



BASIS FOR THE NEW LEAD PEL

OCCUPATIONAL LEAD POISONING PREVENTION PROGRAM

OCCUPATIONAL HEALTH BRANCH
CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

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*Website: Occupational
Health Branch (ca.gov)*



AGENDA

- Review of scientific findings
- Lead biokinetics
- 1978 Federal OSHA lead standard and Bernard Model
- Cal/OSHA revised lead standards and Leggett+ Model
- New CDPH OLPPP resources

Major Changes

OLD

PEL: 50 $\mu\text{g}/\text{m}^3$
AL: 30 $\mu\text{g}/\text{m}^3$



NEW

PEL: 10 $\mu\text{g}/\text{m}^3$
AL: 2 $\mu\text{g}/\text{m}^3$

Goal: Keep worker blood lead levels (BLLs) below 10 $\mu\text{g}/\text{dL}$

MR: $\geq 50 \mu\text{g}/\text{dl}$

RTW: 40 $\mu\text{g}/\text{dl}$



MR: $\geq 30 \mu\text{g}/\text{dl}$ (2025)
 $\geq 20 \mu\text{g}/\text{dl}$ (2026)

RTW: 15 $\mu\text{g}/\text{dl}$

California Labor Code Section 144.6 Comprehensive Framework for Workplace Safety Standards

Core Mandate

Prevent material health impairment from toxic materials and harmful physical agents over entire working life

Scientific Foundation

Standards based on latest research, objective criteria, and performance-based outcomes

Feasibility Doctrine

"To the extent feasible" - prioritizes worker health over economic considerations, rejects cost-benefit analysis

AT THE BEGINNING

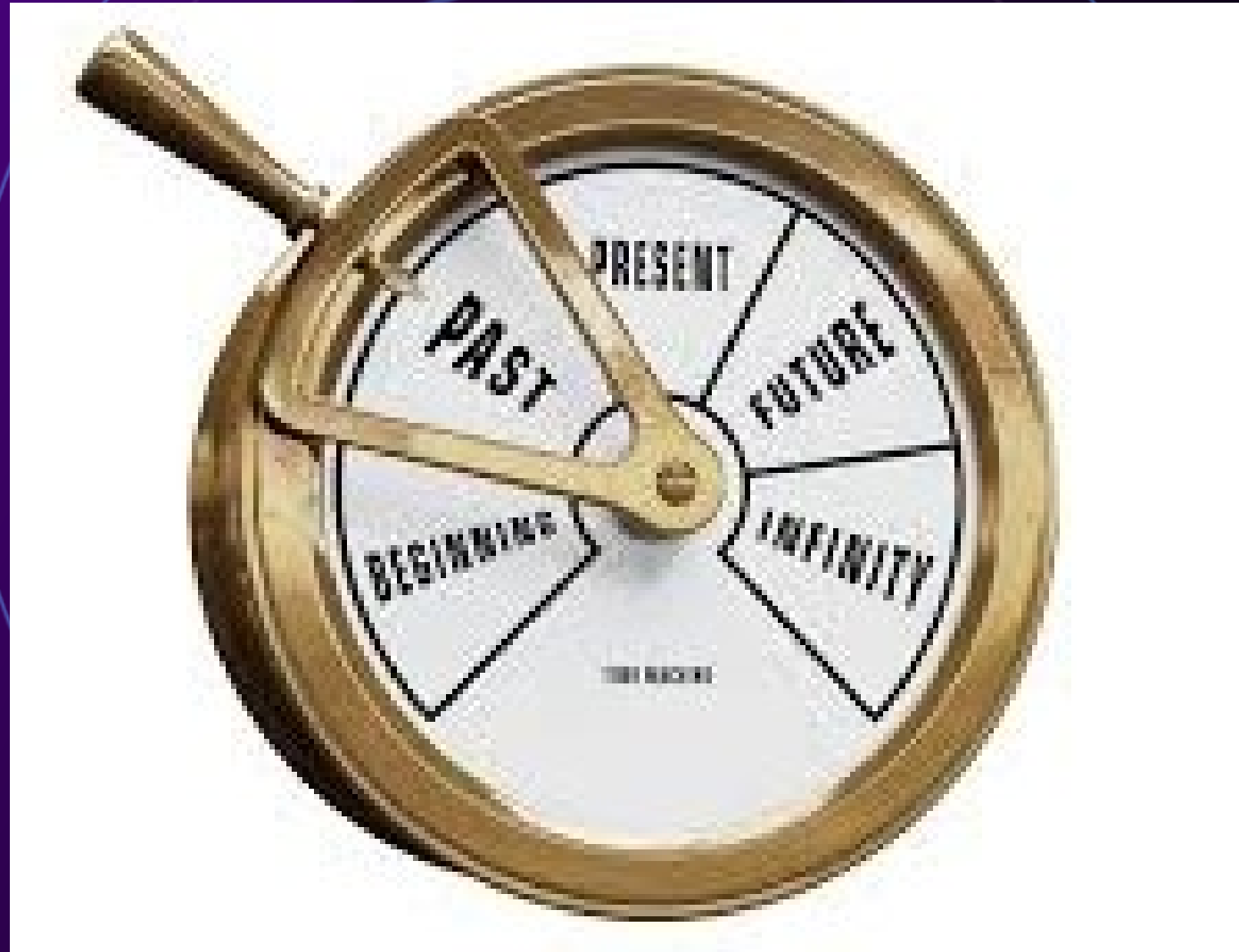
2010-2013 CDPH OHB OLPPP

- Conducted rigorous scientific review process (cardiovascular, renal, neurological, cognitive [esp children], reproductive)
- No threshold for health effects: Studies consistently demonstrated dose-response relationships extending to the lowest measurable BLLs

2013 CAL-EPA OEHHA (Office of Environmental Health Hazard Assessment)

- Used physiologically-based pharmacokinetic (PBPK) modeling to predict the relationship between airborne lead concentrations and worker BLLs

TIME MACHINE



BIOKINETIC MODELING & STUDIES TIMELINE

Bernard Model

Biokinetic foundation for 1978
Federal OSHA lead standards

1977



1980s – 2000s

Scientific Studies

Leggett+ Model (CalEPA)

Biokinetic model for revised
Cal/OSHA lead standards

2013

2019

CA Senate Bill 83

Mandated Cal/OSHA to revise
lead standards to be consistent
with scientific research &
findings

Hearings, Adoption & Implementation

2023 – 2025



= Federal OSHA Standard Passed (1978)

AT THE BEGINNING

2010-2013 CDPH OHB OLPPP

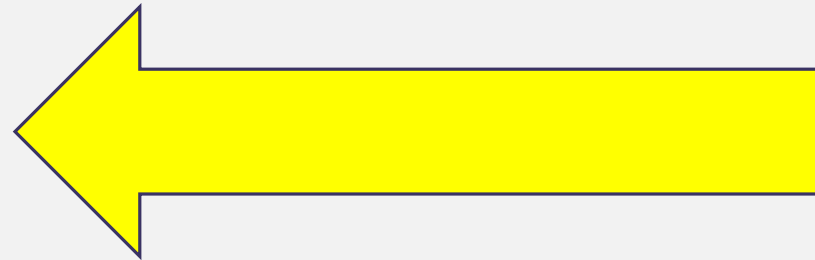
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1980s - 2000s

Scientific Studies



MANY MANY STUDIES!



Decade	Approx. # U.S. Research Studies	Focus
1980–1989	~600–1,000	Studies after gasoline/paint bans
1990–1999	~1,500–2,200	Longitudinal follow-ups Cognitive, cardiovascular, renal, reproductive effects
2000–2009	~3,000–4,000	ADHD, mental health, effect on criminal behavior
2010–2019	~4,500–5,500	Dementia
2020–2025	~2,000–2,500	New exposure sources Global burden, economic cost



KEY REVIEW: MONOGRAPH ON HEALTH EFFECTS OF LOW-LEVEL LEAD (2012)

Publisher: National Toxicology Program (NTP) - Most authoritative U.S. review since 1970s/80s

- Reviewed and synthesized 107 key epidemiological studies (1987-2011)
- Covered both children and adults

Children:

- Cognitive/Academic: Lower IQ, reduced academic achievement, learning deficits, and increased risk for behavioral problems at blood lead levels $<5-10 \mu\text{g/dL}$
- Behavioral: Increased attention and hyperactivity problems
- Other: Growth delays, hearing loss, delayed puberty

ADULTS

- Cardiovascular: Increased blood pressure and hypertension, increased risk of cardiovascular mortality at blood lead levels $<10 \mu\text{g}/\text{dL}$
- Renal: Decreased kidney function, increased risk of chronic kidney disease at low BLLs
- Reproductive/Developmental: Reduced fetal growth, delayed conception, increased risk of spontaneous abortion and preterm birth
- Cognitive, academic, & behavioral: Blood Lead $<5 \mu\text{g}/\text{dL}$ harmful
- Other: Emerging evidence for immune system effects, cancer, and other diseases

KEY REVIEW: ATSDR TOXICOLOGICAL PROFILE FOR LEAD (2020)

Publisher. Agency for Toxic Substances and Disease Registry (ATSDR), CDC

- Synthesized thousands of peer-reviewed studies (human and animal)
- Updated all toxicological data since previous profiles
- Gold standard reference for regulatory agencies and risk assessment

Children (<5 µg/dL)

- Cognitive/IQ: Lower intelligence, learning disabilities, attention deficits
- Behavioral: Increased ADHD symptoms, behavioral problems
- Physical: Growth delays, impaired hearing, anemia

ADULTS

- Health effects (<10 µg/dL)
- Cardiovascular: Increased blood pressure, hypertension, cardiovascular mortality
- Renal: Reduced kidney function, chronic kidney disease
- Reproductive: Infertility, delayed conception, miscarriage, adverse pregnancy outcomes
- Neurological: Possible links to cognitive decline, dementia (emerging evidence)

BOTTOM LINE

No Safe Threshold

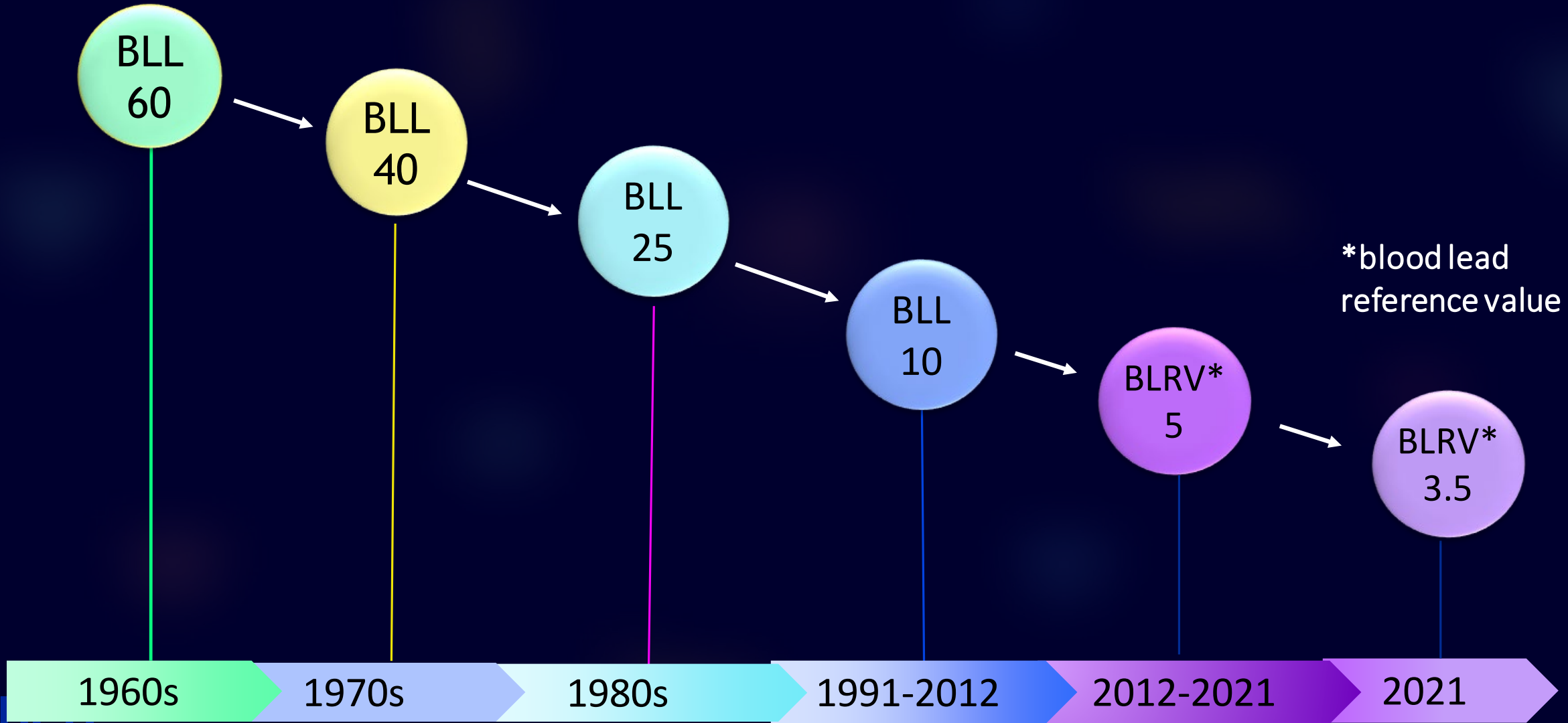
All research confirms that there is no safe blood lead level: Adverse health effects occur at the lowest measurable concentrations

Kosnett, M. J., Wedeen, R. P., Rothenberg, S. J.,
Hipkins, K. L., Materna, B. L., Schwartz, B. S., Hu, H.,
& Woolf, A. (2007). **Recommendations for Medical
Management of Adult Lead Exposure.** *Environmental
Health Perspectives*, 115(3), 463–471.

KOSNETT'S 2007 MEDICAL GUIDELINES

- Remove from exposure: Single level ≥ 30 $\mu\text{g/dL}$ or two ≥ 20 $\mu\text{g/dL}$ (4 weeks apart)
- Pregnant women: Avoid exposure > 5 $\mu\text{g/dL}$
- Chelation: Consider at ≥ 50 - 80 $\mu\text{g/dL}$ if symptomatic
- Health Effects:
 - Cardiovascular: Each doubling of blood lead raises blood pressure 1.0-1.25 mmHg
 - Kidney: Impairment at levels as low as 2-8 $\mu\text{g/dL}$
 - Brain: Cognitive decline at 20-40 $\mu\text{g/dL}$
 - Reproduction: Birth defects and fetal harm at ≥ 5 $\mu\text{g/dL}$
- Impact: Shifted occupational policy from reactive treatment to proactive prevention

CDC BLL of Concern ($\mu\text{g}/\text{dl}$)



*blood lead reference value

CDPH MEDICAL GUIDELINES

Updated 2025



CLINICAL GUIDANCE FOR ADULT BLOOD LEAD LEVELS

These guidelines are for the clinical care of adults exposed lead at home or work. CDPH recommends follow-up for adult blood lead levels (BLL) 3.5 µg/dL and greater. The mean BLL for U.S. adults is < 1 µg/dL; 97.5th percentile for BLL is 3.5 µg/dL (CDC, CSTE 2021). Because chronic adverse health effects can occur even at modestly elevated BLLs, clinicians should monitor patients until BLL is below 3.5 µg/dL.

Blood Lead Level	Action Needed	Timing of Recheck BLL	CLINICAL EVALUATION
3.5–9 µg/dL	Obtain history on lead exposure and minimize contact.	Every 3 months until < 3.5 µg/dL.	Obtain history on potential sources of lead exposure at work and home at all BLLs ≥ 3.5 µg/dL. Minimize lead exposure. Use a venous blood lead sample for diagnosis and monitoring. Testing of hair, urine, or capillary blood and provocation testing are not recommended.
10–19 µg/dL	Check baseline labs if none in past 12 months.	Every 2 months until < 10 µg/dL.	Obtain laboratory tests (CBC, BUN/Cr, and urinalysis) 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 adults with elevated BLL.
20–29 µg/dL	Conduct physical exam and labs if not done in past 12 months.	Monthly until < 10 µg/dL.	IF OCCUPATIONAL EXPOSURE Remove from work or reassign to job duties that do not involve lead if the last two monthly BLLs are ≥ 20 µg/dL or if the average of all BLLs in the last 6 months is ≥ 20 µg/dL.
30+ µg/dL	Conduct physical exam and labs within 2 weeks of BLL result.	Monthly until < 10 µg/dL.	Remove from work or reassign to job duties that do not involve lead if one BLL is ≥ 30 µg/dL.
80+ µg/dL	Prompt physical exam, labs, and consultation with an occupational medicine specialist or toxicologist.		

In pregnancy, BLL should be as low as possible to protect the fetus. Identify and stop lead exposure, remove from work at BLL ≥ 3.5 µg/dL, and repeat BLL at least every 4 weeks until < 3.5 µg/dL. Refer to the [American College of Obstetricians and Gynecologists guidelines](#) and [CDC guidelines on lead in pregnancy and lactation](#) for additional recommendations.

Treatment: Source identification and removal from lead exposure is the primary treatment of both symptomatic and asymptomatic BLL elevation. Chelation is reserved for patients with severe symptoms of toxicity, which typically occur at BLL > 80 µg/dL, or in any patient with an extremely high BLL (e.g. > 100 µg/dL). You may wish to consult with a specialist in toxicology, emergency medicine, or hematology for highly symptomatic patients and those requiring chelation.

Occupational exposure: Refer to medical requirements in Cal/OSHA lead standards §1532.1 for construction and §5198 for general industry. Workers removed from work due to lead poisoning may return after two BLLs checked at least 30 days apart are < 15µg/dL. Cal/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.

For work-related lead toxicity requiring medical care beyond routine medical surveillance: Submit a Doctor's First Report to the employer's Workers' Compensation insurer within 5 days of evaluation.

FOR MORE INFORMATION

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 call (510) 620-5757 and allow at least ten (10) working days to coordinate alternate format services.

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



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AT THE BEGINNING

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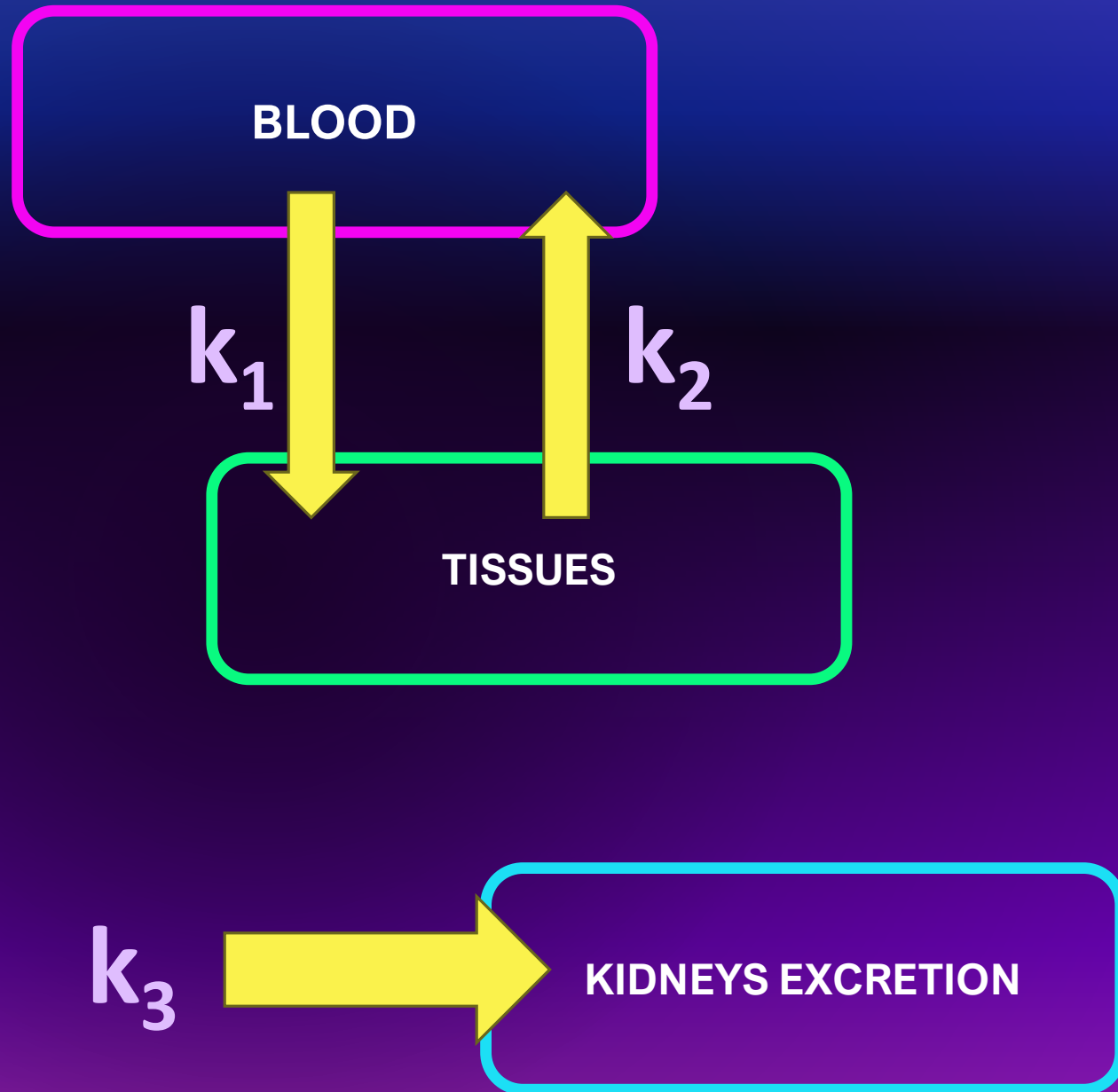
2013: CAL-EPA OEHHA

- Used physiologically-based pharmacokinetic (PBPK) modeling to predict the relationship between airborne lead concentrations and worker BLLs

WHY MODELING IS AN IMPORTANT TOOL

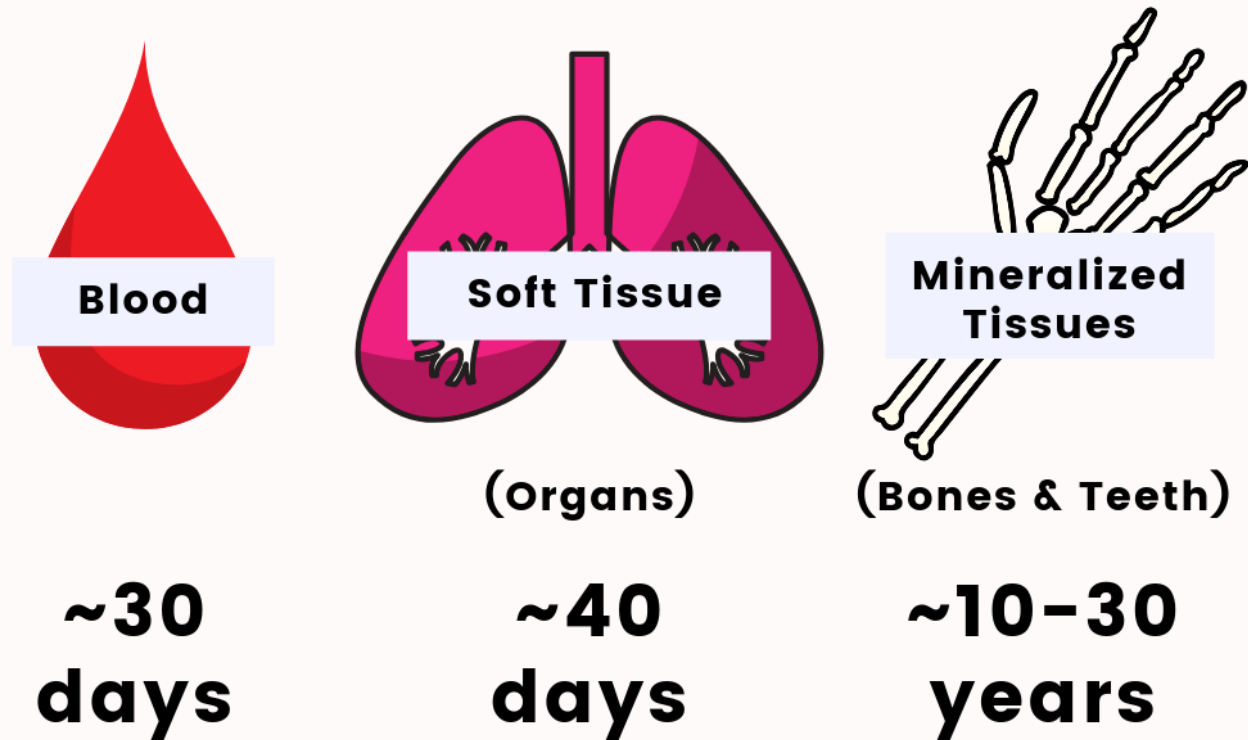
- Difficult to carry out lab/field studies measuring air and blood lead levels over a 40-year working lifetime
- Models must predict complex absorption, distribution, metabolism, and excretion over decades

Example of a
simplified
mathematical
model



Biological fate

The Half-Life of Lead Varies:



Distribution of lead

Lead interferes with the body's production of hemoglobin, causing anemia

Lead delays mental development, lowers IQ, and can cause depression

95% long bones

4% soft tissues (brain, liver, kidneys)

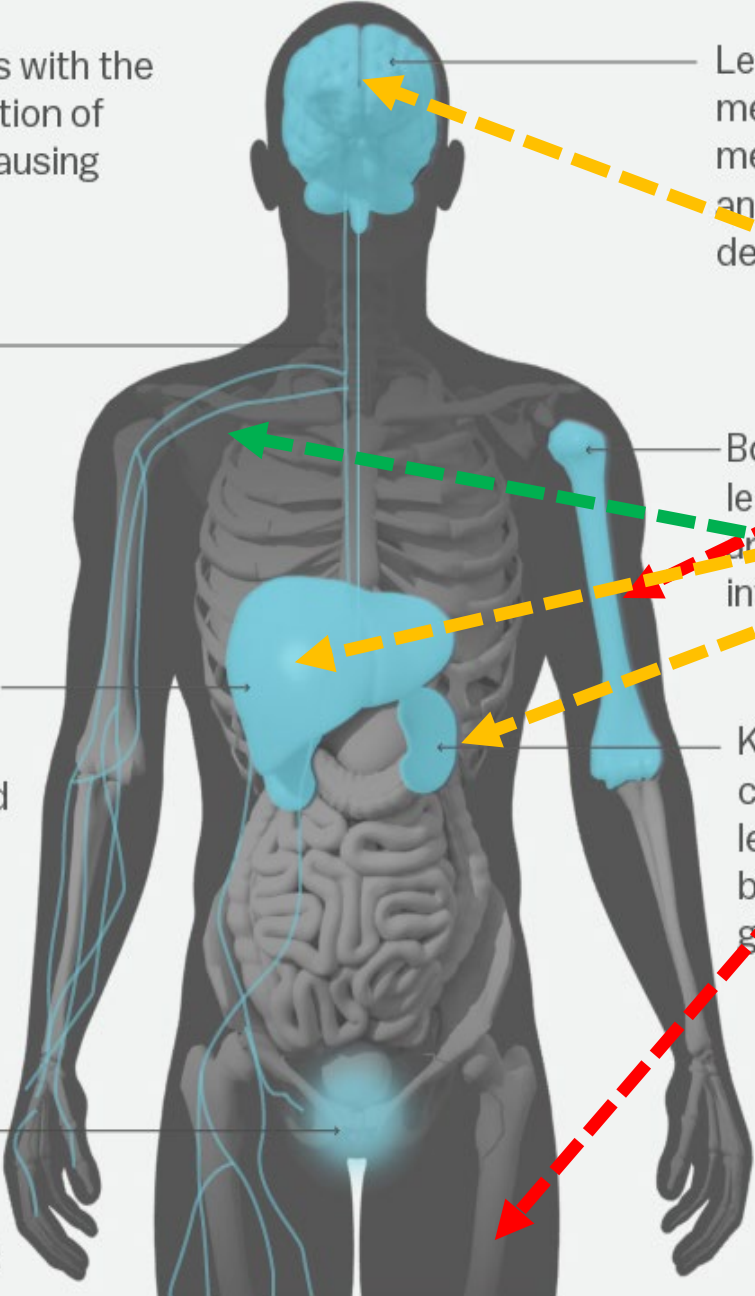
1% blood

Lead inhibits the liver's ability to produce proteins

Bones store lead for years and release it into the blood

In women, lead can cause menstrual disorders and miscarriage; in men, it can cause impotence

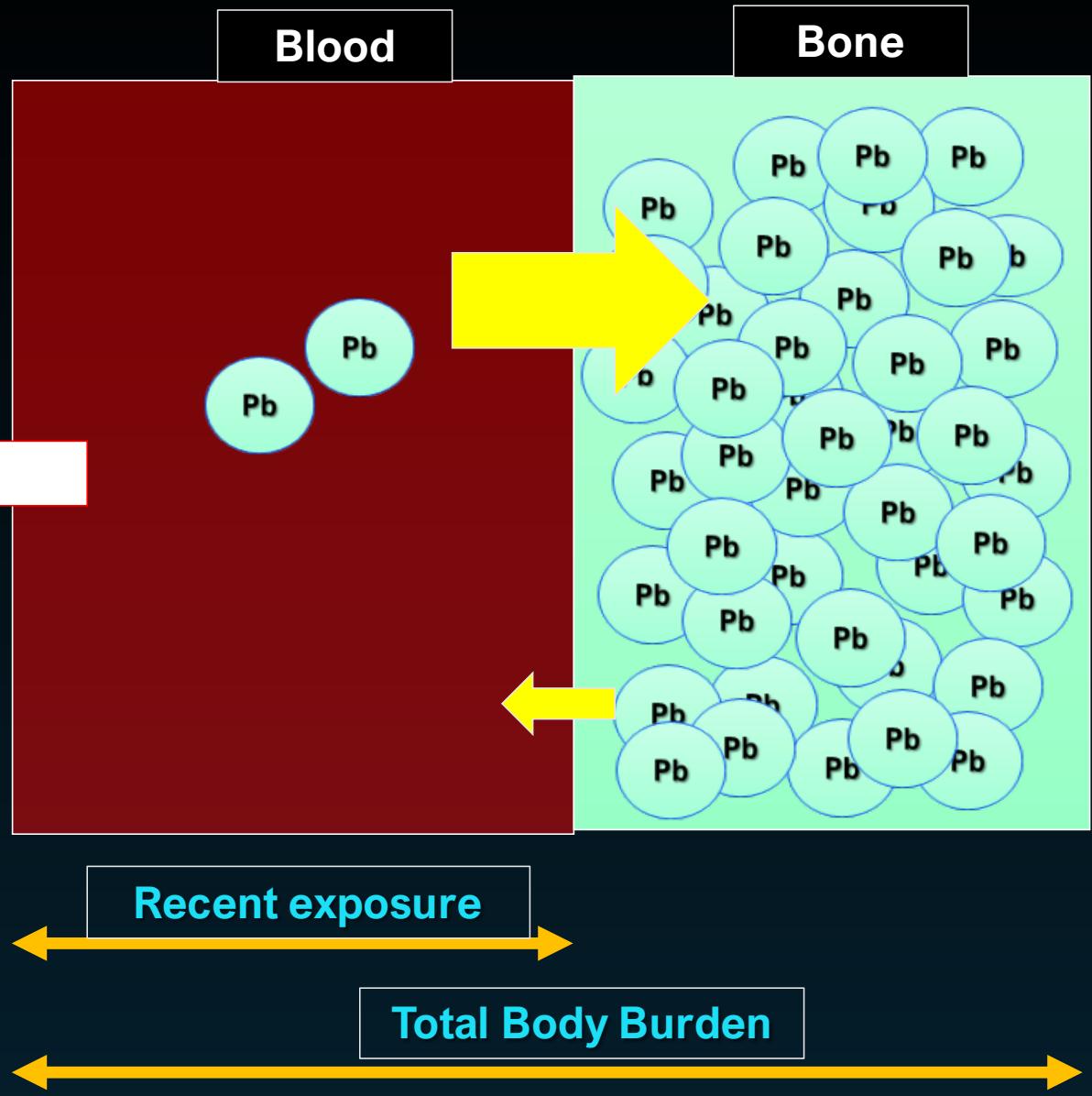
Kidneys can't filter lead from blood and get damaged



SOURCE: CDC



Blood sample = recent exposure. Not necessarily correlated with total body burden of lead (cumulative exposures)



Bernard Model

Biokinetic foundation for 1978
Federal OSHA lead standards



1977



BERNARD MODEL (1977)

- First quantitative biokinetic framework used by Federal OSHA to translate air exposure limits into predicted biological dose levels
- *Approach*: Determine target BLLs associated with adverse effects, followed by pharmacokinetic modeling to correlate those BLLs with airborne concentrations
- Established a methodology that influenced subsequent occupational lead standards

Bernard Model - Limitations

- Outdated health effects knowledge – 40-yr-old medical & scientific studies
- Limited population representation
- Simple compartmental structure
- Lack of age specificity
- Linear kinetics assumptions

PEL

Before

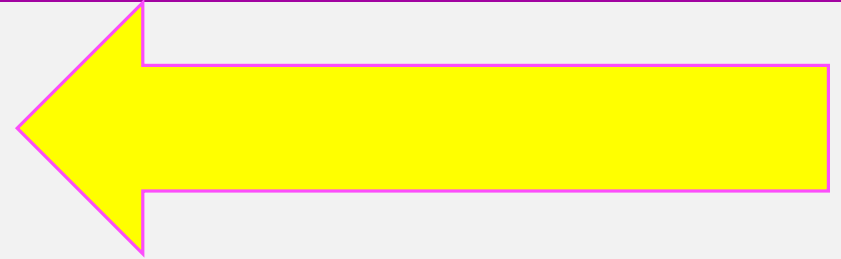
1978?

YEAR	STANDARD	VALUE (ug/m3)	SCIENTIFIC JUSTIFICATION
1946	ACGIH TLV	150	IH judgment, no dose-response
1968	ACGIH TLV	200	Consensus, experience, no specific studies
1969	ANSI Z37.11	200	Administrative, no explicit scientific basis
1971	OSHA Interim PEL	200	Directly adopted from ANSI/ACGIH
1978	OSHA PEL	50	Based on kinetic models, epidemiological studies

Leggett Plus Model (CDPH)

Biokinetic model for revised
Cal/OSHA lead standards

2013 - 2023



LEGGETT+ MODEL

1. Made adjustments to the original 1993 Leggett Model
2. Predicted workplace air-blood lead relationships: Estimate airborne lead concentrations that would result in specific BLLs after 40 years of occupational exposure
3. Modeled blood lead decline: Predicted time required for elevated BLLs to return to 15 $\mu\text{g}/\text{dL}$ after cessation of occupational exposure
4. Population variability: Calculate BLLs at the 90th and 95th percentiles of the worker population using epidemiologic data

LEGGETT+ VS BERNARD

1. Compartmental Complexity

Bernard: 5 simple compartments (blood, bone, liver, kidney, soft tissue)

Leggett+: > 20 compartments with separate plasma/RBC compartments, cortical/trabecular bone, and multiple soft tissue types with different perfusion rates

2. Kinetics

Bernard: Linear first-order kinetics throughout all compartments and blood lead concentrations

Leggett+: Nonlinear kinetics to account for red blood cell saturation at higher BLLs

LEGGETT+ VS BERNARD

3. Workplace-Specific Exposure Parameters

Bernard: None

Leggett+: Breathing to account for 10 hours moderate activity, 6 hours light activity, 8 hours rest

Inhalation transfer coefficient derived from particle size distribution data and respiratory tract deposition modeling for industrial settings

Background ambient air and dietary lead exposure

4. Data Validation

Bernard: Animals

Leggett+: Chronically exposed workers (smelter workers) and general population

LEGGETT+ MODEL PREFERRED

- Accurately predicts BLLs at the low levels now recognized as harmful (<10 µg/dL)
- Adjusted to account for working lifetime exposure scenario
- Accounts for physiological realities like RBC saturation and bone compartmentalization
- Incorporates modern understanding of particle deposition and respiratory uptake

Bernard model served its purpose for the 1970s era when BLLs of 40-60 µg/dL were considered acceptable, but it does not address the current regulatory goal of maintaining worker BLLs below 10 µg/dL

BLL DASHBOARD

CALIFORNIA OCCUPATIONAL LEAD EXPOSURE SURVEILLANCE DASHBOARD

Workers with BLLs ≥ 10 $\mu\text{g/dL}$, by Demographic Characteristics, 2019-2024

	2019		2020		2021		2022		2023		2024	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Total	1,034	-	693	-	793	-	851	-	792	-	798	-
Sex												
Male	999	(97)	672	(97)	766	(97)	829	(97)	763	(96)	763	(96)
Female	35	(3)	21	(3)	27	(3)	22	(3)	29	(4)	35	(4)
Age (years)												
16-24	80	(8)	51	(7)	48	(6)	64	(8)	65	(8)	63	(8)
25-54	662	(64)	429	(62)	517	(65)	552	(65)	497	(63)	507	(64)
55-64	203	(20)	156	(23)	169	(21)	162	(19)	166	(21)	173	(22)
65-80	89	(9)	57	(8)	59	(7)	69	(8)	64	(8)	55	(7)
Hispanic surname												
Yes	604	(58)	419	(60)	510	(65)	556	(65)	508	(64)	525	(66)
No	431	(42)	274	(40)	283	(35)	295	(35)	284	(34)	273	(34)

Jacqueline Chan

Jacqueline.Chan@cdph.ca.gov

Website: [Home Page](#)

Phone: 279-667-0353

The screenshot shows the CDPH website for the Occupational Lead Poisoning Prevention Program. At the top, there is a navigation bar with the CDPH logo and links for 'on Español', 'Contact Us', 'About', 'News & Media', 'Jobs/Careers', 'Select Language', and 'Text Resize'. Below the navigation bar is a search bar and a menu with options: 'I am looking for', 'I am a', 'Programs', and 'A-Z Index'. The main heading is 'OCCUPATIONAL LEAD POISONING PREVENTION PROGRAM'. On the left, there is a sidebar menu with links: 'OLPPP Home', 'About OLPPP', 'For Employers', 'Contact OLPPP', and 'Occupational Health Branch (OHB)'. The main content area features a large image of a worker in a white protective suit and respirator using a tool on a wall. Below the image is the title 'Protecting workers from exposure to lead and the illnesses that can follow'. The text describes the program's goals: tracking worker blood lead levels, investigating work-related lead poisoning cases, and providing education and technical assistance. A note mentions the CDPH Childhood Lead Poisoning Prevention Branch (CLPPB) website. A blue box highlights 'Cal/OSHA Lead Standards — Updated', stating that revised standards for construction and general industry go into effect on January 1, 2025. Below this are several smaller images with labels: 'Workers' (a worker in a hard hat), 'Employers' (a man in a suit), 'Health Professionals' (a person in a lab coat), 'Regulations' (the California State Capitol building), 'Data' (a bar chart), 'Lead Fee' (the California State Seal), 'Laboratories' (test tubes and pipettes), and 'Warning Signs' (a 'DANGER LEAD WORK AREA' sign).



The screenshot shows the top of a webpage from the State of California Department of Industrial Relations (DIR). The logo includes "EST. 1927". Navigation links include "Labor Law", "Cal/OSHA - Safety & Health", "Workers' Comp", "Self Insurance", and "Apprenticeship". The page title is "Cal/OSHA Occupational Lead Exposure Prevention Guidance and Resources".

Cal/OSHA Occupational Lead Exposure Prevention Guidance and Resources


⚠️ On February 15, 2024, The Occupational Safety and Health Standards Board approved updates to Cal/OSHA's Lead Standards (California Code of Regulations (CCR), Title 8 (T8), Sections **1532.1** (for the Construction Industry) and **5198** (for General Industry)).

The updated T8 CCR 1532.1 and T8 CCR 5198 regulations became effective on January 1, 2025.


Employers should review their existing procedures, programs and the guidance resources provided below, to ensure that workers are protected.

This webpage only provides an overview — not all the requirements — of T8 CCR sections 1532.1, 5155, and 5198. The information provided is not meant to be a substitute for, nor a legal interpretation of, the regulations. Readers are cautioned to refer directly to sections 1532.1 and 5198 for detailed information regarding the regulation's scope, specifications, exceptions, and other requirements that may be applicable to their operations.

Occupational Lead Exposure Prevention for General Industry




Educational Materials and Other Resources - *New*
Fact sheets and fillable written safety plans.




Lead Exposure Assessment, Medical Surveillance & Reporting to Employees - *New*
Information on lead exposure assessment and reporting medical surveillance information to employees.


Occupational Lead Exposure Prevention for the Construction Industry




Cal/OSHA Occupational Lead Exposure Prevention in the Construction Industry - *New*
Information and materials related to the Cal/OSHA Lead in Construction standard.



Lead Work Notification - *New*
Information on lead work notification.



Lead Exposure Assessment, Medical Surveillance & Reporting to Employees - *New*
Information on lead exposure assessment and reporting medical surveillance information to employees.



Educational Materials and Other Resources - *New*
Fact sheets, videos and fillable written safety plans.



IN SUMMARY

- Current scientific consensus demonstrates adverse health effects at low BLLS ($< 10 \mu\text{g}/\text{m}^3$), necessitating stricter exposure limits
- New biokinetic models offer a more precise and comprehensive understanding of lead's effects than models in the 1970s

THANK YOU!

Cal/OSHA

Susan Eckhardt

Cal-EPA OEHHA Dr. Kathleen Vork

OHB

Dr. Kristin Cummings

Dr. Alya Khan

OLPPP Team (former & current)

THANK YOU FOR YOUR ATTENTION!

SEEKING: IH or SAFETY ENGINEER!!

WHY WORK FOR CDPH?



Emotional Support Resources

○ PARTING VIDEO MESSAGE

(LEAD: LAST WEEK TONIGHT WITH JOHN OLIVER (HBO))