for lead in the City of Flint (Genesee County). In 2017 through 2019 the number of individuals with BLLs ≥5 µg/dL showed a sharp decrease compared to 2016.

Figure 1. Number of Adults Reported with Tests for Blood Lead, Michigan 1998-2019

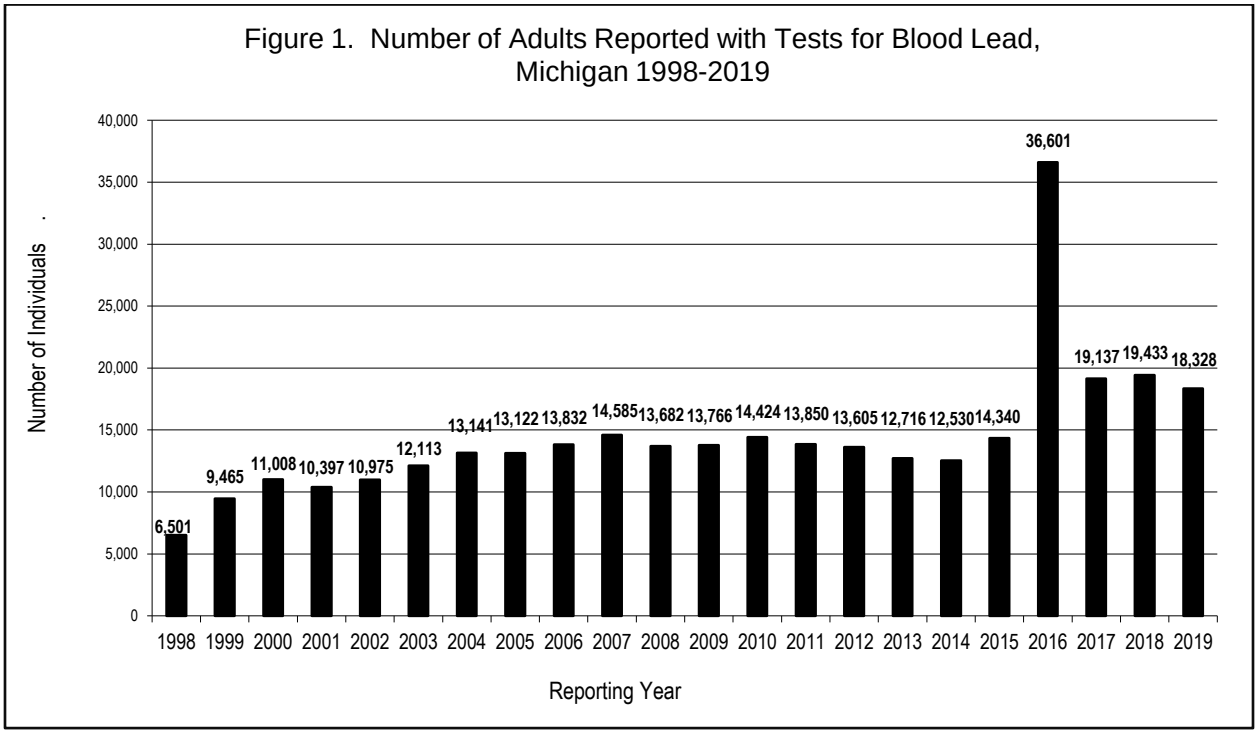
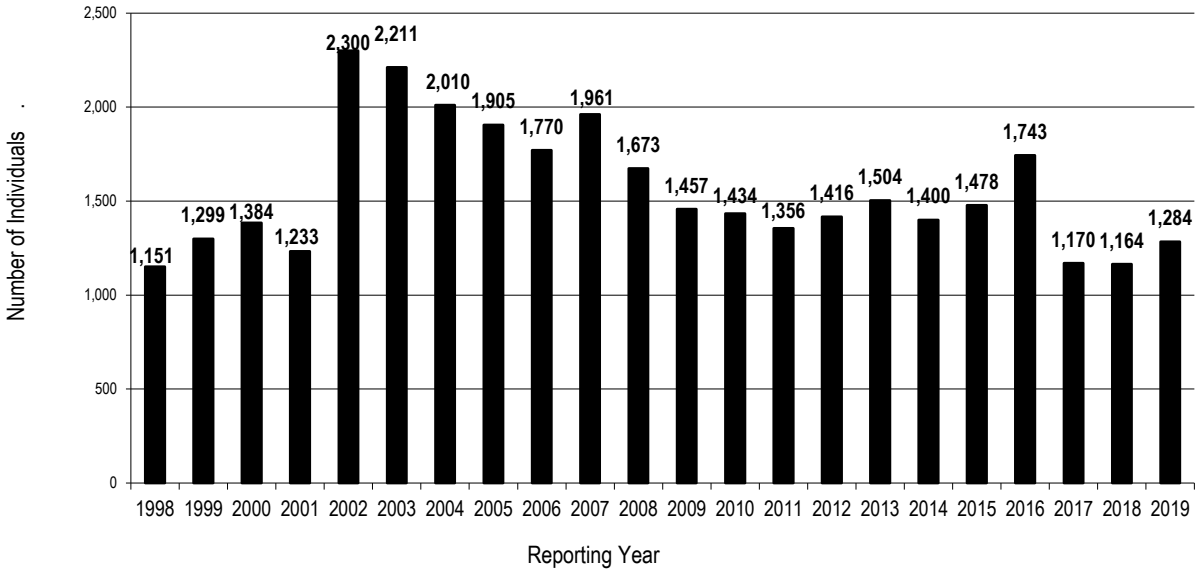


Figure 2. Number of Adults Reported with Tests for Blood Lead ≥5 µg/dL, Michigan 1998-2019



Distribution of BLLs and exposure sources:

(Note: For individuals with multiple BL tests in the same year, only the highest BLL in the year was included. The same individual may be included in multiple years.)

2017-2019 Combined: In 2017 through 2019, 1,126 (42.9%) of the 2,623 adults reported with BLLs ≥5 µg/dL had BLLs ≥10 µg/dL; 169 of those 1,126 had BLLs ≥25 µg/dL and eight of 169 had BLLs ≥50 µg/dL (Table 1).

One thousand four hundred and ninety-seven (57.1%) of adults reported in 2017 through 2019 had BLL 5–9 µg/dL. Individuals with BLL 5–9 µg/dL are not routinely contacted; however, when the source of lead exposure was identified on the lab report, 251 of 307 (81.8%) individuals were identified as occupationally exposed. Fifty-one (20.3%) of these 251 had been tested in the previous two years and 21 of the 51 (41.2%) showed a decrease in their BLL. Among the 957 individuals whose blood lead was 10–24 µg/dL, 488 (51.0.%) individuals had their source of lead exposure identified as occupational as compared to the 96 of 169 (56.8%) of individuals with BLLs ≥25 µg/dL.

Table 1. Distribution of Highest Blood Lead Levels among Adults and Source of Exposure in Michigan: 2017-2019

BLLs (µg/dL)	Work		Non-Work		Source Not Yet Identified		All BLLs	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
5-9	251	30.1[a]	56	33.5[a]	1,190	73.4[a]	1,497	57.1
10-24	488	58.4	84	50.3	385	23.8	957	36.5
25-29	45	5.4	6	3.6	19	1.2	70	2.7
30-39	36	4.3	13	7.8	23	1.4	72	2.7
40-49	12	1.4	5	3.0	2	0.1	19	0.7
50-59	3	0.4	3	1.8	1	0.1	7	0.3
≥ 60	1	0.1	0	-	0	-	1	0.04
Total	**836**	**83.3[b]**	**167**	**16.7[b]**	**1,620**	**100.0**	**2,623[c]**	**100.0**
Total ≥10µg/dL	**585**	**84.1[d]**	**111**	**15.9[d]**	**430**	**26.5**	**1,126**	**42.9**
Total ≥25µg/dL	**97**	**78.2[e]**	**27**	**21.8[e]**	**45**	**2.8**	**169**	**6.4**

[a] No follow-up was conducted of individuals with blood lead test results <10 µg/dL, but often information was known.

[b] Percent of total known exposures.

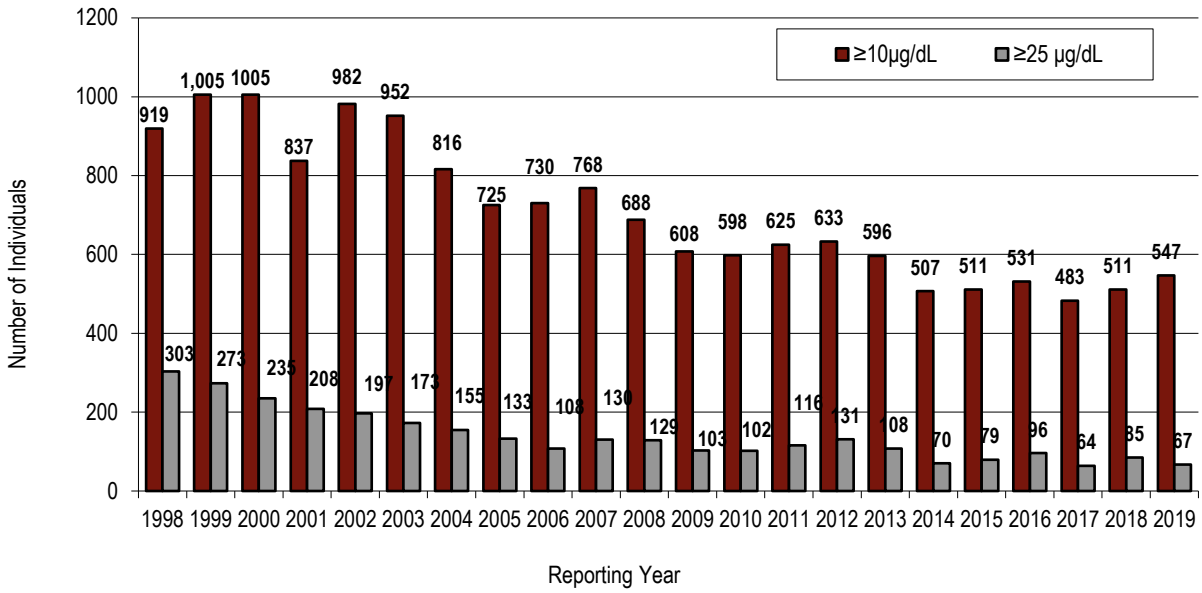
[c] In 2017-19, 5,786 BLL reports ≥5 µg/dL were received for 2,623 individuals.

[d] Percent of known exposures ≥10 µg/dL.

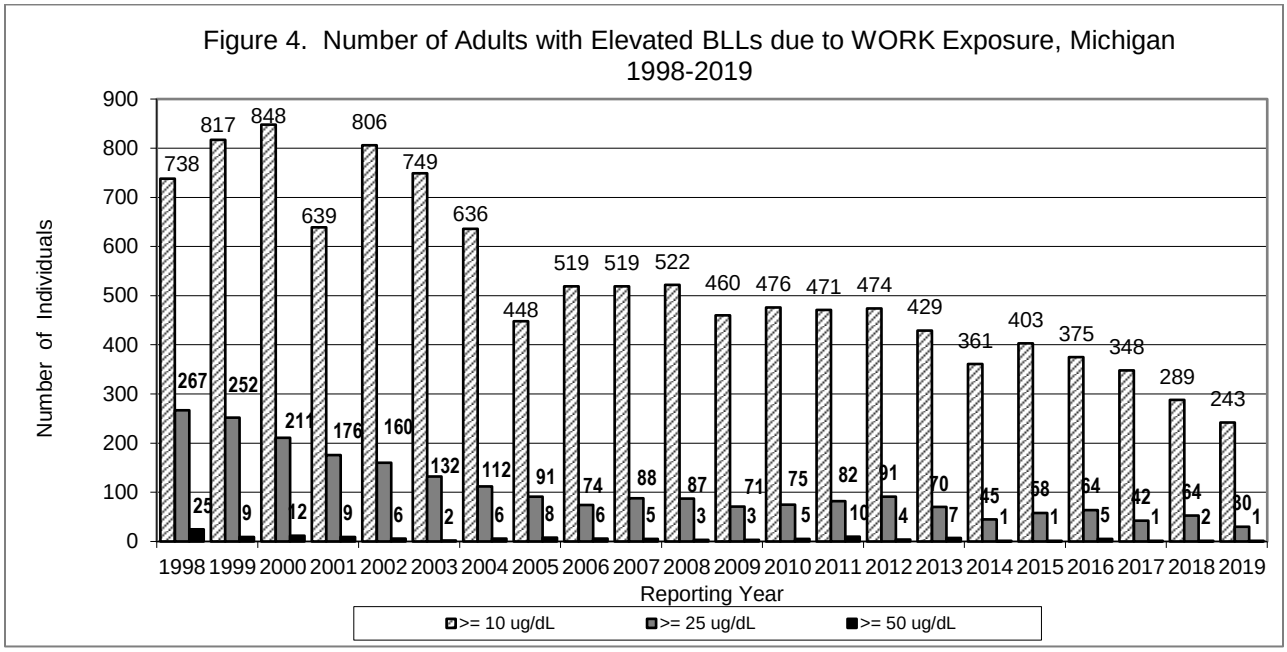
[e] Percent of known exposures ≥25 µg/dL.

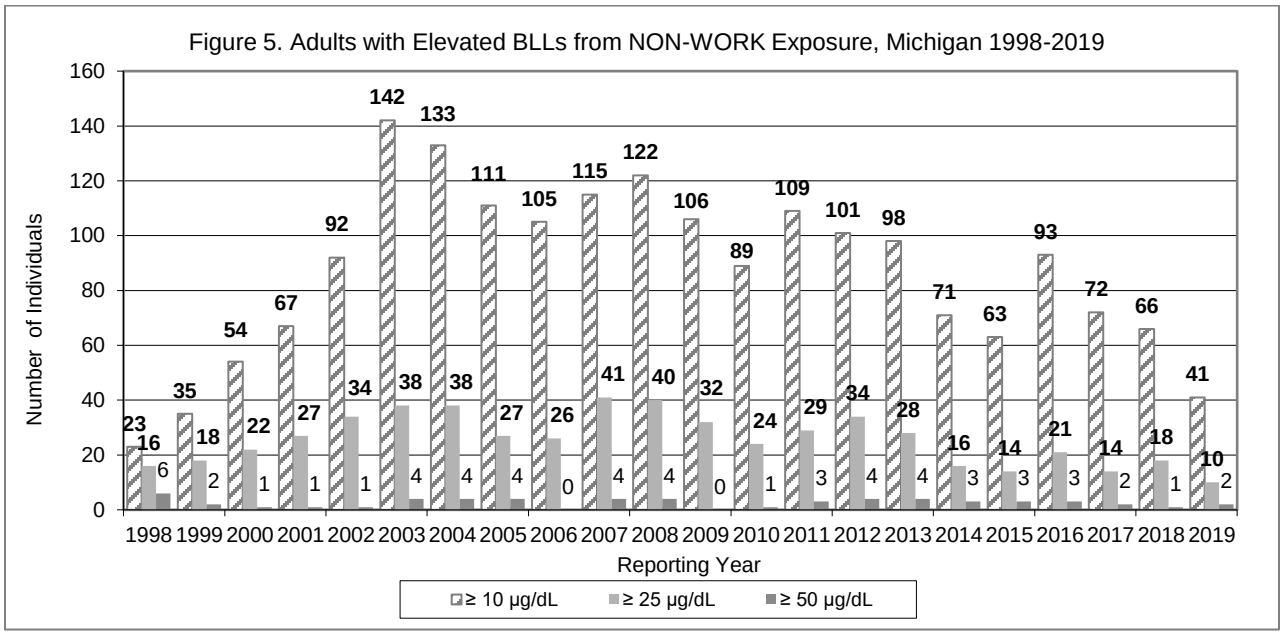
1998-2019 Trends: For twelve consecutive years, from 1999 to 2010, there was a downward trend for BLLs ≥10 µg/dL and BLLs ≥25 µg/dL from the previous year (Figure 3). In 2011 and 2012, the number of BLLs ≥10 µg/dL and ≥25 µg/dL increased, and in 2013 and 2014, the number dropped again. In 2015 and 2016, both BLLs ≥10 µg/dL and ≥25 µg/dL levels increased, and in 2017, the number dropped again. In 2018 and 2019 BLLs ≥10 µg/dL increased to 511 and 547, and BLLs ≥25 µg/dL increased to 85 in 2018 and decreased to 67 in 2019.

Figure 3. Number of Adult BLLs ≥10 µg/dL and ≥25 µg/dL, Michigan 1998-2019



There was a marked decline in the overall number of individuals with elevated blood lead from occupational exposure from 2000 to 2005, the number remained fairly stable from 2006 to 2012, then declined in 2013 and 2014, increased in 2015 and declined in 2016 through 2019 (Figure 4). For non-work exposures, elevated blood lead showed a decline from 2003 to 2006, a slight increase in 2007 and 2008, and then a slight change from 2009 to 2013, a more marked decrease in 2014 and 2015, an increase in 2016, and a decrease from 2017 to 2019 (Figure 5). If the source of exposure was unknown than the BLL was excluded from Figures 4 and 5. If the missing information on source of exposure was available than either or both work and non-work exposures would not show a decrease in recent years.





GENDER AND AGE: 2017-2019

Blood Lead Levels ≥5 µg/dL

Eighty-seven percent of the adults reported to ABLES were male, and thirteen percent were female (Table 2). The mean age was 46.6 and median age 46.2. The age distribution is shown in Table 3.

Table 2. Distribution of Gender among Adults Tested for BLLs in Michigan: 2017-2019

Gender	All Blood Lead Levels ≥5 µg/dL		All Blood Lead Levels ≥10 µg/dL		All Blood Lead Levels ≥25 µg/dL	
	Number	Percent	Number	Percent	Number	Percent
Male	2,273	86.7	1,026	91.1	154	91.1
Female	350	13.3	100	8.9	15	8.9
Total	2,623	100.0	1,126	100.0	169	100.0

Table 3. Distribution of Age Among Individuals Tested for Blood Lead in Michigan: 2017-2019

Age Range	Blood Lead Levels ≥5 µg/dL		Blood Lead Levels ≥10 µg/dL	
	Number	Percent	Number	Percent
16-19	49	1.9	18	1.6
20-29	428	16.3	189	16.8
30-39	537	20.5	240	21.3
40-49	517	19.7	239	21.2
50-59	520	19.8	211	18.7
60-69	367	14.0	154	13.7
70-79	153	5.8	67	6.0
80-89	45	1.7	8	0.7
90-99	7	0.3	0	-
Total	2,623	100.0	1,126	100.0

BLLs ≥10 µg/dL

For the 1,126 adults reported to the Registry with BLLs ≥10 µg/dL, 1,026 (91.1%) were men and 100 (8.9%) were women. The mean age was 45.9 and median age was 45.2.

RACE DISTRIBUTION

Blood Lead Levels ≥5 µg/dL

Although laboratories are required to report the patient's race, this information was frequently not provided. Race was missing for 1,573 (60.0%) of the 2,623 adults reported in 2017 through 2019. In the 1,050 reports where race was known, 842 (80.2%) were reported as Caucasian, 161 (15.3%) were reported as African American, 20 (1.9%) were reported as Native American, 11 (1.1%) were reported as Asian/Pacific Islander, and 16 (1.5%) were reported as Multiracial/Other (Table 4). Information on Hispanic ethnicity was missing for an even higher percentage, 2,290 (87.3%) of the adults.

Table 4. Distribution of Race among Adults Tested for Blood Lead in Michigan: 2017-2019

Race	All Blood Lead Levels ≥5 µg/dL		Blood Lead Levels ≥10 µg/dL	
	Number	Percent	Number	Percent
Caucasian	842	80.2	418	82.9
African American	161	15.3	60	11.9
Native American	20	1.9	10	2.0
Asian/Pacific Islander	11	1.1	4	0.8
Multiracial/Other	16	1.5	12	2.4
Total	1,050[a]	100.0	504[b]	100.0

[a] Race was unknown for 1,573 additional individuals.
[b] Race was unknown for 622 additional individuals.

BLLs ≥10 µg/dL

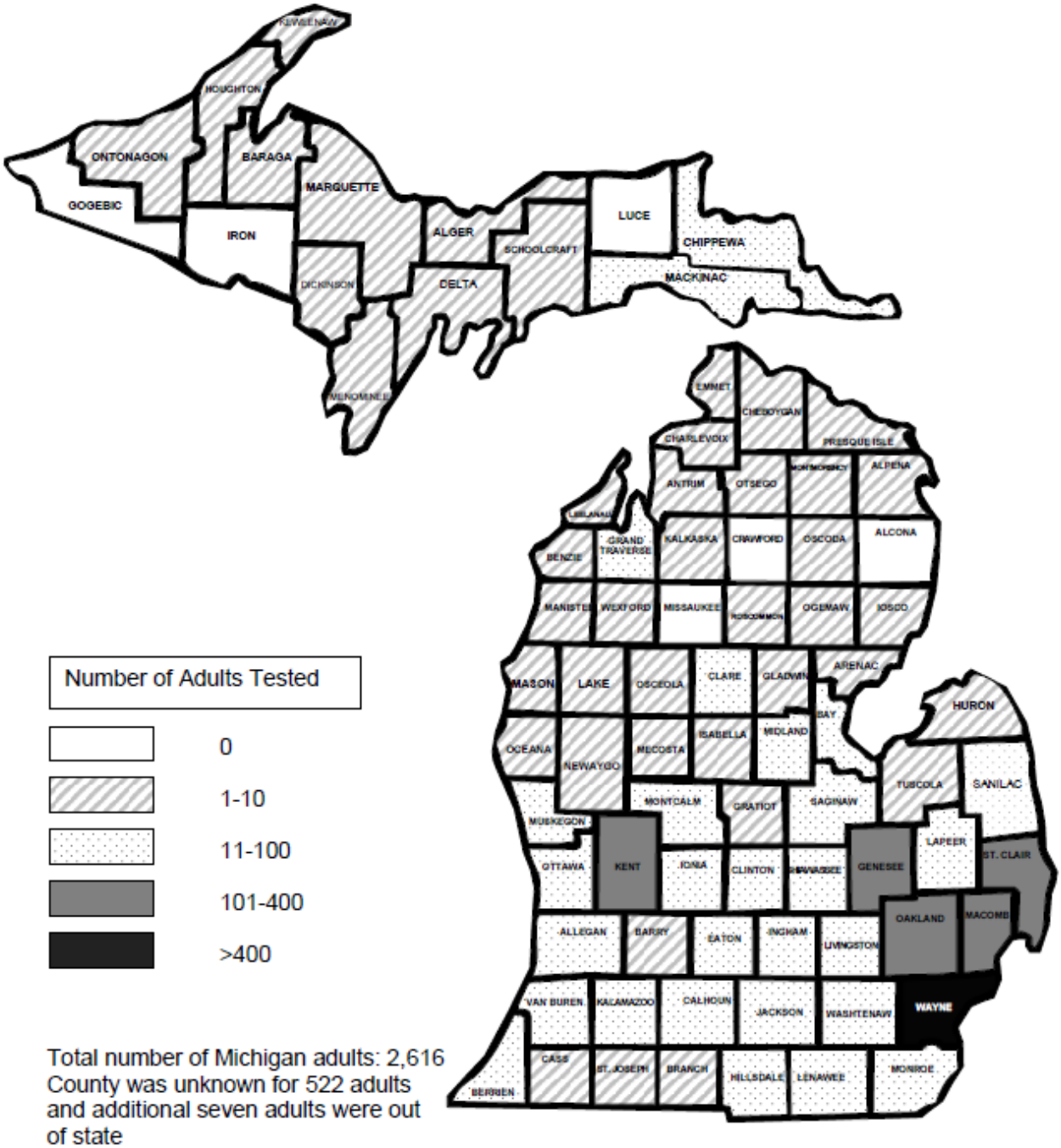
For adults with BLLs greater than or equal to 10 µg/dL where race was indicated, 418 (82.9%) were reported as Caucasian, 60 (11.9%) were reported as African American, 12 (2.4%) were reported as Multiracial/Other, 10 (2.03.6%) were reported as Native American, and four (0.8%) were reported as Asian/Pacific Islander (Table 4).

There were 43 individuals of Hispanic ethnicity with a blood lead ≥10 µg/dL.

GEOGRAPHIC DISTRIBUTION

County of residence was determined for 2,094 of the 2,623 adults reported to the Registry. They lived in 77 of Michigan's 83 counties. The largest number of adults tested in 2017 through 2019 lived in Wayne County (432, 20.6%), followed by Macomb County (174, 8.3%) and Saint Clair County (146, 7.0%). The county was unknown for 522 adults tested for blood lead (Figure 6 and Table 5).

Figure 6. Geographic Distribution of Adults Tested with BLLs ≥5 µg/dL In Michigan by County of Residence, 2017-2019



Total number of Michigan adults: 2,616
County was unknown for 522 adults and additional seven adults were out of state

Wayne and Macomb counties had the highest number of adults tested with 432 and 174 respectively.

Table 5. Number and Percent of Adults with Blood Lead Levels (BLLs) ≥5 µg/dL, BLLs ≥10 µg/dL and≥25 µg/dL by County of Residence and Percent of Adults with BLLs ≥10 µg/dL and ≥25 µg/dL among All Adults Tested for BLL in each County of Residence in Michigan: 2017-2019

	BLLs ≥5 µg/dL		BLLs ≥10 µg/dL			BLLs ≥25 µg/dL		
County	Number	Percent	Number	Percent of all BLLs in State	Percent of all BLLs in County	Number	Percent of all BLLs in State	Percent of all BLLs in County
Alcona	0	-	0	-	-	0	-	-
Alger	2	0.1	2	0.2	100.0	0	-	-
Allegan	29	1.4	14	1.6	48.3	2	1.6	6.9
Alpena	5	0.2	2	0.2	40.0	0	-	-
Antrim	3	0.1	0	-	-	0	-	-
Arenac	1	0.0	0	-	-	0	-	-
Baraga	2	0.1	0	-	-	0	-	-
Barry	8	0.4	5	0.6	62.5	0	-	-
Bay	13	0.6	2	0.2	15.4	0	-	-
Benzie	2	0.1	0	-	-	0	-	-
Berrien	38	1.8	20	2.3	52.6	3	2.3	7.9
Branch	5	0.2	3	0.3	60.0	0	-	-
Calhoun	23	1.1	12	1.4	52.2	1	0.8	4.3
Cass	4	0.2	2	0.0	0.0	0	-	-
Charlevoix	2	0.1	1	0.0	0.0	0	-	-
Cheboygan	3	0.1	1	0.1	33.3	0	-	-
Chippewa	21	1.0	9	1.0	42.9	2	1.6	9.5
Clare	28	1.3	17	1.9	60.7	3	2.3	10.7
Clinton	11	0.5	4	0.5	36.4	0	-	-
Crawford	0	-	0	-	-	0	-	-
Delta	3	0.1	1	0.1	33.3	1	0.8	33.3
Dickinson	2	0.1	1	0.1	50.0	1	0.8	50.0
Eaton	25	1.2	8	0.9	32.0	1	0.8	4.0
Emmet	5	0.2	3	0.3	60.0	1	0.8	20.0
Genesee	135	6.4	48	5.4	35.6	6	4.7	4.5
Gladwin	7	0.3	1	0.1	14.3	0	-	-
Gogebic	0	-	0	-	-	0	-	-
Grand Traverse	11	0.5	5	0.6	45.5	0	-	-
Gratiot	7	0.3	4	0.5	57.1	1	0.8	14.3
Hillsdale	15	0.7	4	0.5	26.7	0	-	-
Houghton	1	0.0	0	-	-	0	-	-
Huron	9	0.4	2	0.2	22.2	0	-	-
Ingham	48	2.3	15	1.7	31.3	1	0.8	2.1
Ionia	18	0.9	9	0.1	50.0	1	0.8	5.6
Iosco	3	0.1	0	-	-	0	-	-
Iron	0	-	0	-	-	0	-	-
Isabella	10	0.5	6	0.7	60.0	1	0.8	10.0
Jackson	15	0.7	6	0.7	40.0	2	1.6	13.3
Kalamazoo	65	3.1	31	3.5	47.7	4	3.1	6.2
Kalkaska	5	0.2	1	0.1	20.0	0	-	-
Kent	103	4.9	46	5.2	44.7	9	7.0	8.7
Keweenaw	2	0.1	2	0.0	-	1	0.8	50.0
Lake	1	0.0	0	-	-	0	-	-
Lapeer	17	0.8	5	0.6	29.4	1	0.8	5.9

Table 5 continued. Number and Percent of Adults with Blood Lead Levels (BLLs) ≥5 µg/dL, BLLs ≥10 µg/dL and ≥25 µg/dL by County of Residence and Percent of Adults with BLLs ≥10 µg/dL and ≥25 µg/dL among All Adults Tested for BLL in each County of Residence in Michigan: 2017-2019

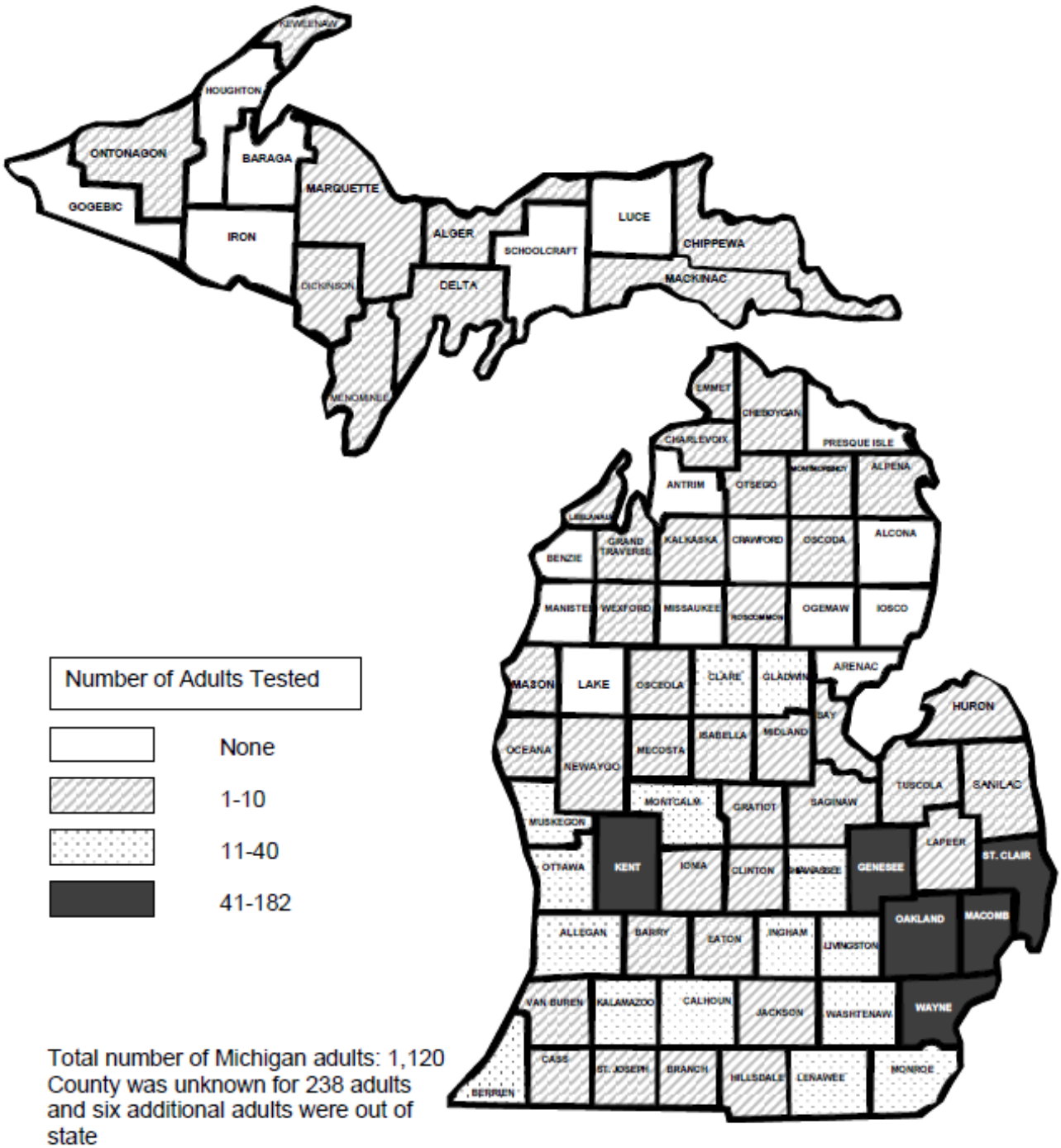
	BLLs >5 µg/dL		BLLs >10 µg/dL			BLLs >25 µg/dL		
County	Number	Percent	Number	Percent of all BLLs in State	Percent of all BLLs in County	Number	Percent of all BLLs in State	Percent of all BLLs in County
Leelanau	3	0.1	1	0.1	33.3	0	-	-
Lenawee	15	0.7	11	1.2	73.3	3	2.3	20.0
Livingston	28	1.3	12	1.4	42.9	2	1.6	7.1
Luce	0	-	0	-	-	0	-	-
Mackinac	11	0.5	5	0.6	45.5	1	0.8	9.1
Macomb	174	8.3	56	6.4	32.2	7	5.5	4.0
Manistee	6	0.3	0	-		0	-	-
Marquette	9	0.4	3	0.3	33.3	0	-	-
Mason	1	0.0	1	0.1	100.0	0	-	-
Mecosta	7	0.3	5	0.6	71.4	0	-	-
Menominee	1	0.0	1	0.1	100.0	0	-	-
Midland	18	0.9	8	0.9	44.4	0	-	-
Missaukee	0	0.0	0	-	-	0	-	-
Monroe	68	3.2	27	3.1	39.7	2	1.6	2.9
Montcalm	42	2.0	19	2.2	45.2	4	3.1	9.5
Montmorency	7	0.3	7	0.8	100.0	1	0.8	14.3
Muskegon	61	2.9	27	3.1	44.3	2	1.6	3.3
Newaygo	5	0.2	2	0.2	40.0	0	-	-
Oakland	137	6.5	68	7.7	49.6	13	10.2	9.5
Oceana	2	0.1	1	0.1	0.0	0	-	-
Ogemaw	2	0.1	0	-	-	0	-	-
Ontonagon	1	0.0	1	0.1	100.0	0	-	-
Osceola	4	0.2	1	0.0	0.0	0	-	-
Oscoda	1	0.0	1	0.1	100.0	1	0.8	100.0
Otsego	6	0.3	4	0.5	66.7	1	0.8	16.7
Ottawa	32	1.5	15	1.7	46.9	4	3.1	12.5
Presque Isle	1	0.0	0	-	-	0	-	-
Roscommon	7	0.3	3	0.3	42.9	0	-	-
Saginaw	28	1.3	8	0.9	28.6	0	-	-
Saint Clair	146	7.0	73	8.3	50.0	10	7.8	6.8
Saint Joseph	10	0.5	3	0.3	30.0	0	-	-
Sanilac	15	0.7	6	0.7	40.0	0	-	-
Schoolcraft	1	0.0	0	-	-	0	-	-
Shiawassee	18	0.9	12	1.4	66.7	2	1.6	11.1
Tuscola	7	0.3	3	0.3	42.9	0	-	-
Van Buren	11	0.5	5	0.6	45.5	0	-	-
Washtenaw	63	3.0	16	1.8	25.4	4	3.1	6.3
Wayne	432	20.6	182	20.7	42.1	28	21.9	6.5
Wexford	7	0.3	3	0.3	0.0	1	0.8	14.3
TOTAL	**2,094[a]**	100.0	**882[b]**	100.0	42.1	**128[c]**	100.0	6.1

[a] County was unknown for 522 additional adults and 7 lived out of state.

[b] County was unknown for 238 additional adults and 6 lived out of state.

[c] County was unknown for 39 adults and 2 lived out of state.

Figure 7. Geographic Distribution of Adults Tested with BLLs ≥10 µg/dL In Michigan by County of Residence, 2017-2019



Total number of Michigan adults: 1,120
County was unknown for 238 adults and six additional adults were out of state

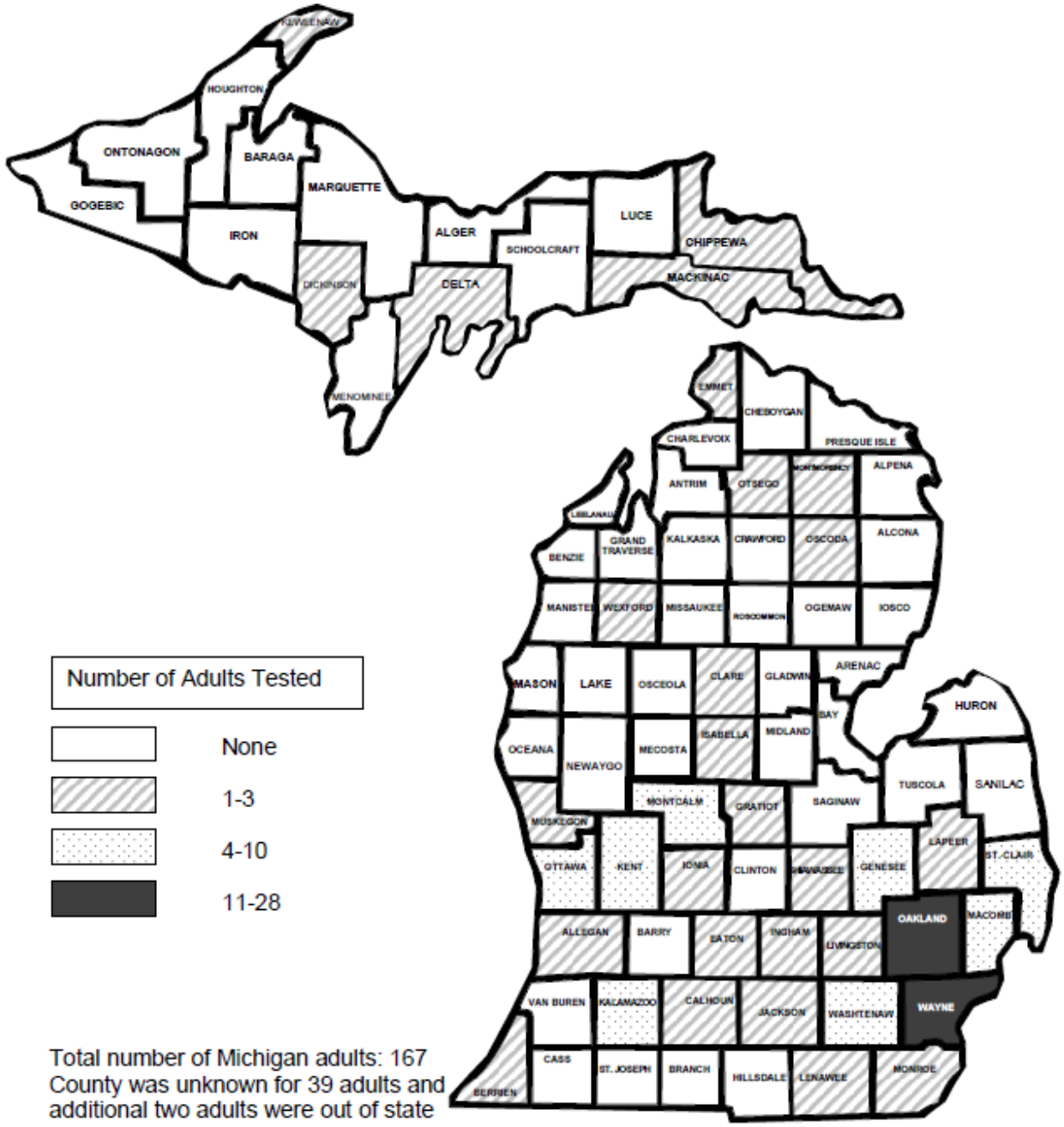
Wayne and Saint Clair counties had the largest number of adults with BLLs ≥10 µg/dL, with 182 and 73, respectively

Figure 7 and Table 5 show the county of residence of the 882 adults with BLLs ≥10 µg/dL where county of residence could be determined. The largest number of adults reported with a BLL ≥10 µg/dL were from Wayne County (182, 20.6%), followed by Saint Clair County (73, 8.3%) and Oakland County (68, 7.7%). The county was unknown for 238 adults with BLLs ≥10 µg/dL. Six lived outside of Michigan.

Figure 8 and Table 5 show the county of residence for the 128 adults with BLLs ≥25 µg/dL where county of residence could be determined. The largest number of adults reported with a BLL ≥25 µg/dL were from Wayne County (28, 21.9%), followed by Oakland County (13, 10.2%), and Saint Clair County (10, 7.8%). The county was unknown for 39 adults with BLLs ≥25 µg/dL. Two lived outside of Michigan.

Table 5 shows the percentage of tested adults in each county with BLLs ≥5 µg/dL, ≥10 µg/dL and BLLs ≥25 µg/dL. Wayne (20.6%), Macomb (8.3%), and Saint Clair (7.0%) counties had the highest percentages of adults with BLL ≥5 µg/dL within their respective counties. Alger, Menominee, Mason, Montmorency, Ontonagon and Oscoda (each 100%) counties had the highest percentages of adults with BLL ≥10 µg/dL within their respective counties. Oscoda (100%), Dickinson (50%) and Keweenaw (50%) counties had the highest percentage of tested adults with BLL ≥25 µg/dL.

Figure 8. Geographic Distribution of Adults Tested with BLLs ≥25 µg/dL In Michigan by County of Residence, 2017-2019



Total number of Michigan adults: 167
County was unknown for 39 adults and additional two adults were out of state

Wayne and Oakland counties had the largest number of adults with BLLs ≥25 µg/dL, with 28 and 13, respectively.

GENDER DISTRIBUTION

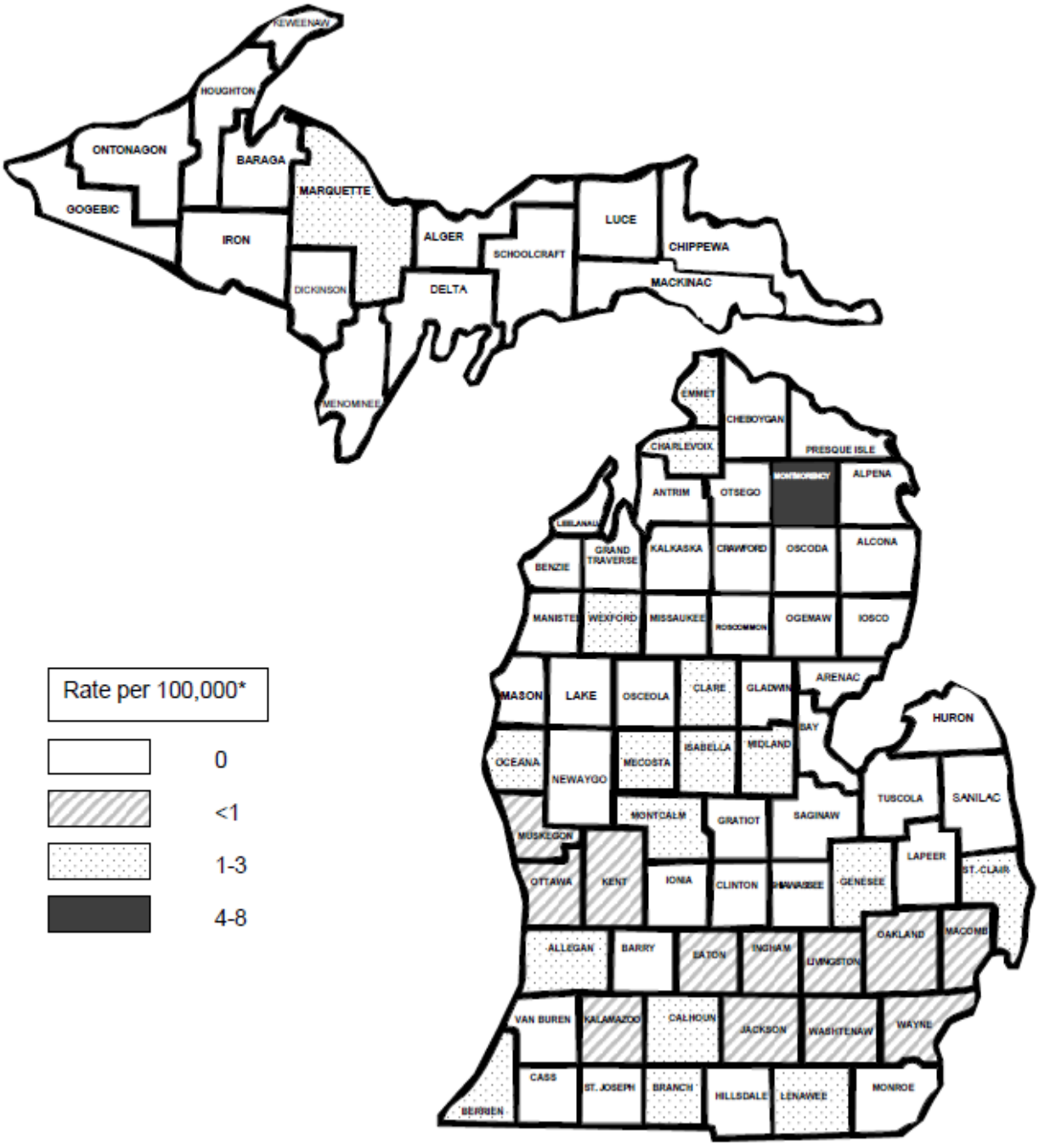
Women: Figure 9 and Table 6 show the incidence rates of BLL ≥10 µg/dL by county for women. There were 83 women reported in 2017 through 2019 with a BLL ≥10 µg/dL, where county was known. County of residence was unknown for an additional sixteen women; one woman was from out of state. Montmorency (8.4/100,000), Clare (5.2/100,000), and Oceana (3.2/100,000), had the three highest incidence rates.

Twenty-six women (61.9%) with elevated blood lead were exposed at work: seven at a finish carpentry contractor, four at an automotive stamping, three at copper rolling, drawing and extruding establishment, one at police work, one at rolled steel shape manufacturer, one at motor vehicle metal stamping, one at an industrial painting company, one at a waste management services, one at a storage battery manufacturer, one at a painting and wall covering contractor, one at a gun range, one at a remediation services, one at a non-ferrous foundry, one was self-employed doing stained glass and historic building restoration and one individual with an unknown work exposure.

Sixteen women (38.1%) with elevated blood leads had non-work exposures: four from a gunshot wound, three from firearms, two presumed from drinking water, one from home remodeling, one from food (e.g. spice), one from leather tooling, one from making stained glass, one from lead dust from a home boiler explosion, one from non-firearm hobby, and one from take home exposure.

The source of exposure was unknown for fifty-eight of the 100 women.

Figure 9. Annual Incidence of BLLs ≥10 µg/dL Among Women By County of Residence, Michigan 2017-2019



*Denominator for Rate per 100,000 women age 16+ was from U.S. Census Bureau of County Resident Population, Annual Estimate for July 1, 2019

Table 6. Number and Rate of BLLs ≥10 µg/dL among Women in Michigan by County of Residence: 2017-2019

County	Number Reported	Michigan Population Women	Rate[c]
Allegan	2	46,881	1.4
Berrien	1	63,981	0.5
Branch	1	16,625	2.0
Calhoun	3	55,366	1.8
Charlevoix	1	11,116	3.0
Clare	2	12,785	5.2
Eaton	1	46,387	0.7
Emmett	1	14285	2.3
Genesee	7	171,138	1.4
Ingham	2	124,930	0.5
Isabella	1	30,613	1.1
Jackson	1	63,017	0.5
Kalamazoo	2	110,684	0.6
Kent	7	264,932	0.9
Lenawee	2	40,068	1.7
Livingston	1	78,933	0.4
Macomb	6	370,305	0.5
Marquette	1	27,931	1.2
Mecosta	1	18,185	1.8
Midland	1	34,478	1.0
Montcalm	1	24,777	1.3
Montmorency	1	3,992	8.4
Muskegon	1	70,325	0.5
Oakland	6	529,476	0.4
Oceana	1	10,540	3.2
Ottawa	2	117,677	0.6
Saint Clair	4	66,246	2.0
Washtenaw	2	156,228	0.4
Wayne	20	728,065	0.9
Wexford	1	13,376	2.5
Total	83[a]	4,145,351[b]	0.7

[a]County was unknown for additional 16 women, one was out of state.

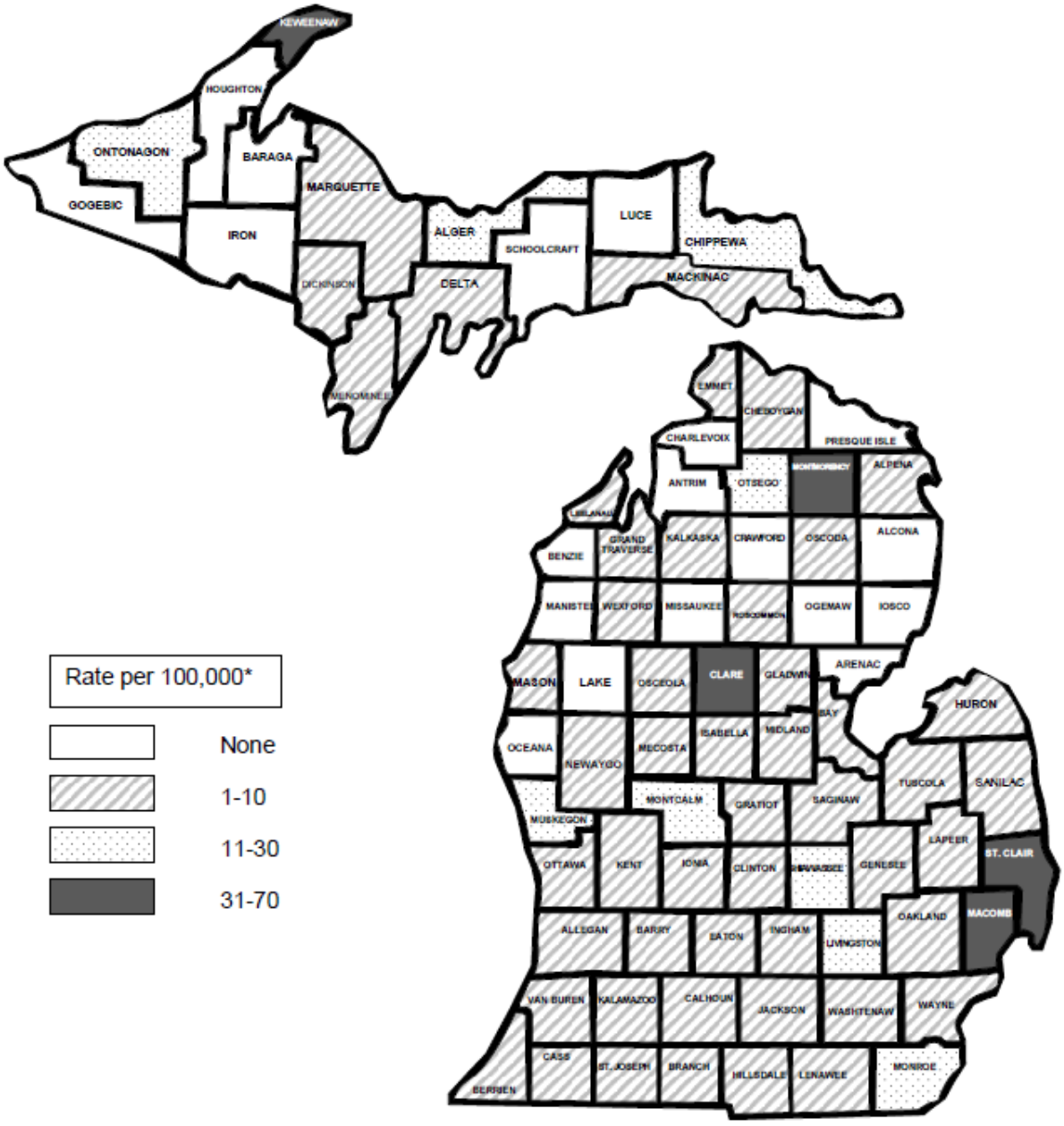
[b]Total number of women in all 83 counties of Michigan age 16+ years; 7/1/2019 County Characteristics Resident Population Estimates, U.S. Census Bureau.

[c]Rate per 100,000 women, age 16+ years.

Men: Figure 10 and Table 7 show the incidence rates of BLL of ≥10 µg/dL and above by county for men. There were 800 men reported in 2017 through 2019 with a BLL ≥10 µg/dL where county of residence could be determined. Keweenaw (70.1/100,000),

Montmorency (48.2/100,000), and Clare (39.4/100,000) had the highest incidence rates per 100,000 men based on the 2019 County Characteristics Resident Population Estimates from the U.S. Census Bureau. The overall incidence rate for men was 6 times higher than that for women (6.7/100,000 vs. 0.7/100,000) in 2017 through 2019.

Figure 10. Annual Incidence of BLLs ≥10 µg/dL Among Men by County of Residence, Michigan 2017-2019



*Denominator for Rate per 100,000 men age 16+ was from U.S. Census Bureau of County Resident Population, Annual Estimate for July 1, 2019

Table 7. Number and Rate of BLLs ≥10 µg/dL among Men by County of Residence: Michigan 2017-2019

County	Number Reported	Michigan Population Men	Rate[c]	County	Number Reported	Michigan Population Men	Rate[c]
Alcona	0	4,679	-	Lake	0	5,098	-
Alger	2	4,449	15.0	Lapeer	5	36,536	4.6
Allegan	12	46,268	8.6	Leelanau	1	9,172	3.6
Alpena	2	11,677	5.7	Lenawee	9	40,494	7.4
Antrim	0	9,791	-	Livingston	11	78,394	4.7
Arenac	0	6,317	-	Luce	0	3,242	-
Baraga	0	3,916	-	Mackinac	5	4,740	35.2
Barry	5	24,961	6.7	Macomb	50	344,027	4.8
Bay	2	41,430	1.6	Manistee	0	10,891	-
Benzie	0	7,439	-	Marquette	2	28,240	2.4
Berrien	19	60,080	10.5	Mason	1	11,733	2.8
Branch	2	18,049	3.7	Mecosta	4	18,240	7.3
Calhoun	9	51,920	5.8	Menominee	1	9,747	3.4
Cass	2	21,126	3.2	Midland	7	33,221	7.0
Charlevoix	0	10,824	-	Missaukee	0	6,080	-
Cheboygan	1	10,793	3.1	Monroe	27	60,171	15.0
Chippewa	9	17,694	17.0	Montcalm	18	26,693	22.5
Clare	15	12,702	39.4	Montmorency	6	4,147	48.2
Clinton	4	31,446	4.2	Muskegon	26	68,118	12.7
Crawford	0	5,998	-	Newaygo	2	19,781	3.4
Delta	1	14,629	2.3	Oakland	62	500,261	4.1
Dickinson	1	10,382	3.2	Oceana	0	10,704	-
Eaton	7	43,974	5.3	Ogemaw	0	8,731	-
Emmet	2	13,668	4.9	Ontonagon	1	2,597	12.8
Genesee	41	154,949	8.8	Osceola	1	9,453	3.5
Gladwin	1	10,651	3.1	Oscoda	1	3,477	9.6
Gogebic	0	6,031	-	Otsego	4	9,954	13.4
Grand Traverse	5	37,093	4.5	Ottawa	13	112,767	3.8
Gratiot	4	18,373	7.3	Presque Isle	0	5,416	-
Hillsdale	4	18,349	7.3	Roscommon	3	10,430	9.6
Houghton	0	15,953	-	Saginaw	8	74,125	3.6
Huron	2	12,719	5.2	Saint Clair	69	64,468	35.7
Ingham	13	116,413	3.7	Saint Joseph	3	23,746	4.2
Ionia	9	28,450	10.5	Sanilac	6	16,619	12.0
Iosco	0	10,585	-	Schoolcraft	0	3,372	-
Iron	0	4,728	-	Shiawassee	12	27,459	14.6
Isabella	5	28,503	5.8	Tuscola	3	21,501	4.7
Jackson	5	65,674	2.5	Van Buren	5	29,678	5.6
Kalamazoo	29	103,808	9.3	Washtenaw	14	151,733	3.1
Kalkaska	1	7,546	4.4	Wayne	162	655,590	8.2
Kent	39	252,374	5.2	Wexford	2	13,358	5.0
Keweenaw	2	951	70.1	Total	799[a]	3,951,566	6.7

[a] County was unknown for additional 222 male adults; 5 were out of state residents.

[b] Total number of men in all 83 counties of Michigan age 16+ years; 7/1/2019 County Characteristics Resident Population Estimates, U.S. Census Bureau.

[c] Rate per 100,000 men, age 16+ years.

SOURCE OF EXPOSURE

For 585 (84.1%) individuals with BLLs ≥10 µg/dL, work was the identified source, and for 111 (15.9%) individuals, non-occupational activities were identified as the source of exposure (Table 8). Two sources of exposure predominated for the 111 non-occupationally exposed individuals with BLLs ≥10 µg/dL. Seventy (63.1%) individuals were exposed from a hobby related to guns and eighteen (16.2%) were exposed due to a retained bullet fragment. Six (5.4%) individuals were presumed exposed to lead in drinking water (five because they lived in Flint Area-Zip Codes 48501-48507 and one lived in Zip Code: 49686 and their provider presumed water to be the source of exposure) and reported no other source of lead exposure. For an additional 385 individuals, source of exposure was still being investigated. For 45, the source was still unknown after an interview with the individual or review of medical records.

Table 8. Source of Exposure among Adults with BLLs ≥10 µg/dL: Michigan 2017-2019

Exposure Source Description	Number	Percent	Percent Non-Work
Work-Related	585	84.1	
Hobby: Firearms, Reloading, Casting	70	10.1	63.1
Gun Shot Wound	18	2.6	16.2
Drinking Water	6	0.9	5.4
Remodeling	3	0.4	2.7
Stained Glass	3	0.4	2.7
Environment	2	0.3	1.8
Other, Not Work	2	0.3	1.8
Food, Pottery, Ceramics	1	0.1	0.9
Hobby: Other	3	0.4	2.7
Hobby: Unknown	3	0.4	2.7
Total	696[a]	100.0	100.0

[a] For 36 additional adults, source was pending an interview and for 349 we are waiting for receipt of medical records; for 45 additional adults, source was inconclusive, and no patient interview was possible.

Table 9 shows the occupational sources of lead for individuals reported in 2017 through 2019. The most frequent reports were on individuals in the manufacturing (36.9%) and construction sector (21.8%).

Table 9. Industry Source of Exposure among Adults with BLLs ≥10 µg/dL: Michigan 2017-2019

NORA Sector Group[a]	NAICS Code[b]	Number	Percent
Agriculture, Forestry & Fishing (except Wildland Firefighting)	11	0	–
Construction	23	92	22.7
Healthcare & Social Assistance	62, 54194, 81291	5	1.2
Manufacturing	31-33	154	37.9
Mining (except Oil & Gas Services)	21	0	–
Oil & Gas Extraction	211, 213111, 213112	0	–
Public Safety (including Wildland Firefighting)	92212, 92214, 92216, 62191	0	–
Services (except Public Safety)	51, 52, 53, 54, 55, 56, 61, 71, 72, 81, 92	64	15.8
Transportation, Warehousing & Utilities	48-49, 22	53	13.0
Wholesale & Retail Trade	42, 44-45	38	9.4
Total		406[c]	100.0

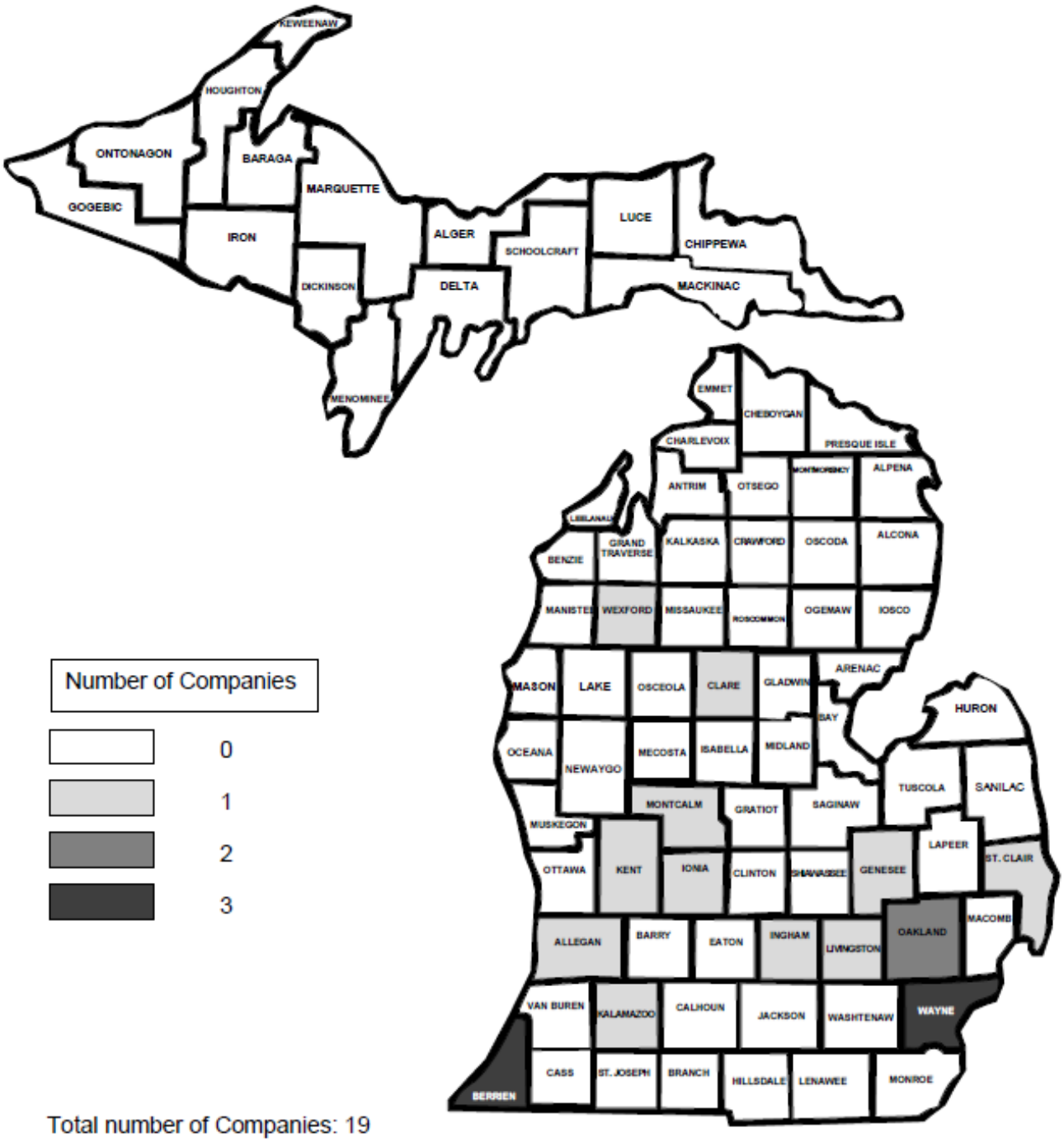
[a] National Occupational Research Agenda (NORA).
[b] North American Industry Classification System (NAICS).
[c] Another 179 were work-related; however, the industry was unknown.

Figure 11 shows the geographic distribution of the nineteen non-construction companies that reported at least one adult with a BLL of ≥25 µg/dL in Michigan during 2017 and 2019. In addition, there were two out-of-state companies and one company for which an address could not be determined due to multiple locations. These 22 companies included primary metal industries, fabricated metal products, an automotive stampings establishment, a storage battery manufacturer, electric services, remediation services, a recyclable material wholesaler, a battery wholesaler, a sporting goods store, a non-ferrous copper foundry, an industrial machinery and equipment manufacturer, a fitness and recreational sports center, and firing ranges.

Two hundred and twenty-seven (38.8%) of the 585 individuals with a blood lead ≥10 µg/dL where exposure occurred at work, and 51 (52.8%) of the 97 individuals with a blood lead ≥25 µg/dL were from these 22 companies.

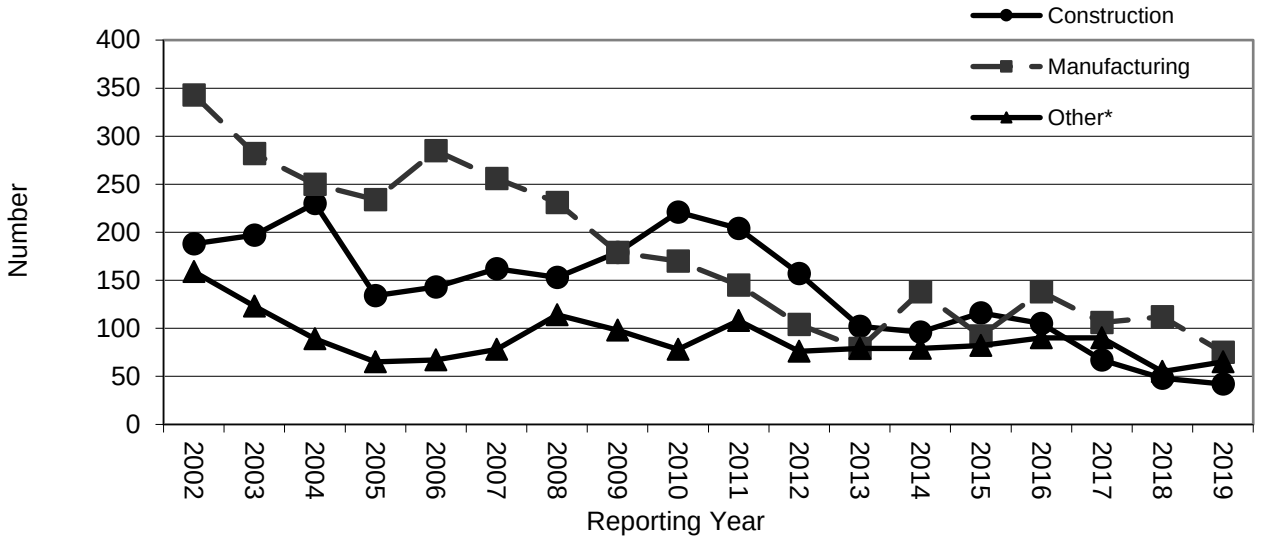
The recent elevated BLLs have generally been decreasing since 2002 in all sectors (Figure 12). Some of this reduction is due to improvements in workplace controls. Manufacturing sector had the highest number of individuals with elevated BLLs in 2017 through 2019.The “Other” sector, which includes public utilities, police and public firing ranges, was a more frequent source of lead exposure than the Construction sector.

Figure 11. Geographic Distribution of Non-Construction Companies Reporting Adult BLLs ≥25 µg/dL In Michigan, 2017-2019



Total number of Companies: 19

Figure 12. Number of Individuals with BLLs ≥ 10 µg/dL by Industry Where Exposed to Lead, Michigan 2002-2019



*Includes public utilities, police and retail firing ranges

BLOOD LEAD TESTING IN FLINT

In April of 2014, the City of Flint switched its source of drinking water, resulting in release of lead from water service lines into the drinking water. Although the increased exposure to lead in Flint drinking water began in April 2014, concern about lead exposure did not become widespread until the fall of 2015. The data for 2014 showed a decrease in the overall number of adults tested for lead and the number of elevated blood lead levels from previous years for Genesee County. Part of the reduction in 2014 in the number of elevated blood lead levels in adults in Genesee County was the reduction from three to one in the number of companies in Genesee County where workers were exposed to lead. Beginning in late 2015 and continuing in 2016, the number of adults being tested in Michigan for lead markedly increased, particularly in Flint residents (Figure 13). This was associated with a public health campaign to have everyone in Flint, regardless of age, tested for lead. Table 10 shows the numbers of individuals in the seven Flint zip codes (48501-48507) where most residents were on municipal drinking water, by blood lead level and source of exposure. Source of exposure was identified based on information reported by the laboratory (primarily related to work exposure) and interviews of individuals with elevated blood lead levels.

Figure 13. Adults with Blood Lead Test ≥ 5 µg/dL in the Genesee County and Flint-Area Zip Codes 48501-48507, Michigan 2014-2019

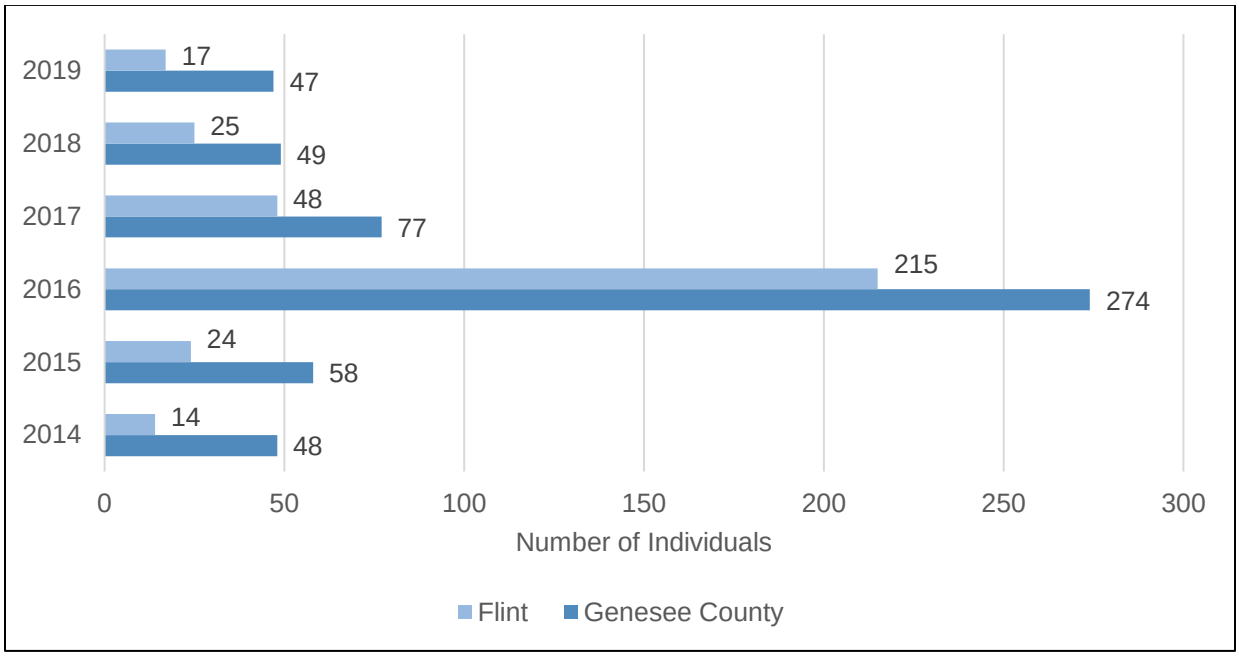


Table 10. Adults with Blood Lead Tests in Flint-Area Zip Codes 48501-48507 Michigan 2017-2019

: Blood Lead Level	Number of Individuals	Source of Exposure		
		Work	Non-Work	Unknown
≥5 µg/dL	74	15	33	26
5-9 µg/dL	*51*	*8*	*25*[a]	*18*
10-24 µg/dL	*21*	*7*	*6*[b]	*8*
≥25 µg/dL	*2*	*0*	*2*[c]	*0*
Total	74	15	33	26

[a] 14: drinking water; 6 gunshot wound; 2: remodeling; 1: firearms; 1: environment; 1: unknown, not work
[b] 4: drinking water; 2: gunshot wound
[c] 1: drinking water; 1: gunshot wound

SUMMARY OF INDUSTRIAL HYGIENE INSPECTIONS CONDUCTED FOR BLOOD LEAD LEVELS ≥ 25 µg/dL, 2017-2019

The MIOSHA General Industry Safety and Health Division (GISHD) conducted eight inspections: a recyclable material merchant wholesaler, a copper rolling, drawing and extruding manufacturer, a fitness and recreational sports center, an industrial machinery and equipment wholesaler, a storage battery manufacturer, a gun range, a nonferrous

metal foundry, a fabricated structural metal manufacturer. One GISHD inspection at a rolled steel shape manufacturer, which was completed in 2016 but was not included in the 2015-2016 report is reported in this report.

1) Recyclable Material Wholesaler

The first GISHD inspection completed in 2017 was initiated because an employee at a recyclable material wholesaler had a BLL of 27 µg/dL.

The company was cited for one Serious lead violation: It was determined that an employee during facility recycling operations involving lead-sheathed cables was exposed to an airborne concentration of lead in excess of the eight-hour, action level of 0.030 mg/m^3 of air. Though initial monitoring had been conducted in 2013 to characterize employee lead exposures during similar work operations, additional monitoring to characterize each employee's lead exposure was not conducted after the process was modified from that utilizing a rotating blade to that of a fixed, stationary knife.

2) Copper Rolling, Drawing and Extruding Manufacturer

The second GISHD inspection completed in 2018 was initiated because eleven employees at a copper rolling, drawing and extruding manufacturer had BLLs of 21-40 µg/dL, with six workers with BLLs ≥25 µg/dL.

The company was cited for five lead violations (four Serious and one Other-than-Serious) and one Other-than-Serious non-lead violation: 1) Table surfaces in the maintenance conference room, where employees consumed food, were not maintained in a manner that kept them as free as practicable from accumulation of lead on the surface. Areas in the casting locker room were also not kept clean as practicable; 2) Wipe samples taken by MIOSHA Industrial Hygienists in the change room for casting employees found elevated levels of contamination on surfaces of which the employees were exposed; 3) Separate storage or locker facilities were not provided. Employees who worked in the casting area were exposed to lead contamination and were not provided with separate locker facilities for work clothing and street clothing. The changing room used both for dirty and clean clothes were the same and was contaminated with lead; 4) Employees that were utilizing the maintenance breakroom for an eating area were not properly trained to recognize the hazards associated with lead including cleaning and washing before eating if exposed to contaminated areas. Wipe samples taken by MIOSHA showed multiple areas of elevated surface contamination; 5) MIOSHA determined on May 8, 2018 and on July 19, 2018, that furnace operators and casting department employees were exposed to copper and zinc fumes, and total particulates, above the time-weighted average permissible exposure limits; 6) MIOSHA determined on May 8, 2018, and on July 19, 2018, that furnace operators and casting department employees were exposed to lead TWA > than 50 ug/m^3.

3) Fitness and Recreational Sports Center

The third GISHD inspection completed in 2018 was initiated because an employee at a fitness and recreational sports center had a BLL of 31 µg/dL.

The company was cited for four Serious lead violations and two Serious non-lead violations: 1) There was no initial determination for employees working with and around lead containing materials; 2) Employees who had potential exposure to lead were not

informed of the contents of Appendices A and B to 29 C.F.R. §1910.1025 'Lead'; 3) A copy of these rules and their appendices were not readily available to all affected employees; 4) Lead was not addressed in the hazard communication program. Employees were potentially exposed to lead while working with firearms and ammunition; 5) Employees were exposed to chemicals while cleaning and maintaining guns. The following elements of the hazard communication program were missing: a) No written program; b) No employee training; Once the program has been developed employees would need to be trained on its contents; 6) The following elements of the respiratory protection program were missing: a) No written program; b) No medical evaluation; 3) No training on respirator use.

4) Industrial Machinery and Equipment Wholesaler

The fourth GISHD inspection completed in 2018 was initiated because an employee at an industrial machinery and equipment wholesaler had a BLL of 29 µg/dL.

The company was cited for three Serious lead violations, one Repeat-Serious lead violation, one Other-than-Serious lead violation, one Other-than-Serious non-lead violation: 1) Employees were exposed to lead in excess of the permissible exposure limit (PEL) in a regulated area. Engineering and administrative work practice controls had not been investigated or implemented to reduce exposures to the lowest feasible level; 2) The ventilation system in the regulated area had not been assessed for effectiveness at least quarterly as required. Employees working in the regulated area were exposed to lead in excess of the PEL more than thirty days in a year; 3) Employees were provided cilantro oil and instructed to put a few drops of the oil in their drinks daily to reduce the accumulation of lead in the body. Employees were exposed to lead above the PEL when working in the battery shredding area; 4) The respiratory protection program developed was not adequately implemented at the facility. Employees in the battery shredding area did not have a fit test or training within the previous 12 calendar months. Employee exposure to lead exceeded the PEL. *The company was previously cited for a violation of this occupational safety and health standard in 2014*; 5) The written lead program had not been reviewed and updated annually as required. The last review date was 2014; 6) Employees, who wore full face air purifying respirators were exposed to concentrations of lead in excess of 10 times the PEL, required quantitative fit testing.

5) Storage Battery Manufacturer

The fifth GISHD inspection completed in 2018 was initiated because an employee at a storage battery manufacturer had a BLL of 30 µg/dL.

The company was cited for eight Serious lead violations: 1) The employees performing mixing and pasting operations were exposed to an airborne concentration of lead in excess of the eight-hour PEL of 50 µg/m3. The operator in the mix room was exposed to an eight-hour TWA exposure of 1,203 µg/m^3. The pasting tech in the pasting room was exposed to an eight-hour TWA of 357 µg/m^3. The operator in the pasting room was exposed to an eight hour TWA of 258 µg/m^3; 2) Although the employees utilized respirators which were selected for the hazards presented by the work operation, such use was not in accordance with Occupational Health Standard Part 451 "Respiratory Protection", as evidenced by the following: a) The use of inadequate respiratory protection during the work operation where employee exposures exceeded the PEL for lead; b) A

site specific written respiratory protection program had neither been developed nor implemented, as evidenced by the following deficiencies: no written program, no respirator program administrator, medical questionnaires not provided for all required users, no physician's written opinions, and inadequate storage of respirators; 3) A written compliance program to reduce employee lead exposures to at or below PEL was not developed or implemented as evidenced by the following: employee exposure monitoring was not conducted at proper time intervals, no ventilation measurements taken, adequate respiratory protection was not provided, employees not showering prior to leaving the workplace and medical exams not offered; 4) The existing lead warning signs did not contain all of the information necessary for such posting [i.e., the signs did not include the following: 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]; 5) A written hazard communication program and the required elements of a program had not been developed, implemented or maintained. There was no written hazard communication program and hazard communication training had not been provided to employees; 6) Employees were not trained or informed of the contents of Appendices A and B to 29 C.F.R. §1910.1025 'Lead'; 7) Although showers were provided, the employees did not shower and were not required to shower prior to leaving the workplace; 8) Prior to the employees' assignment to these work areas where lead exposures were in excess of the action level of 30 µg/m^3, these employees were not provided an initial medical examination.

6) Gun Range

The sixth GISHD inspection completed in 2018 was initiated because an employee at a gun range had a BLL of 40 µg/dL.

The company was cited for three Repeat-Serious violations: 1) Wipe sample results indicated 100 µg lead/100 cm^2, on the surface of the kitchen counter in front of the microwave used by employees. *The range was previously cited for a violation of this occupational safety and health standard or its equivalent standard Part 310, Lead in General Industry, Rule 25, which was contained in MIOSHA inspection in 2016. The range was also previously cited for a violation of this occupational safety and health standard Part 310, Lead in General Industry, Rule 25, which was contained in MIOSHA inspection in 2013. The range was also previously cited for a violation of this occupational safety and health standard Part 310, Lead in General Industry, Rule 25, which was contained in MIOSHA inspection in 2011;* 2) A range attendant, performing range cleaning, was exposed to lead at a concentration of more than 50 µg/m^3. The eight-hour TWA exposure was 437 µg/m^3; this exposure included range cleaning but also included entering the range throughout the shift. *The range was previously cited for a violation of this occupational safety and health standard or its equivalent standard Part 310, Lead in General Industry, Rule 3, which was contained in MIOSHA inspection in 2016. The range was also previously cited for a violation of this occupational safety and health standard or its equivalent standard Part 310, Lead in General Industry, Rule 3, which was contained in MIOSHA inspection in 2011;* 3) An employee's blood lead level resulted in 10µg/100g of whole blood on 1/24/2018. This employee's blood was not tested again until 6/14/2018. *The range was previously cited for a violation of this occupational safety and health*

standard or its equivalent standard Part 310, Lead in General Industry, Rule 33, which was contained in MIOSHA inspection in 2011.

7) Nonferrous Metal Foundry

The seventh GISHD inspection completed in 2018 was initiated because an employee at a nonferrous metal foundry (except die-casting) had a BLL of 25 µg/dL.

The foundry was a small family owned non-ferrous jobbing foundry founded in the 1940s. Molds were fabricated from green sand, air-set and Petro-bond. The foundry poured a variety of non-ferrous metal alloys including aluminum, brass and bronze. The most common alloys poured by the foundry included: 80 & 85 red brass, no lead brass and aluminum. Brass was melted using an induction furnace, whereas the aluminum was melted using a natural gas furnace. Foundry cores were made onsite using a semi-automated core machine that utilized resin coated sand.

The employee with the high (593 ug/m^3) exposure worked as a grinder in the grinding department. His job consisted of using a 36-grit belt grinder to remove casting imperfections (sprue and gate marks) from brass and aluminum castings. The equipment used in the grinding department (Shotblast, band saw and belt grinders) were all equipped with local exhaust ventilation.

The foundry was cited for three Serious lead violations and one Serious non-lead violation: 1) An employee was exposed to an airborne concentration of lead in excess of the nine-hour adjusted PEL of 44 µg/m^3 while working in the cutoff/grinding area of the foundry. Though respiratory protection, 3M half-face 6200 series equipped with 3M P100 filter cartridges, was utilized during monitoring event, the employee's lead exposure exceeded the assigned protection factor of the respirator; 2) An employee was exposed to an airborne concentration of lead [593 µg/m^3] in excess of the nine-hour adjusted PEL of 44 µg/m^3 while working in the cutoff/grinding area of the foundry. Though respiratory protection, 3M half-face 6200 series equipped with 3M P100 filter cartridges] was utilized during the monitoring event, the employee's lead exposure exceeded the assigned protection factor of the respirator; a respirator filter combination that was inappropriate for the lead exposures present at this work operation; 3) MIOSHA observed that the capture hood on an in-use belt grinder was not connected to the dust collector. The local exhaust capture hood/dust collector combination was intended to capture and remove lead-containing grinding dust from the breathing zone of the employee.

Picture 1. The shake out area for green sand molds. The shake out area had a vibratory work surface designed to break up the mold. The shake out area was equipped with a slotted hood to supply local exhaust ventilation.

Picture 2. The furnace room showing the induction furnace. The induction coil was lowered over the crucible and could be repositioned to enclose an additional crucible. Local exhaust hood was incorporated into the induction coil to capture fume generated during melting operations.

Picture 3. The core machine, the unit used heat to fuse resin coated sand into cores.

Picture 4. Photos of an employee using a 36-grit belt grinder to remove casting marks from bronze castings. Note: the flexible duct work providing local exhaust ventilation to the belt grinder was disconnected and laying on the floor. The dust collector was not turned on when this photo was taken.

Picture 5. Photo showing workers pouring brass.

8) Fabricated Structural Metal Manufacturer

The eighth GISHD inspection completed in 2018 was initiated because an employee at a fabricated structural metal manufacturer had a BLL of 36 µg/dL.

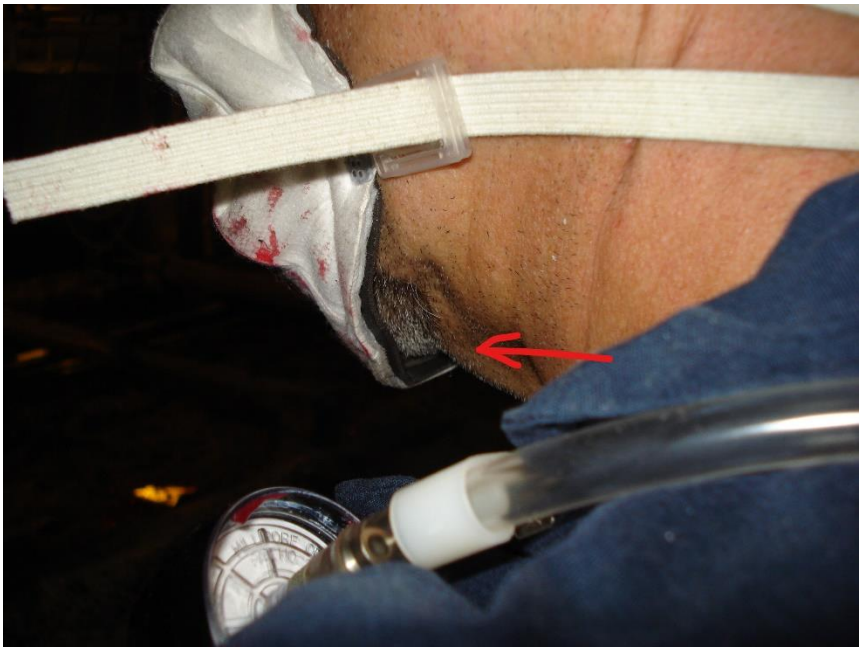
The employer used a lead bath to heat treat spools of steel stock. The employer had 3-4 inches of charcoal ash floating on top of the molten lead to help contain the heat. The lead bath was heated to 1600F during heat treating. The lead bath was dropped to 1200F during cleaning. The lead bath ash blanket was removed one a week on the Sunday night shift.

The company was cited for ten Serious lead violations: 1) An employee performing weekly maintenance [i.e., removal and replacement of a charcoal ash blanket] on a lead-containing heat treated bath was exposed to an airborne concentration of lead in excess of the eight hour PEL of 50 µg/m^3; 2) An employee performing weekly maintenance [removal and replacement of a charcoal ash blanket] on a lead-containing heat treated bath was exposed to an airborne concentration of lead in excess of the eight hour, PEL of 50 µg/m^3 of air. Although the employee utilized a respirator which was appropriately selected for the hazards presented by the work operation, such use was not in accordance with Occupational Health Standard Part 451; 3) MIOSHA observed three locations where ventilation was used (large canopy hood positioned over the top of the lead-containing heat treating bath, a local exhaust unit utilized during weekly maintenance operations involving the molten lead tank, and a local exhaust-equipped abrasive blasting cabinet used to clean the down keepers) in an effort to control employee exposures to lead. It was determined that these ventilation systems were neither measured nor evaluated as to their effectiveness in controlling employee exposures to lead; 4) While performing weekly maintenance, an employee was observed pulling a half moon plate out of the ash blanket allowing it to fall to the floor surface. This resulted in a visible release of ash into the work area and on the floor surface. The ash and related-debris was not immediately cleaned up, allowing employees and equipment to track and spread

it over the floor surface throughout the immediate molten lead tank area; 5) Although showers were provided; the employee did not shower prior to leaving the workplace; 6) MIOSHA observed that the employee entered the lunchroom with the visibly contaminated (charcoal ash) work clothing that had been worn while he was cleaning the heat treating bath; 7) MIOSHA observed that the existing lead warning signs did not contain all of the information necessary of such a posting [i.e., the signs did not include the following: Danger, May Damage Fertility or The Unborn Child, Causes Damage to the Central Nervous System, and No Drink In This Area]; 8) The existing written compliance program to reduce employee lead exposures to at or below the PEL was not implemented as evidenced by the following: employee exposure monitoring was not conducted at proper time intervals, no ventilation measurements were taken, respiratory protection was not required, inadequate housekeeping practices, employees not showering prior to leaving the workplace, contaminated uniforms worn in the breakroom, medical surveillance (biological monitoring) not offered at proper time intervals, and medical exams not offered; 9) It was determined that two employees performing weekly maintenance (removal and replacement of a charcoal ash blanket) on a lead-containing heat treating bath were exposed to an airborne concentration of lead in excess of the eight-hour, action level of 0.030 mg/m^3 of air. Biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin was only made available to these employees once per year, rather than every six months as required by the standard; 10) Prior to assigning two employees performing weekly maintenance to their work area where lead exposures were in excess to the action level, these employees were not provided an initial medical examination.

Picture 1. Lead heat treat bath. Note the canopy hood over the entire lead bath. The lead was kept at 1200F when cleaning on Sundays. Then ramped up to 1600F for heat treating. Note the light gray powder on the floor that resulted from an employee pulling the ½ moon out of the ash and allowing it to drop to the floor. Ash went all over. It was not cleaned up until the end of the day or shift. Employees walked through it and drove a lift truck through it.

Picture 2. A closer look of the lead bath showing the racks of keepers. In this picture you can also see the ash blanket floating on top of the molten lead.



Picture 3. Showing the gap at the bottom of employee's chin

Picture 4. The company purchased this residential shop vacuum from a local box store. The vacuum was said to be equipped with a HEPA filter; however, this type of vacuum was not meant for industrial use to control potentially heavy lead levels.

2016 Inspection

Rolled Steel Shape Manufacturer

A GISHD inspection completed in 2016 was initiated because an employee at a rolled steel shape manufacturer had a BLL of 26 µg/dL.

All lead citations were Other-than-Serious citations because of a long-time lapse between inspection initiation and citation issuance. There were three employees employed in this establishment. The employer supplied PPE however, the site had not conducted PPE hazard assessments, had not done PPE training and had not trained, fit-tested or provided a medical evaluation for the employee who wore a tight-fitting respirator. Operation of the facility/processing machinery was not constant, depending on material availability and customer demand. In the mill, dust collected connected to the building and equipment in the mill was changed every 100,000 pounds of brass run. The mill consists of a screw machine and hopper, heat tube, cyclone, hammer mill, shaker table, and final screening. The material was run through the mill and then collected into hoppers or barrels. PPE and respiratory protection shown and claimed to be worn during operation: a full Tyvex suit over clothes, thrown away after use; IH was shown nitrile gloves, thick leather gloves and mechanics gloves; And company supplied uniform worn each day under Tyvek, which was laundered by outside company that picked up when called. Did not take clothes home to be washed. Respirator worn when running operation used HEPA filters on tight-fitting mask. Earmuffs worn whenever machine was running. On day of lead monitoring, the employee was wearing protective footwear and overalls to help protect his clothes from being contaminated but did not remove his street clothing or shower after working.

The company was cited for eleven Other-than-Serious lead violations and five Other-than-Serious non-lead violations: 1) An employee working in the Hammer Mill Building was exposed to lead >50 µg/m^3 averaged over an eight-hour period; 2) Air monitoring of each employee or job description was not performed to make an initial determination of employee exposures to lead. An employee was exposed to lead above the action level; 3) An employee working in the Hammer Mill Building was exposed to lead at 190 µg/m^3 based upon an eight-hour TWA; 4) A written respiratory protection program was not developed or implemented for employees exposed to lead above the TWA limit. Affected employees had not been provided medical evaluations, had not been fit tested, and had not been trained on the proper use and care of their respirator; 5) At least one employee was exposed to lead above the action level for more than 30 days a year. A medical surveillance program was not instituted; 6) At least one employee was exposed to lead above the PEL. A written compliance plan had not been developed or implemented; 7) An employee exposed to lead above the PEL was not provided a shower; 8) A sign "Danger, Lead May Damage Fertility or the Unborn Child, Causes Damage to the Central System, Do Not Eat, Drink, or Smoke" was not posted in the work area where employees exposures were above the permissible exposure level; 9) Required training was not provided to at least one employee exposed to airborne lead above the permissible exposure level; 10) A copy of the rules and appendices were not made available to affected employees; 11) The required elements of a hazard communication program related to lead were not established; 12) The rotary kiln in the Hammer Mill Building had a belt and pulley exposed at less than 7 feet from the floor surface (*corrected during inspection*); 13) An exposed chain and sprocket on the rotary kiln in the hammer mill building was unguarded (*corrected during inspection*); 14) The general exhaust fan located in the wall of the hammer mill building was not guarded on the inside or the outside of the building (*corrected during inspection*); An employee working in the Hammer Mill Building was exposed to lead >50 µg/m^3 averaged over an eight-hour period; 15) A hazard communication program, including a written program, labeling requirements, safety data sheets, a list of hazardous chemicals, and employee training was not developed or implemented; 16) An employee was exposed to occupational noise above the action limit of 85 dBA. The employee was provided and wore earmuffs but was not provided an annual audiogram.

Picture 1. General Exhaust ventilation fan used in the hammer mill building located along the south wall of the building. Note the amount of metal dust on the floor of the building.

Picture 2. Scrap brass was run through a rotary kiln to remove any machining oils from the metal prior to being processed in the hammer mill. This operation was exhausted to the outside of the building.

Picture 3. Outside of the building where the general exhaust fan was located. There was no guarding across the fan so that employees were not protected from reaching into the rotating blade.

CASE NARRATIVES FOR THE SEVEN INDIVIDUALS WITH A BLL ≥50 µg/dL IN 2017-2019

Work-Related (4 Individuals)

- A man in his 40s, employed at an energy company, had multiple elevated BLLs, the highest being 61 µg/dL in 2018.
- A man in his 30s, employed at a firing range, had an elevated BLL of 53 µg/dL in 2017.
- A male in his 30s, employed at a recyclable material wholesaler, had multiple elevated BLLs, the highest being 50 µg/dL in 2019.
- A male in his 30s, employed at a painting and wall covering establishment, had an elevated BLL of 54 µg/dL in 2018.

Non-Work-Related (3 Individuals)

- A male in his 70s had multiple elevated BLLs, the highest being 52 µg/dL in 2019. His elevated BLLs were caused by casting bullets and firearm target shooting.
- A male in his 70s had multiple elevated BLLs, the highest being 50 µg/dL in 2017. His elevated BLLs were caused by firearm target shooting.
- A female in her 60s had multiple elevated BLLs, the highest being 56 µg/dL in 2019 and 54 µg/dL in 2018, because of retained bullet fragments. In prior years, her BLL had been as high as 155 µg/dL.

TWENTY-TWO YEARS OF INTERVIEWS OF ADULTS WITH BLLs ≥10 µg/dL REGARDING THEIR CHILDREN'S POTENTIAL EXPOSURE TO "TAKE HOME" LEAD

Since October 15, 1997 there have been 2,071 questionnaires completed over the telephone with adults with BLLs ≥10 µg/dL. Table 11 indicates the number of households with children (≤ six years old) potentially exposed to take home lead from adults with BLLs ≥10 µg/dL. Twenty-five percent of the households where an adult had an elevated BLL had children age ≤ 6 living or spending time in the home (Table 12). Children from only 163 (34.2%) of these 556 households were tested for blood lead. Among the 163 households where the child's blood test results were reported, 53 (34.6%) reported a child with a blood lead level ≥10 µg/dL. Contact information for individuals reporting young children in their household who had not been tested for lead was forwarded to MDHHS so that a letter could be sent encouraging adults in those households to have the children tested for lead.

Table 12. Number and Percent of Households with Children (6 or under) Potentially Exposed to Take Home Lead from Adults with BLLs ≥10 µg/dL (based on highest reported BLL) Interviewed 10/15/1997 to 12/31/2019, by Highest Blood Lead of Adult

Description of Households	10-24 µg/dL		25-29 µg/dL		30-39 µg/dL		40-49 µg/dL		50-59 µg/dL		≥ 60 µg/dL		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Households with Children Living or Spending Time	316	23.6	86	27.7	102	27.0	34	27.9	11	25.6	7	26.9	556	25.0[a]
Households with Children Tested for Lead	96	36.4	22	29.3	23	25.0	15	51.7	4	36.4	3	50.0	163	34.2[b]
Households Where Children had Elevated Lead	28	30.4	5	22.2	9	36.0	8	53.3	1	33.3	2	66.6	53	34.6[c]

[a]Among individuals within blood lead category, percentage of their households with children living or spending time in house. n=2,220

[b]Among individuals within blood lead category, percentage of "Households with Children Living/Spending Time", where the children were tested for lead. Because of missing data, the denominator may be less than the number "Households w/ Children Living/Spending Time" in the first row. n=477

[c]Among individuals within blood lead category, percentage of "Households w/Children Living/Spending Time ", where "Children Tested for Lead", had blood lead levels ≥ 10 µg/dL. Because of missing data, the denominator may be less than the "Children Tested for Lead" in the second row. n=153

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 are then sent by the testing laboratories to the MDHHS as required by law. If the individual tested is 16 years and older, the report is then forwarded to MSU and maintained in the ABLES program lead registry. Individuals with a blood lead level ≥25 µg/dL, individuals with BLLs of 10-24 µg/dL, where lead exposure source is not already known, and Flint residents with a blood lead level ≥5 µg/dL were contacted by mail and then contacted by a trained interviewer for a voluntary 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 ≥25 µg/dL was occupationally exposed at a company that has not had a recent MIOSHA inspection, an enforcement inspection was conducted by MIOSHA to assess that company's compliance with the lead standard.

In 2017 through 2019, there were 1,126 adults with BLLs ≥10 µg/dL and another 1,497 with a BLL 5-9 µg/dl. Among individuals with a BLL ≥10 µg/dL, approximately 91% were men. Their mean age was 45.9. They were predominately white (82.9%) and lived in the southern part of the state from Kalamazoo to Saint Clair. The source of exposure to lead was predominately their work (84.1%). The most common work exposures occurred during demolition of lead painted metal structures and abrasive blasting to remove paint, during the fabricating of non-ferrous metal parts and metal products and while working in a firing range.

In 2017 through 2019, eight Michigan adults were reported with BLLs greater than or equal to 50 µg/dL. Four of the eight adults were exposed to lead exclusively at work (recyclable material wholesaler, energy company, gun range, painting and wall covering establishment). There was one individual with non-work exposure to lead who had retained bullet fragments, one individual exposed to lead through casting bullets and firearm target shooting, one individual exposed to lead through firearm target shooting.

Lead exposure remains an important public health concern in the U.S. Environmental Protection Agency (EPA) regulations, which required the removal of lead from commercial products such as gasoline, house paint and solder in plumbing pipes and food cans. As a result, exposure to lead has been greatly reduced in the general population. Average BLLs in the general population have dropped from 15 µg/dL in the 1970s to the current 0.973 µg/dL (3).

The problem of lead in drinking water is not unique to Flint. Lead is a potential problem in many urban areas with aging water infrastructure. What made the issue so dramatic in Flint was the change in water source and lack of provision to deal with the corrosiveness of the new water source. This abrupt change in water source allowed for the recognition of changes in blood lead, which would normally not be identified with the ongoing slow deterioration of water infrastructure. As a society, we have reduced human lead exposure by removal of lead from gasoline and consumer products, and initiated programs to

remove lead paint from housing built before 1978. It is likely that lead in drinking water from aging water infrastructures will become an increasingly high percentage of lead exposure to the general population. This will be particularly true for young infants ingesting formula made with tap water, who do not have the potential to be exposed to lead dust on surfaces or ingest dust-containing lead from paint chips because they are not yet crawling.

Occupational exposure has not declined as much as environmental lead exposure. Data from 28 state lead surveillance systems shows that nationally, approximately 95% of adult elevated lead exposure is work-related (1). Occupational Safety and Health Administration (OSHA) lead standards, established in 1978 for general industry and in 1993 for construction, set the level for removal of a worker from lead exposure in general industry at 60 µg/dL or two consecutive values above 50 µg/dL and construction at 50 µg/dL. These levels were established when general population levels from environmental exposure were much higher than they are today. The Michigan OSHA program revised and updated administrative rules that lowered acceptable blood lead levels, replacing decades-old standards. The new rules became effective December 11, 2018 (2). Similar efforts are underway in two other state plan states, California and Washington.

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 (1,11-13). Levels as low as 5 µg/dL have been associated with adverse cardiovascular and neurologic health effects in adults (11,14).

Both the International Agency for Research on Cancer (IARC) and the National Toxicology Program have classified lead to be a probable human carcinogen (15,16), 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 (1), making both mortality from stroke and heart disease outcomes of interest. High lead exposure is known to cause non-malignant kidney disease (17), but it is not known if lower levels contribute to this outcome.

Michigan occupations with lead exposure include abrasive blasting to remove lead paint from outdoor metal structures such as bridges, overpasses or water towers; casting brass or bronze fixtures; fabricating metal products; or exposure to lead fumes or dust from firing guns or retrieval of spent bullets at firing ranges. While the use of lead in non-battery products has declined in the U.S., the use of lead worldwide continues to grow, especially in battery applications. Recycling the growing amount of “e-waste” created by discarded electronic and lead battery consumer products and the increased demand for raw metals and specifically recycled lead worldwide puts a new group of workers at risk to significant exposure to lead.

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 individuals begin at 5 µg/dL and interpretative language for the healthcare providers who

ordered the blood lead needs to be compatible with these recommendations since laboratory reports are often their main source of information (6) (See Appendix E). The February 2015 update of the Fourth Annual CDC Report shows that blood leads in the general population are continuing to fall and the 95th confidence limit for the upper limit of normal in 2011-2012 was 3.36 µg/dL (2.98-3.93) (3).

Although the major source of lead exposure to children is living in housing built before 1978 that has deteriorating lead paint, another source is adults working in lead occupations who bring lead home on their shoes or clothes and expose their spouse and children. MIOSHA regulations require employers to wash work clothes and provide showering facilities and clean and dirty change rooms for lead-exposed employees to reduce "take-home" exposure to their families. It is important that workers who have children six years or younger who live in or frequently visit their home assure that these children are tested for lead. Unfortunately, this is not happening; only one in three families with adults exposed to lead at work report that their young children are tested for lead. When these children are tested, 34.6% are found to have an elevated blood lead level (Table 11). This is a much higher percentage of elevated blood lead levels than typically found among children less than six years of age tested for blood lead in the state (3.1%) (18). Children of lead-exposed workers are a high-risk group for having an elevated blood lead and efforts to increase lead testing in these children should be expanded. In a separate project funded by the Michigan Child Lead Exposure Elimination Commission (CLEEC), a program for the monitoring and mitigation of take-home lead exposures was conducted in Genesee and Ingham counties (19). This project identified 320 establishments that potentially used lead so as to provide them with educational materials concerning best practices for reducing the potential for take-home lead exposures and for cleaning lead dust in the home, and information on getting themselves and their families blood lead levels measured. Questionnaire results showed that, while 55.4% of workers did work with or have exposure to lead on at least an occasional basis, only 43.2% of establishments trained workers on lead hazards and a minority implemented recommended practices for reducing take-home lead exposures, such as having employees change clothes (49.1%) and shoes (43.6%) before leaving the work site. Thirty eight percent of the workplaces employed workers with children younger than six years old. Dust sampling on the floors of employees' vehicles across all industry types sampled showed all vehicles sampled had measurable amounts of lead and nearly all samples were over the EPA dust-lead standard for house floors, with many samples containing lead at a concentration several orders of magnitude higher than the EPA standard.

In its twenty-second year of operation, the surveillance system for lead continues to prove successful in identifying adults with elevated lead levels and sources of exposure that could be remediated to reduce exposures in Michigan. The number of individuals with elevated blood lead levels has plateaued in recent years and more work is needed to reduce BLLs in adults (Figures 3-5).

Continued outreach is planned to the medical community to promote recognition and management of potential lead-related medical problems in both individuals and their young family members. The administrative procedure to update workplace lead standards

in Michigan has been in effect since December 11, 2018 (2). The main aim of the adoption of new regulations is not only to reduce the major source of lead exposure to adults, but also to reduce lead exposure to workers' children because of reduction in lead taken home on the clothes and footwear of individuals who work with lead. Ongoing surveillance in future years will continue to target and evaluate intervention activity to assure a continued downward reduction in blood lead levels and exposure to lead.

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APPENDICES

Appendix A. Elevated Blood Lead Levels Among Employed Adults – United States, 1994 – 2013. *Morbidity and Mortality Weekly Report* October 14, 2016

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

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

Appendix D. Reference Blood Lead Levels (BLL) for Adults in the U.S.

Appendix E. Management Guidelines for Blood Lead Levels in Adults

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

APPENDIX A

Elevated Blood Lead Levels Among Employed Adults – United States, 1994 – 2013. *Morbidity and Mortality Weekly Report*

October 14, 2016

Elevated Blood Lead Levels Among Employed Adults — United States, 1994–2013

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Preface

CDC's National Institute for Occupational Safety and Health (NIOSH) and state health departments collect data on laboratory-reported adult blood lead levels (BLLs). This report presents data on elevated BLLs among employed adults (defined as persons aged ≥16 years) in the United States for 1994–2013. This report is a part of the *Summary of Notifiable Noninfectious Conditions and Disease Outbreaks — United States*, which encompasses various surveillance years but is being published in 2016 (*1*). The *Summary of Notifiable Noninfectious Conditions and Disease Outbreaks* appears in the same volume of the Morbidity Mortality Weekly Report (*MMWR)* as the annual *Summary of Notifiable Infectious Diseases* (*2*).

Background

Since 1987, NIOSH and state health departments have maintained the Adult Blood Lead Epidemiology and Surveillance (ABLES) Program, a state-based surveillance program of laboratory-reported adult BLLs (*3*). The BLL is an often-used estimate of recent external exposure to lead (*4*,*5*). This report summarizes data on elevated BLLs among employed adults during January 1, 1994–December 31, 2013.

Information is provided by geographic division and reporting state, for "all cases" reported by a state (these include cases among adult residents in the reporting state plus cases identified by the reporting state but occurring among persons who reside in another state) and "state-residents" only, by exposure source, for BLLs ≥10 μg/dL (definition of elevated BLL from 2009 until 2014) (*3*,*6*–*8*), and for BLLs ≥25 μg/dL (previous definition of elevated BLL) (*9*). The current case definition (BLL ≥5 μg/dL) was adopted in 2015 and became effective in 2016, on the basis of mounting evidence for adverse health outcomes among adults with BLLs between 5 μg/dL and 25 μg/dL (*4*,*5*). State prevalence rates of elevated BLLs (≥10 μg/dL) for 2013 are categorized into two groups (above or below the national prevalence rate) (Figure 1). Trends of national prevalence rates of BLLs ≥10 μg/dL and BLLs ≥25 μg/dL from 1994 to 2013 are provided (Figure 2).

ABLES is the only program conducting nationwide adult lead exposure surveillance. It has provided the occupational safety and health community with essential information for setting research and intervention priorities. ABLES' impact is achieved through its longstanding strategic partnerships with state ABLES programs, federal agencies, and worker-affiliated organizations. For example, in 2008, the Occupational Safety and Health Administration (OSHA) updated its National Lead Emphasis Program to reduce occupational lead exposure by targeting unsafe conditions and high-hazard industries (*10*). To accomplish this objective, OSHA used national ABLES data to identify industries whose employees exhibit high BLLs. OSHA has agreements with state ABLES programs to use their lead exposure data to target workplace inspections.

Although federal funding for state ABLES programs was discontinued in September 2013, a total of 30 states continue to collaborate with NIOSH (down from a peak of 41 states) to provide data. In August 2015, funding to support adult BLL surveillance was resumed at a reduced level. To sustain lead exposure surveillance and prevention activities, state ABLES programs share resources with two other CDC programs: the Childhood Lead Poisoning Prevention Program and the Environmental Public Health Tracking Program. Since September 2013, NIOSH has continued to provide technical assistance to states with adult blood lead surveillance programs and maintains the ABLES website for reporting ABLES findings.

The BLL is a direct index of a worker's exposure to lead as well as an indication of the potential for adverse effects from that exposure (*4*,*5*). The half-life of lead in blood is approximately 40 days in males (*11*), so the BLL is an estimate primarily of recent exposure to lead. Because lead accumulates in bone and BLL is in equilibrium with bone lead, the BLL might be elevated in some persons who have not had recent exposure to lead. Because this equilibrium can lead to persistent BLL elevations, the public health burden of elevated BLLs in adults is measured as prevalence. In contrast, the public health burden of elevated BLLs in children aged <3 years is measured as incidence because these young children have little lead

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storage in their bones at birth and thus their early childhood blood lead tests reflect recent exposures.

Over the past several decades in the United States, a marked reduction has occurred in environmental sources of lead, and protection from occupational lead exposure has improved. As a result, there is an overall decreasing trend in the mean BLL and in the prevalence of elevated BLLs among adults. During 2011–2012, the mean BLL in adults in the United States was 1.09 μg/dL (*12*). Nonetheless, lead exposures among adults continue to occur at unacceptable levels (*3*).

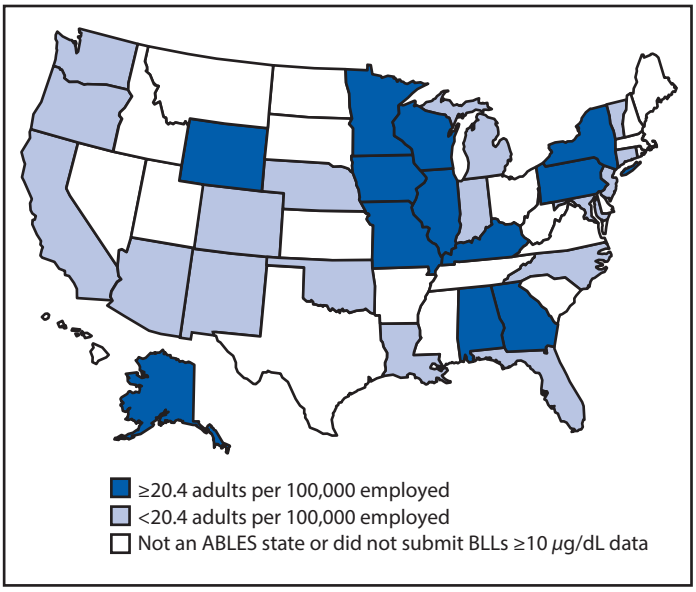
Data Sources

The ABLES program is a state-based surveillance system of adult BLLs. The number of cases (numerator) is currently provided by ABLES programs in 30 states (29 states provided data on BLLs ≥10 μg/dL). The number of employed adults (denominator) is obtained from the Local Area Unemployment Statistics (LAUS), Bureau of Labor Statistics, in the U.S. Department of Labor (http://www.bls.gov/data). A direct link to annual averages of states' employment status of the civilian noninstitutionalized population is available (http://www.bls.gov/lau/staadata.txt). NIOSH consolidates data from reporting state ABLES programs, conducts data quality control, analyzes the data, and disseminates the findings among stakeholders. State ABLES programs 1) collect data on adult BLLs from laboratories and physicians through mandatory reporting; 2) assign unique identifiers to each adult to account for multiple BLL records per person, protect individual privacy, and permit longitudinal analyses; 3) follow-up on adults with BLLs ≥10 or ≥25 μg/dL with laboratories, health care providers, employers, or workers to ensure completeness of information (e.g., the industry in which the adult is employed and whether the exposure source is occupational, nonoccupational, or both); 4) provide guidance and information to workers and employers to prevent lead exposures; and 5) submit data annually to NIOSH. Most ABLES states submit data on all BLLs (both occupational and nonoccupational) to NIOSH, including records from adults whose BLLs fall below the state mandatory reporting requirement.

Interpreting Data

The primary measure of adult lead exposure in the United States is the national prevalence rate of elevated BLLs among employed adults. This measure is provided by the ABLES program and can be used to estimate the magnitude and monitor trends of lead exposures and to target areas requiring further investigation or interventions.

FIGURE 1. Prevalence rate* of adults with blood lead levels (BLLs) ≥10 μg/dL, by state — State Adult Blood Lead Epidemiology and Surveillance (ABLES) programs, United States, 2013†



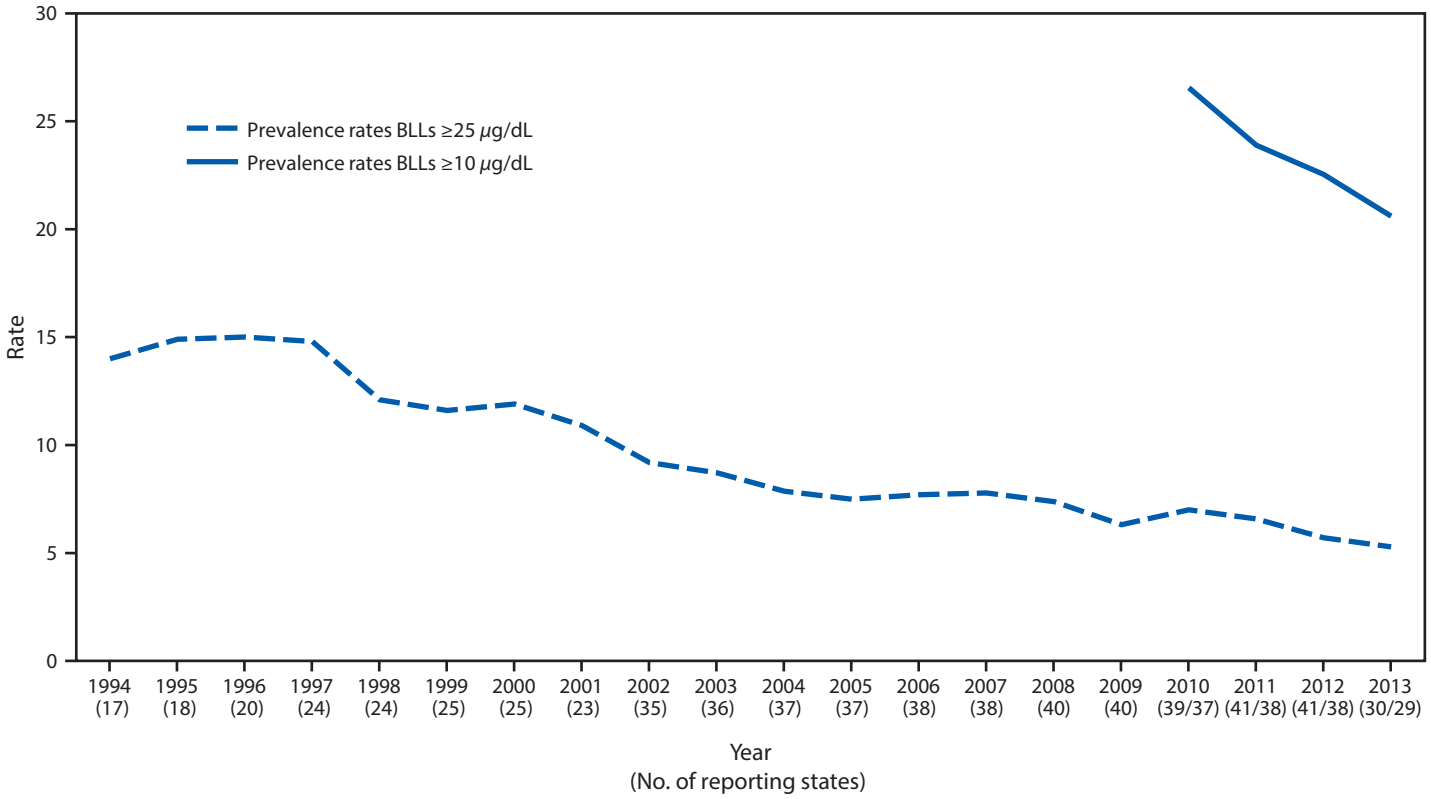
* Rate per 100,000 employed adults aged ≥16 years. State-resident prevalence rate might be lower for some states. Data from the Adult Blood Epidemiology and Surveillance (ABLES) Program, National Institute for Occupational Safety and Health (NIOSH/CDC). Denominators for 2013 extracted from 2015 U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics program (http://www.bls.gov/lau/staadata.txt).

† The national rate in 2013 was 20.4 cases per 100,000 employed adults aged ≥16 years. A total of 30 states submitted data in 2013: Alabama, Alaska, Arizona, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, Vermont, Washington, Wisconsin, and Wyoming. Massachusetts provided data for BLLs ≥25 μg/dL. In 2013, Missouri (111.8) and Iowa (53.7) reported the highest prevalence rates of elevated blood lead levels.

Efforts to reduce lead exposures have resulted in considerable progress in reducing the prevalence of elevated BLLs. However, many adults in the United States continue to have BLLs known to be associated with acute and chronic adverse effects in multiple organ systems ranging from subclinical changes in function to symptomatic intoxication. These include neurologic, cardiovascular, reproductive, hematologic, and kidney adverse effects. The risks for adverse chronic health effects are even higher if the exposure is maintained for many years (*4*,*5*). Current research has found decreased renal function associated with BLLs at ≤5 μg/dL and increased risk of hypertension and essential tremor at BLLs <10 μg/dL (*13*).

Prevalence rates of adults with BLLs ≥25 μg/dL are available since 1994. Beginning in 2002, state ABLES programs reported individual BLL laboratory test results and state of residence. Formerly, state resident and nonresident data could not be separated. When an adult has multiple blood lead tests in a given year, only the highest BLL for that adult in that year is counted. Prevalence rates of BLLs ≥10 μg/dL are available for

FIGURE 2. National prevalence rate* of reported cases of elevated blood lead levels,† by year — State Adult Blood Epidemiology and Surveillance Programs, United States, 1994–2013§



Abbreviation: BLL = blood lead level.

* Per 100,000 employed adults aged ≥16 years. Denominator data extracted from 2015 U.S. Department of Labor, Bureau of labor Statistics Local Area Unemployment Statistics (LAUS) program (http://www.bls.gov/lau/staadata.txt).

† Since 2009, the case definition for an elevated blood lead level is a BLL ≥10 μg/dL. For historical comparisons, prevalence rates at the previous case definition (BLL ≥25 μg/dL) are provided.

§ A total of 30 states submitted data in 2013 (down from 41 states in 2012): Alabama, Alaska, Arizona, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Jersey, New Mexico, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, Vermont, Washington, Wisconsin, Wyoming. Massachusetts provided data for BLLs ≥25 μg/dL. For 2013, the first number is the number of states reporting BLLs ≥25 μg/dL (i.e., 30 states in 2013), and the second number is the number of states reporting BLLs ≥10 μg/dL (i.e., 29 states in 2013).

2010 forward. Prevalence rates of BLLs ≥25 μg/dL are a subset of prevalence rates of BLLs ≥10 μg/dL. In the United States, most lead exposures among adults are occupational (*9*). A total of 29 states submitted work-relatedness information in 2013. Prevalence rate differences across states could reflect improved compliance with required OSHA monitoring in some states.

These counts and rates of elevated BLLs must be considered minimum estimates of the actual magnitude of the problem of lead exposures in the United States. This is for multiple reasons:

- not all states participate in the ABLES program;
- not all employers provide BLL testing to lead-exposed workers as required by OSHA regulations;
- not all nonoccupationally exposed adults are tested; and
- some laboratories might not report all tests as required by state laws or regulations.

For specific explanations, interpretation, and possible updates on data for any individual state, the state ABLES program investigator should be contacted directly. Contact information is available at http://www.cdc.gov/niosh/topics/ABLES/state.html.

Methods for Identifying Elevated BLLs Among Employed Adults

Beginning in 2016, a nationally reportable case of an employed adult with an elevated BLL is defined as a case in an employed person aged ≥16 years at the time of blood collection with a venous blood lead level ≥5 μg/dL of whole blood. The standardized diagnostic test is the BLL test using a venous blood sample. All participating state health departments have a requirement for laboratories and/or health care providers

to report laboratory blood lead results to the state health department. However, this requirement varies among ABLES states, ranging from the reporting of all BLLs to reporting only BLLs ≥40 μg/dL (*3*). The ABLES program ultimately aims to establish a national database for all BLL tests among adults and encourages all states to share information with NIOSH.

Publication Criteria

Cases meet the publication criteria if the employed adult (aged ≥ 16 years) had a venous BLL ≥25 μg/dL during 1994–2013 or a venous BLL ≥10 μg/dL during 2010–2013. When an adult had multiple blood lead tests in a given year, only the highest BLL for that adult in that year was counted. Prevalence rates of BLLs ≥25 μg/dL are a subset of prevalence rates of BLLs ≥10 μg/dL and are included for historic comparison.

Highlights

In 2013, the prevalence rate of BLLs ≥10 μg/dL was 20.4 adults per 100,000 employed population, calculated from 29 reporting states. In 2013, a total of 30 states submitted data on 5,504 adults with BLLs ≥25 μg/dL, and 29 states submitted data on 20,880 adults with BLLs ≥10μg/dL (Table 1). A total of 23 states submitted individual level data, and seven states submitted count data only. Overall, the national prevalence rate of BLLs ≥10 μg/dL declined from 26.6 adults per 100,000 employed in 2010 (among 37 states) to 20.4 in 2013 (among 29 reporting states). In 2013, of the 29 reporting states, 12 had prevalence rates of BLLs ≥10μg/dL equal to or above the national prevalence rate (20.4/100,000) (Figure 1). The national prevalence rate of BLLs ≥25 μg/dL among state residents and nonresidents declined from 14.0 adults per 100,000 employed in 1994 (among 17 states) to 5.2 in 2013 (among 30 states).

Historically, in the United States, most lead exposures among adults have been occupational. In 2013, a total of 29 states submitted data on 5,491 adults with BLLs ≥25 μg/dL of which 944 (17.2%) had no known exposure history (Table 2). Among the 4,547 adults with known exposure, 93.7% had occupational exposure, ranging from 42.9% to 100% among reporting states. Individual level data on 2,313 occupational cases with BLLs ≥25 μg/dL were available from 22 states. The majority of these adults were employed in four main industry sectors: manufacturing (n = 1,227 [53.1%]), construction (n = 468 [20.2%]), services (n = 194 [8.4%]), and mining (n = 182 [7.9%]). Within manufacturing, the majority of cases (n = 878; 71.6%) were among workers employed in storage battery manufacturing (North American Industry Classification System [NAICS] 33591), alumina and aluminum production and processing (NAICS 33131), and nonferrous metal (except copper and aluminum) rolling, drawing, extruding, and alloying (NAICS 33149) industries. Within construction, the majority of cases (n = 329 [70.3%]) were among workers employed in painting and wall covering contractors (NAICS 23832); highway, street, and bridge construction (NAICS 23731); and residential building construction (NAICS 23611) industries. Within the services sector, the majority of cases (n = 128 [66%]) were among workers employed in remediation services (NAICS 56291); all other amusement and recreation industries (NAICS 71399); automotive, mechanical, and electrical repair and maintenance (NAICS 81111); and fitness and recreational sports centers (NAICS 71394). Copper, nickel, lead, and zinc mining (NAICS 21223) accounted for 98.9% of the mining cases.

TABLE 1. Reported numbers of cases and prevalence rates of adults* with blood lead levels ≥10 μg/dL and blood lead levels ≥25 μg/dL, by geographic division and area — state Adult Blood Lead Epidemiology and Surveillance programs, United States, 2013†

Division/State	No. of employed state-resident adults (in 1,000s)	Blood lead levels ≥10 μg/dL				Blood lead levels ≥25 μg/dL§			
		All cases¶		State residents**		All cases		State residents	
		No.	(Rate)	No.	(Rate)	No.	(Rate)	No.	(Rate)
Total	**105,474**	**20,880**	**(20.4)**	**19,603**	**(19.2)**	**5,504**	**(5.2)**	**5,183**	**(4.9)**
New England									
Connecticut	1,724	331	(19.2)	313	(18.2)	62	(3.6)	61	(3.5)
Massachusetts	3,272	—††	(—)	—	(—)	126	(3.9)	105	(3.2)
Vermont	336	47	(14.0)	47	(14.0)	12	(3.6)	12	(3.6)
Mid Atlantic									
New Jersey	4,164	832	(20.0)	832	(20.0)	158	(3.8)	158	(3.8)
New York	8,891	1,873	(21.1)	1,731	(19.5)	295	(3.3)	270	(3.0)
Pennsylvania	5,964	2,928	(49.1)	2,915	(48.9)	1,533	(25.7)	1,527	(25.6)
East North Central									
Illinois	5,961	1,279	(21.5)	1,253	(21.0)	283	(4.7)	279	(4.7)
Indiana	2,947	596	(20.2)	596	(20.2)	113	(3.8)	113	(3.8)
Michigan	4,306	596	(13.8)	595	(13.8)	108	(2.5)	108	(2.5)
Wisconsin	2,877	687	(23.9)	686	(23.8)	105	(3.7)	105	(3.7)
West North Central									
Iowa	1,594	856	(53.7)	856	(53.7)	202	(12.7)	202	(12.7)
Minnesota	2,819	598	(21.2)	598	(21.2)	107	(3.8)	107	(3.8)
Missouri	2,814	3,145	(111.8)	2,835	(100.8)	690	(24.5)	613	(21.8)
Nebraska	983	195	(19.8)	195	(19.8)	32	(3.3)	32	(3.3)
South Atlantic									
Florida	8,783	888	(10.1)	863	(9.8)	270	(3.1)	266	(3.0)
Georgia	4,368	898	(20.6)	897	(20.5)	237	(5.4)	237	(5.4)
Maryland	2,917	275	(9.4)	234	(8.0)	75	(2.6)	62	(2.1)
North Carolina	4,310	219	(5.1)	218	(5.1)	99	(2.3)	99	(2.3)
East South Central									
Alabama	2,012	928	(46.1)	548	(27.2)	433	(21.5)	299	(14.9)
Kentucky	1,892	478	(25.3)	468	(24.7)	94	(5.0)	92	(4.9)
West South Central									
Louisiana	1,965	380	(19.3)	380	(19.3)	92	(4.7)	92	(4.7)
Oklahoma	1,707	144	(8.4)	121	(7.1)	29	(1.7)	27	(1.6)
Mountain									
Arizona§§	2,804	178	(6.3)	178	(6.3)	20	(0.7)	20	(0.7)
Colorado	2,591	103	(4.0)	41	(1.6)	29	(1.1)	15	(0.6)
New Mexico	859	48	(5.6)	48	(5.6)	13	(1.5)	13	(1.5)
Wyoming	292	66	(22.6)	66	(22.6)	12	(4.1)	12	(4.1)
Pacific									
Alaska	340	123	(36.1)	62	(18.2)	8	(2.4)	6	(1.8)
California	17,003	1,825	(10.7)	1,790	(10.5)	192	(1.1)	191	(1.1)
Oregon	1,761	92	(5.2)	79	(4.5)	12	(0.7)	9	(0.5)
Washington	3,217	272	(8.5)	158	(4.9)	63	(2.0)	51	(1.6)

* An employed person aged ≥16 years at the time of blood collection. When an adult had multiple blood lead tests in a given year, only the highest blood lead level for that adult in that year was counted. Rate per 100,000 employed adults. Data from the Adult Blood Epidemiology and Surveillance (ABLES) Program, National Institute for Occupational Safety and Health (NIOSH/CDC). Denominators extracted from 2015 U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics (LAUS) program (http://www.bls.gov/lau/staadata.txt).

† A total of 30 states participated in the ABLES Program in 2013.

§ The numbers and rates of adults with BLLs ≥25 μg/dL are subsets of the numbers and rates of adults with BLLs ≥10 μg/dL.

¶ All cases reported by a state. These include cases among adult residents in the reporting state plus cases identified by the reporting state but who reside in another state.

** Adults residing in the reporting state.

†† 10–15 μg/dL BLL data were not available.

§§ Data from Arizona were available only for January to August 2013.

TABLE 2. Reported numbers of adults* with blood lead levels ≥25 *μg*/dL, by exposure source and area — state Adult Blood Lead Epidemiology and Surveillance programs, United States, 2013†

	Occupational§		Nonoccupational		Unknown		Total
Division/State	No.	(%)	No.	(%)	No.	(%)	No.
Total	**4,262**	**(77.6)**	**285**	**(5.2)**	**944**	**(17.2)**	**5,491**
New England							
Connecticut	37	(59.7)	23	(37.1)	2	(3.2)	**62**
Massachusetts	71	(56.3)	24	(19.0)	31	(24.6)	**126**
Vermont	3	(25.0)	4	(33.3)	5	(41.7)	**12**
Mid Atlantic							
New Jersey	105	(66.5)	—¶	(—)	53	(33.5)	**158**
New York	191	(64.7)	78	(26.4)	26	(8.8)	**295**
Pennsylvania	1,449	(94.5)	—	(—)	84	(5.5)	**1,533**
East North Central							
Illinois	177	(62.5)	14	(4.9)	92	(32.5)	**283**
Indiana	67	(59.3)	—	(—)	46	(40.7)	**113**
Michigan	70	(64.8)	28	(25.9)	10	(9.3)	**108**
Wisconsin	88	(83.8)	9	(8.6)	8	(7.6)	**105**
West North Central							
Iowa	200	(99.0)	2	(1.0)	—	(—)	**202**
Minnesota	92	(86.0)	3	(2.8)	12	(11.2)	**107**
Missouri	682	(98.8)	8	(1.2)	—	(—)	**690**
Nebraska	25	(78.1)	2	(6.3)	5	(15.6)	**32**
South Atlantic							
Florida	82	(30.4)	11	(4.1)	177	(65.6)	**270**
Georgia	100	(42.2)	—	(—)	137	(57.8)	**237**
Maryland	57	(76.0)	4	(5.3)	14	(18.7)	**75**
North Carolina	89	(89.9)	8	(8.1)	2	(2.0)	**99**
East South Central							
Alabama	353	(81.5)	—	(—)	80	(18.5)	**433**
Kentucky	—	(—)	—	(—)	94	(100.0)	**94**
West South Central							
Louisiana	78	(92.9)	5	(6.0)	1	(1.2)	**84**
Oklahoma	7	(24.1)	2	(6.9)	20	(69.0)	**29**
Mountain							
Arizona	12	(80.0)	3	(20.0)	–	(—)	**15**
Colorado	4	(13.8)	3	(10.3)	22	(75.9)	**29**
New Mexico	4	(30.8)	3	(23.1)	6	(46.2)	**13**
Wyoming	12	(100.0)	—	(—)	–	(—)	**12**
Pacific							
Alaska	5	(62.5)	—	(—)	3	(37.5)	**8**
California	146	(76.0)	45	(23.4)	1	(0.5)	**192**
Oregon	7	(58.3)	1	(8.3)	4	(33.3)	**12**
Washington	49	(77.8)	5	(7.9)	9	(14.3)	**63**

* An employed person aged ≥16 years at the time of blood collection. When an adult had multiple blood lead tests in a given year, only the highest blood lead level for that adult in that year was counted.

† Among the 30 reporting states, 29 states submitted data on exposure source in 2013. These data include adult residents in the state and residents of other states reported by the state ABLES programs.

§ Includes 23 cases coded with both occupational and nonoccupational exposure source.

¶ No cases were reported.

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APPENDIX B

Michigan’s General Industry Safety and Health Standard

MIOSHA-STD-1207 (01/19)
40 Pages

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

DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS

DIRECTOR'S OFFICE

GENERAL INDUSTRY SAFETY AND HEALTH 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)**

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 licensing and regulatory affairs 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, and 2011-4, MCL 330.3101, 445.2001, 445.2011, 445.2025, and 445.2030)

R 325.51933, R 325.51936, R 325.51937, R 325.51938, R 325.51943, and R 325.51945 of the Michigan Administrative Code are amended, as follows:

R 325.51901 of the Michigan Administrative Code is amended, and R 325.51902, R 325.51902a, R 325.51903, R 325.51904, R 325.51905, R 325.51906, R 325.51907, R 325.51908, R 325.51909, R 325.51910, R 325.51911, R 325.51912, R 325.51913, R 325.51914, R 325.51915, R 325.51916a, R 325.51916b, R 325.51917, R 325.51918, R 325.51922, R 325.51923, R 325.51924, R 325.51924a, R 325.51925, R 325.51926, R 325.51928, R 325.51929, R 325.51930, R 325.51931, R 325.51931a, R 325.51932, R 325.51934, R 325.51935, R 325.51938a, R 325.51939, R 325.51940, R 325.51941, R 325.51942, R 325.51944, R 325.51946, R 325.51947, R 325.51948, R 325.51949, R 325.51950, R 325.51950a, R 325.51950b, R 325.51951, R 325.51952, R 325.51953, R 325.51954, R 325.51955, R 325.51956, and R 325.51957 are rescinded, as follows:

GENERAL INDUSTRY SAFETY AND HEALTH STANDARD
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 March 26, 2012, 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 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 1910.1200 means General Industry Safety Standard Part 92. "Hazard Communication."

(5) A reference to 1910.141 means General Industry Safety and Health Standard Part 474. "Sanitation."

(6) A reference to 1910.1020 means General Industry and Construction Safety and Health Standard Part 470. "Employee Medical Records and Trade Secrets."

(7) A reference to 1910.134 means Occupational 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 Licensing and Regulatory Affairs, MIOSHA Regulatory Services 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 Licensing and Regulatory Affairs, MIOSHA Regulatory Services 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 Licensing and Regulatory Affairs, MIOSHA Regulatory Services 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 then 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) Occupational Health Standard Part 451. "Respiratory Protection," R 325.60051 to R 325.60052.

R 325.51902 Rescinded.
R 325.51902a Rescinded.
R 325.51903 Rescinded.
R 325.51904 Rescinded.
R 325.51905 Rescinded.
R 325.51906 Rescinded.
R 325.51907 Rescinded.
R 325.51908 Rescinded.
R 325.51909 Rescinded.
R 325.51910 Rescinded.
R 325.51911 Rescinded.
R 325.51912 Rescinded.
R 325.51913 Rescinded.
R 325.51914 Rescinded.
R 325.51915 Rescinded.
R 325.51916a Rescinded.
R 325.51916b Rescinded.
R 325.51917 Rescinded.
R 325.51918 Rescinded.
R 325.51922 Rescinded.
R 325.51923 Rescinded.
R 325.51924 Rescinded.
R 325.51924a Rescinded.
R 325.51925 Rescinded.
R 325.51926 Rescinded.
R 325.51928 Rescinded.
R 325.51929 Rescinded.
R 325.51930 Rescinded.
R 325.51931 Rescinded.
R 325.51931a Rescinded.
R 325.51932 Rescinded.
R 325.51934 Rescinded.
R 325.51935 Rescinded.
R 325.51938a Rescinded.
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R 325.51950b Rescinded.
R 325.51951 Rescinded.
R 325.51952 Rescinded.
R 325.51953 Rescinded.
R 325.51954 Rescinded.
R 325.51955 Rescinded.
R 325.51956 Rescinded.
R 325.51957 Rescinded.

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.

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 and social security number 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. As medical 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, social security number, 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, social security number, 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 social security 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]

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 social security 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 • If PbB increases ≥ 5 µg/dL, evaluate exposure and protective measures. • Increase monitoring if indicated
10-19 µg/dL	As above for PbB < 10 µg/dL, plus: • PbB every 3 months • Evaluate exposure, engineering controls, and work practices • 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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APPENDIX C

Michigan’s Construction Safety and Health Standard

MIOSHA-STD-1403 (12/18)
40 Pages

For further information
Ph: 517-284-7740
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DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS

DIRECTOR'S OFFICE

CONSTRUCTION SAFETY AND HEALTH 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)**

These rules become effective immediately upon filing with the Secretary of State
unless adopted under Section 33, 44, or 45a(6) of 1969 PA 306.

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 licensing and regulatory affairs
by sections 14 and 24 of 1974 PA 154, MCL 408.1014 and 408.1024;
and Executive Reorganization Order Nos. 1996-1, 1996-2, 2003-1, 2008-4,
and 2011-4, MCL 330.3101, 445.2001, 445.2011, 445.2025, and 445.2030)

R 325.51991, R 325.51992, and R 325.51993 of the Michigan administrative code are amended,
and R 325.51983, R 325.51984, R 325.51985, R 325.51986, R 325.51987, R 325.51988, R 325.51989,
and R 325.51990 are added, as follows:

CONSTRUCTION SAFETY AND HEALTH STANDARD
PART 603. LEAD EXPOSURE IN CONSTRUCTION

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R 325.51983 Scope and application.

Rule 83. 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.

R 325.51984 Adoption by reference of federal regulations.

Rule 84. (1) The federal Occupational Safety and Health Administration (OSHA) regulation 29 C.F.R. §1926.62, "Lead," as amended on March 26, 2012, is adopted in these rules.

(2) The adopted federal regulations shall 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.

(3) 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.

(4) A reference to 1926.51 "Sanitation," means Construction Safety and Health Standard Part 1 "General Rules," as referenced in R 325.51985.

(5) A reference to 1910.133 "Eye and face protection," means Construction Safety and Health Standard Part 6 "Personal Protective Equipment," as referenced in R 325.51985.

(6) A reference to 1910.134 "Respiratory Protection," means General Industry and Construction Safety and Health Standard Part 451 "Respiratory Protection," as referenced in R 325.51985.

(7) A reference to 1910.20 means 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," as referenced in R 325.51985.

(8) A reference to 1910.1025 "Lead," means General Industry Safety and Health Standard Part 310 "Lead in General Industry," as referenced in R 325.51985.

(9) A reference to 1910.1200 "Hazard Communication," means Construction Safety and Health Standard Part 42 "Hazard Communication," as referenced in R 325.51985.

R 325.51985 Availability of OSHA adopted standard and MIOSHA referenced standards.

Rule 85. (1) 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.

(2) The regulation adopted in these rules is available for inspection at the Department of Licensing and Regulatory Affairs, MIOSHA Regulatory Services Section, 530 West Allegan Street, P.O. Box 30643, Lansing, Michigan, 48909-8143.

(3) The regulation adopted in these rules may be obtained from the publisher or may be obtained from the Department of Licensing and Regulatory Affairs, MIOSHA Regulatory Services 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.

(4) 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 Licensing and Regulatory Affairs, MIOSHA Regulatory Services 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 then 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.

1926.62 LEAD

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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 $\mu g/m^3$) 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 person 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 $\mu g/m^3$) 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 $\mu g/m^3$) = 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 paragraph (d) of this section, 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 Table 1 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) 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 to lead in excess of 2,500 µg/m$^{(3)}$ (50 x PEL), the employer shall treat the employee as if the employee were exposed to lead in excess of 2,500 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 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 Table I 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)(10) 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)(10) 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 and social security number 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 µg/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 µg/$m^{(3)}$ 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 µg/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 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

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 LEAD WORK AREA POISON 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, social security number, 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, social security number, 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 and social security number 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]

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 and social security 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. 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 • If PbB increases ≥ 5 µg/dL, evaluate exposure and protective measures. • Increase monitoring if indicated
10-19 µg/dL	As above for PbB < 10 µg/dL, plus: • PbB every 3 months • Evaluate exposure, engineering controls, and work practices • 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.

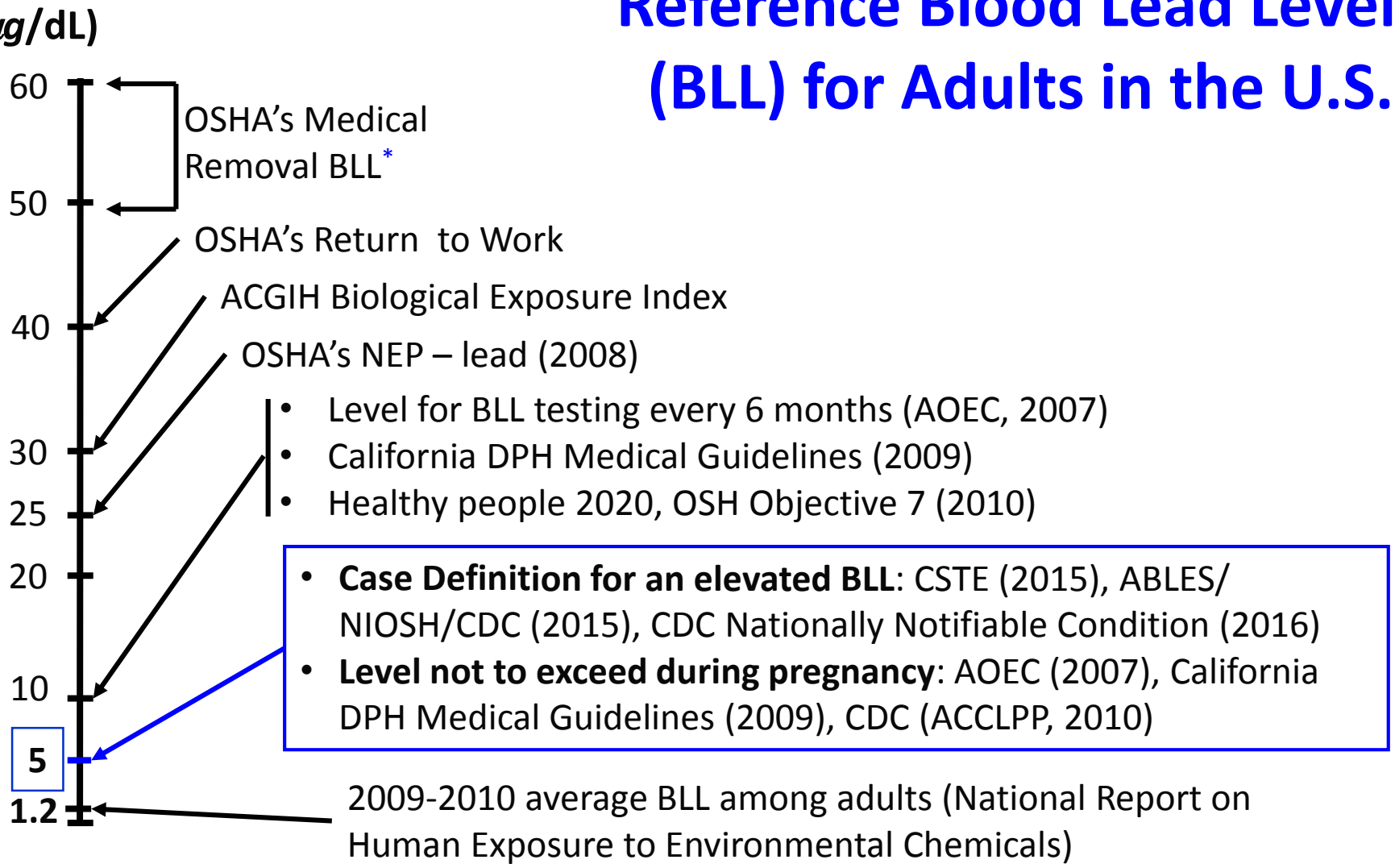
Michigan Occupational Safety and Health Administration
PO Box 30643
Lansing, Michigan 48909-8143
For technical questions of this standard – Ph: 517-284-7680 (CSHD) or 517-284-7720 (CETD)
To order copies of this standard – Ph: 517-284-7740

APPENDIX D

Reference Blood Lead Levels (BLL) for Adults in the U.S.

Slide updated 12/18/2015

Reference Blood Lead Levels (BLL) for Adults in the U.S.



*The OSHA Lead Standards state that the examining physician has broad flexibility to tailor protections to the worker's needs.

Source Documents for Reference Blood Lead Levels in slide 1

1. **Occupational Safety and Health Administration (OSHA). Lead Standards:** http://www.osha.gov/SLTC/lead/
2. **American Conference of Governmental Industrial Hygienists (ACGIH). Biological Exposure Indices:** http://www.acgih.org/Products/beiintro.htm
3. **OSHA Instruction: National Emphasis Program (NEP) on Lead:** http://www.osha.gov/OshDoc/Directive_pdf/CPL_03-00-0009.pdf "Inspections will also be conducted in establishments where reported employee blood lead levels were at or above 25 µg/dL"
4. **Association of Occupational and Environmental Clinics (AOEC). Medical Management Guidelines for Lead-Exposed Adults, Revised 04/24/2007. CSTE Medical Management Guidelines Added October 2013, see Pages 16-17:** http://www.aoec.org/documents/positions/mmg_revision_with_cste_2013.pdf
5. **Kosnett MJ et al. Recommendations for Medical Management of Adult Lead Exposure.** http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1849937/
6. **California Department of Public Health (CDPH) Medical Guidelines for the Lead-Exposed Worker:** http://www.cdph.ca.gov/programs/olppp/Documents/medgdln.pdf
7. **Department of Health and Human Services. Healthy People 2020 Occupational Safety and Health objective 7 (OSH-7):** http://www.healthypeople.gov/2020/topics-objectives/topic/occupational-safety-and-health/objectives **and operational definition in** http://www.healthypeople.gov/node/5049/data_details
8. **Council of State and Territorial Epidemiologists (CSTE) Position Statement 15-EH-01. Public Health Reporting and National Notification for Elevated Blood Lead Levels.** http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/2015PS/2015PSFinal/15-EH-01.pdf
9. **Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH), Adult Blood Lead Epidemiology and Surveillance (ABLES) case definition for an elevated blood lead level:** http://www.cdc.gov/niosh/topics/ABLES/description.html
10. **CDC. National Notifiable Diseases Surveillance System (NNDSS). Nationally Notifiable Non-Infectious Conditions. Lead, Elevated Blood Levels 2016 Case Definition:** http://wwwn.cdc.gov/nndss/conditions/lead-elevated-blood-levels/case-definition/2016/
11. **CDC. Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP): Guidelines for the Identification and Management of Lead Exposure in Pregnant and Lactating Women**: http://www.cdc.gov/nceh/lead/publications/LeadandPregnancy2010.pdf These guidelines recommend follow-up activities and interventions beginning at blood lead levels (BLLs) ≥ 5 µg/dL in pregnant women. The essential activity in management of pregnant women with BLLs ≥5 µg/dL is removal of the lead source, disruption of the route of exposure, or avoidance of the lead-containing substance or activity.
12. **National Toxicology Program (NTP). Health Effects of Low-level Lead Evaluation**: http://ntp.niehs.nih.gov/go/36443
13. **CDC. National Report on Human Exposure to Environmental Chemicals.** http://www.cdc.gov/exposurereport/ **Updated tables, February 2015:** http://www.cdc.gov/biomonitoring/pdf/FourthReport_UpdatedTables_Feb2015.pdf

APPENDIX E

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. Centers for Disease Control and Prevention (CDC, 2012) report that the mean BLL for US adults age 20 years and older is 1.38 μg/dL.

Blood Lead Level (μg/dL)	Management Recommendations
<5	No action needed Monitor BLL if ongoing exposure
5-9	Discuss health risks Minimize exposure Consider removal for pregnancy and certain medical conditions Monitor BLL
10-19	Decrease exposure Remove from exposure for pregnancy Consider removal for certain medical conditions or BLL ≥ 10 for an extended period of time Monitor BLL
20-29	Remove from exposure for pregnancy Remove from exposure if repeat BLL in 4 weeks remains ≥ 20 Annual lead medical exam recommended
30-49	Remove from exposure Prompt medical evaluation
50-79	Remove from exposure Prompt medical evaluation Consider chelation with significant symptoms
≥ 80	Remove from exposure Urgent medical evaluation 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:

"Medical Guidelines for the Lead-Exposed Worker"

http://www.cdc.gov/niosh/topics/ABLES/publication.html – scroll down to "State Publications" and click on the link for *Medical Guidelines for the Lead-Exposed Worker*.

"Association of Occupational and Environmental Clinics Medical Management Guidelines for Lead-Exposed Adults"

http://www.aoec.org/documents/positions/MMG_FINAL.pdf

"Guidelines for the Identification and Management of Lead Exposure in Pregnant and Lactating Women"

http://www.cdc.gov/nceh/lead/publications/leadandpregnancy2010.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):

- Contact your local and/or state health department
- http://www.cdc.gov/nceh/lead/publications/#screening - click on Screening and Case Management Guidelines
- http://www.osha.gov/html/RAmap.html - use this map to find an OSHA Office in your State
- http://www.aoec.org/directory.htm - Online directory of member clinics of the Association of Occupational and Environmental Clinics

APPENDIX F

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 all 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 (CDC). Chronic adverse health effects have no threshold, so clinicians should monitor patients with elevated BLL until below 5 µg/dL. **For occupational lead exposure,** 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>5–9 µg/dL</td><td>Obtain history on lead exposure and minimize contact.</td><td>Repeat BLL every 3 months until < 5 µg/dL.</td><td rowspan="2">Obtain history on potential sources of lead exposure at work and home at all BLLs ≥ 5 µg/dL and minimize lead contact.
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.
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.
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
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 ≥ 5 µg/dL, and repeat BLL at least every 4 weeks until < 5 µg/dL. Refer to the American College of Obstetricians and Gynecologists guidelines and CDC guidelines on lead in pregnancy and lactation for more detailed information.</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.